Galileo

D1.1 Context analysis and co-creation methodology

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Executive Summary

This report is a deliverable of GALILEO Task 1.1: Context definition and context-based methodology development to co-create promising management innovations of AFSPs (M1–M8), led by CIRAD, with support of all in-country partners. T1.1 sheds light on the social and institutional context of GALILEO project's focal zones and develops the multi-actor co-creation methodology. Deliverable D1.1 establishes the contextual baseline and a shared co-creation pathway for eight Living Labs (LLs) across Senegal (2), Kenya (1), Ghana (3) and Cameroon (2), providing a harmonised evidence base and practical procedures to initiate multi-actor design of agro-(silvo-)pastoral innovations. The tables in the section 3.1 offer condensed information about the LLs.

The document synthesises country contributions developed under a common yet flexible methodology and sets out how each team assembled and analysed data to build a comparable foundation for subsequent tasks in WP1 and beyond. It is explicitly presented as a synthesis of the data collected and analysed in each LL and supporting materials produced through coordinated fieldwork and analysis, with methodological sensitisation sessions conducted to ensure consistent application in all sites.The overall description (title, size, coauthors) of the 4 countries (8 LLs) documents is available in ANNEX 8 and the original files (anonymized) are shared in Zenodo. The overall approach described in T1.1 articulated a sequence of "five-step" process that combines secondary and primary sources in iterative cycles of collection and interpretation. After an initial organisation of roles and the desk review (about 500 documents screened), teams conducted key informant interviews (155 KII), launched internal data collection, and prepared the data analysis to inform two cornerstone activities: the baseline survey (under WP5) and the LL inception workshop. These, in turn, feed a second round of analysis that straddles several tasks of the GALILEO project (T1.2, T1.3, T2.1, T5.1).

A comparative analysis of the eight LLs reveals clear ecological and institutional contrasts that shape co-creation priorities. Three broad clusters emerge: Sahelian crop–livestock and rangeland systems in Senegal (Niakhar, Ouarkhokh); humid and semi-deciduous cocoa landscapes in Cameroon and Ghana (Loum-Tombel, Ntui-Bokito, Aponoapono–Suhum, New Edubiase, Joabeso–Goaso); and mid-altitude smallholder mosaics in Kenya (Embu). Across these contexts, recurrent challenges include rainfall variability, soil-fertility decline, and market-coordination gaps, while convergent opportunities centre on tree-based regulation of microclimates, improvement of soil functions, and farmer-led diversification. The synthesis points to differentiated lines of work within a shared co-creation framework: rangeland and water-governance options for Sahelian sites; tenure-sensitive agroforestry, shade management and varietal choices for cocoa landscapes; and erosion control, input–service bundling and market access in the Kenyan highlands. Taken together, the comparative lens justifies a portfolio approach that flexes common methods to local conditions and deliberately fosters cross-site learning around "robust" practices that travel well.

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List of acronyms

Accronym	Definition
AFD	French Development Agency
AFS	Agroforestry System
AIS	Agricultural Innovation Systems
ANCAR	Agricultural Council
ANIDA	National Agency for Agricultural Integration and Development
ANR	Assisted Natural Regeneration
AU	African Union
CFI	Cocoa & Forest Initiative
CIFOR-ICRAF	Centre for International Forestry Research and World Agroforestry
CIRAD	International Cooperation Centre of Agricultural Research for Development
CMR	Cameroon
CNDN	National Council for Nutrition Development
CRIG	Cocoa Research Institut of Ghana
DAF	Dynamic Agroforestry
EIGS	Economic interested Group
FAO	Food and Agriculture Organization of the United Nations
FBO	Farmer-based organisation
GA	Grant Agreement
GDA	Green Development Advocates
GGWI	Great Green Wall Initiative
GHA	Ghana
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
ICIPE	International Center for Insect Physiology
IGAs	Non Agricultural Income Generating Activities
IPs	Innovation Platforms
IRAD	Institute of Agricultural Research for Development
IRD	French Research Institute for Development
ISRA	National Agricultural Research Institutes
JICA	Japan International cooperation Agency
KARLO	Kenya Agriculture and Livestock Research Organization
KII	Key Informant Interview

KEFRI	Kenya Forestry Research Institute
KEN	Kenya
KKFU	Kuapa Kokoo Farmer Union
LDN	National Domain Law
LL	Living Lab
MAA	Multi-Actor Approach
MAA	Multi Actor Approaches
MINADER	Ministry of Agriculture and Rural Development
MINEPDED	Ministry of the Environment, Nature Protection and Sustainable Development
MINFOF	Ministry of Forestry and Wildlife
NGO	Non Governemental Organisation
NTFP	Non-Timber Forest Products
ONCC	National Cocoa & Coffee Board
PES	Payment for Environmental Services
PM	Progress Markers
RDUE	European Union Deforestation Regulation
SEN	Senegal
SSA	Sub-Saharan Africa
VSB	Village-Based Advisors

1. Introduction

1.1 Background and rationale for documenting the Living Labs

African food systems face a number of interconnected challenges, including food and nutritional security, climate change adaptation and mitigation, ecosystem degradation and biodiversity loss. These challenges are particularly acute in the semi-arid zones of sub-Saharan Africa, where agricultural productivity is lower than the global average, with increasingly long dry seasons and recurrent extreme weather events threatening the livelihoods of rural populations.
Faced with these challenges, agroforestry - the intentional integration of trees, crops and/or livestock on farms - represents a unique opportunity to support the productivity, resilience and sustainability of food systems. Agroforestry practices can help to adapt to and mitigate climate change, while preserving and enhancing biodiversity. However, to fully generate these benefits, agroforestry innovations adapted to specific local contexts, in terms of biophysics, socioeconomics and institutions, are needed.

The overall objective of GALILEO is to rely on genuine Multi-Actor Approaches (MAA) to co-develop context-specific, people-centered agroforestry innovations in representative agro-pastoral, agroforestry, and agro-silvo-pastoral systems from Sub-Saharan Africa (SSA). The aim is to promote agroforestry as leverage to significantly improve agricultural, household, and climate change adaptation and mitigation performances and to enhance biodiversity in SSA. We build upon 8 agroforestry Living Labs (LLs: local scale and actors), 4 national and 1 regional Innovation Platforms (IPs), set up across 4 AU SSA countries. Through MAA, the project will co-construct potentially adoptable scenarios ex-ante with various actors including Innovator, Target, and Control farmers in our LLs. The selected actors will then implement, assess, and compare performances in their pilot plots during the whole project. Using field observations to calibrate process models, the project will be able to simulate under future CC scenarios.

Thus, the project relies on transdisciplinary research, providing qualitative and quantitative data on the biophysical, socio-economic, and environmental performances.

Galileo WP1 *« 'Farm2Policies': Socio-institutional innovations to stimulate agroforestry »* is designed as a WP1 as a support service for co-creation in the Galileo project. WP1 set the scene to support this process of co-creation by identifying the key actors who will take part of the co-creation process, by collecting the key data to be shared among the various actors, by facilitating building of trust among the various actors by creating space for the co-creation process and setting a conducive or enabling institutional environment through the LL and innovation platforms at national and regional levels. The co-creation of ex-ante and ex-post scenarios is at the heart of the Galileo project. That's why WP1 is organised in a way of putting the co-creation process at the middle and embedding this process through different tasks and products. The tasks include the contextual analysis (ecological, historical, social, economical and institutional), the setting up of the multistakeholder partnerships, and the monitoring of the co-creation process to facilitate learning among the actors involved. The main products are the diagnosis that will be updated along the project, the established networks and facilities (LL and innovation platforms); and the co-creation process real time monitoring system. Figure 1 provides a visual organisation of tasks in WP1.

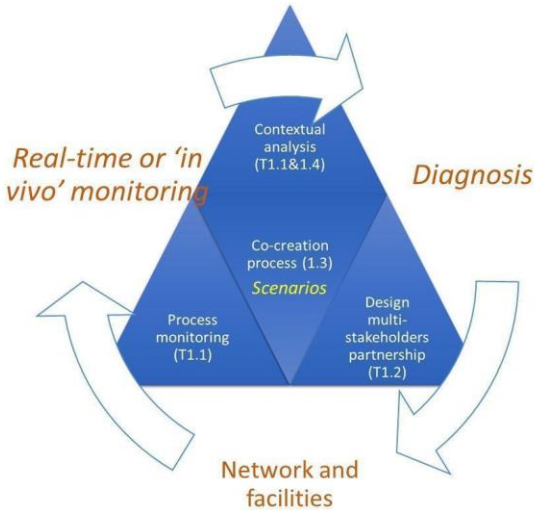

Figure 1. Interconnections of tasks in WP1

Deliverable 1.1 'Context analysis and co-creation' methodology is developed as part of the WP 1. It aims at describing the context in each living-lab in order, including preliminary findings on instituional context (T1.4), to facilitate the setting-up of the eight living labs (T1.2) and facilitate the co-creation process of promising innovations for AFSP (T1.3).

The main objective of deliverable 1.1 is to:

- Define the context of each living lab so that all actors that will be included in the future process of co-creation start with the same understanding of the context
- Prepare the ground for T1.4, which will focus on the innovation ecosystem and propose policy and institutional solutions
- Develop the methodology for the co creation process in Galileo project (T1.3)

One of the main objective of Galileo is to engage multi-actors at different levels (local, national and regional) to co-create and implement sustainable agroforestry management solutions for AFSPs resilient : ''We build on participatory approaches and interdisciplinary research, blending biophysical and socio-cultural research with local knowledge, covering all social dimensions of agroforestry (equity, justice, policy mechanisms, social networks), to co-create people-centered, context-specific agroforestry management innovations for increased long-term adoption''.

The multi-actors approach (MAA) has been chosen to develop more on-demand research. The approach suggested is based on an Action-Research approach to support context-based innovations and produce more transformation and impact in agriculture and agrifood systems : ''*Dynamic multi-actor partnerships in the form of LLs and IPs are gaining increased recognition and implementation in Africa as effective means for steering research and experimentation in real life settings and as socio-cultural catalysts for transformations of local food systems*''. The on-demand research produced will nevertheless focus on certain entry points : « *Our key entry points will be improved crop productivity and fodder provision, improved soil properties and water functions, enhanced biodiversity, new value chains, income diversification through secondary products, increased access to market through certification, additional income through payment for ecosystem services and carbon farming, with a focus on extending productivity during the dry season and facing erratic climatic droughts* ».

Participatory research is the new paradigm for conducting research and Innovation projects as Galileo. It gives a central space for human relations and interactions. It implies a set of soft rules to condition a successful participatory process. For example, importance of time given to building trust

among the actors or importance of processes and not to focus only on results. This condition applies even in the consortium partnership.

1.2 Some key definitions of mobilised concepts

Agroforestry systems can be defined as a resource management system, controlled by the local population, where trees are associated with agricultural or livestock activity on the same plot so that the resulting ecosystem resembles that of a natural forest in terms of species richness, plant structure and above-ground and root biomass. Agroforests are thus generally characterized by a dominant stand, the main source of income or use (rubber, coffee, cocoa, etc.), while being made up of many other components (trees, lianas, shrubs), both in species and frequency, organized in several strata (Jagoret, 2011).

Alternatively, agroforestry is defined as a natural resource management system that, through the integration of trees on farms, diversifies and sustains production, and increases the resilience of rural landscapes and livelihoods.

The definitions of agroforestry used by the GALILEO project are:

- **Agroforestry systems (AFS**) include both traditional and modern land-use systems where trees are managed together with crops and/or animal production systems in agricultural settings.
- **Silvo-pastoral systems (SPS)** combine trees and shrubs with forage grasses, boost animal nutrition, and produce co-benefits such as improved soil productivity and increased accumulation of C (Murgueitio et al., 2011).
- **Agro-pastoral, agroforestry and silvo-pastoral systems (AFSP)** is the term used whenever we need to mention both types of systems

Living Lab (LL): A participatory, real-world environment where stakeholders—farmers, researchers, policymakers, private sector actors—collaborate to co-design, test, and evaluate sustainable innovations. For Galileo project, the **Living Lab** is a local agora where the local actors meet to debate and make decisions around the questions of agriculture, forestry, livestock, etc. The Living Lab is at the same time a methodology and a socio-ecological reality, in which citizens, residents and users (including external researchers) are seen as key players in the research and innovation process.

Mobilising LL, the project adopts the widely recognised **Agricultural Innovation Systems (AIS)** concept, seen *as « network of actors, organizations or individuals together with supporting institutions and policies in the agricultural and related sectors that bring existing or new products, processes, and forms of organization into social and economic use, including policies and institutions (formal and informal) which shape the way these actors interact, generate, share and use knowledge as well as jointly learn" (World Bank 2006, Klerkx et al. 2010)*. Thus, innovation is taken not only as a result of adoption of a new technique or technology but also and above all as **a social process** In Galileo project, we will give a wide attention to the **innovation process**. Several innovation process models exist in the literature. One of the most known is the « diffusion curve » of Roger, 2003. This curve is widely used but has also shortcomings concerning its norming and linear character and implicit value judgements (Hoffmann et al, 2008). New models have been developed with more details in the innovation phases (Wielinga et al., 2016) and with more emphasis on the feedbacks loops during the process. There are several representations of the innovation process through the **spiral** or the **timeline tools**. Both help to understand the previous trend of the innovation process and give insights to better adapt the research intervention in order to not starting from scratch in a certain context. Context in which we are working are historic, understand the innovation context in which we are working is a key step in a research and innovation project. We can identify a diversity of technical, technological, economic, social, organisational and institutional innovations. In Galileo we are interested in those different types of innovation because one type of innovation can't appear without other type of change. Leeuwis and Aarts (2011) define those successful technical innovations with

three innovative dimensions : '**Hardware'** (i.e. new technical devices and practices), **'software'** (i.e. new knowledge and modes of thinking) and **'orgware'** (i.e. new social institutions and forms of organisation). Co-creation helps to integrate these different dimensions in the scenarios.

Galileo pays a particular attention to endogenous innovations which are locally developed practices, techniques, or organizational forms created by farmers or community actors using indigenous knowledge and available resources to address agricultural or environmental challenges. These innovations are context-specific and often evolve from traditional knowledge. Endogenous innovation processes can occur thanks to individual or group of **positive deviants : «** *Positive deviants challenge existing organisational structures and institutional set-ups, and promote alternative approaches to solving seemingly intractable social problems, either playing direct role of a boundary spanner or indirect role as activists »* (Pant and Hambly Odame 2009). The innovation tracking will help to identify the positive deviants and the endogeneous innovations that they are developing. What is interesting in that innovation tracking is also to be able to identify farmers who show **capacity to innovate** (Allebone-Webb et al. 2016) and mobilise them in experimentation, testing and dissemination.

By mobilising MAA and innovation process approaches in the Galileo project, researchers are engaged in changing their paradigm of work adding two main dimensions. Firstly, research should move from a technology transfer approach to a more open innovation approach. Secondly, beyond the production of knowledge, research can play a diversity of roles within this innovation process (Toillier et al. 2018) such as innovation tracking, realisation of innovation pilots in real conditions, facilitation of co-creation process, initiate policy dialogue at local and national level for innovation uptake and scaling. Participatory approaches require paying more attention to the power relations between the stakeholders. In fact, the innovation process doesn't take place in an vacuum or asceptic environment. It is embedded in the social environment of the stakeholders which means that the stakeholders come with their different hats, but also with their usual social relationship. For example, if a chief is part of the process we will have to facilitate the discussion by setting specific rules in the group so that the others can contribute without thinking they are disrespecting the chief. That's why research can endorse the role of facilitator or identify a facilitator to support the whole process. Facilitation includes various activities that ease collaborations in co-creation processes such as knowledge sharing, creating connections, managing resources (including time), motivating stakeholders, managing tensions and conflicts. An innovation facilitator can also act as a broker (Klerkx and Gildemacher 2012) which means he will help to translate various stakeholders' languages into understandable language. For example he can explain knowledge brought by researchers about water dynamics and recharge of the aquifer in a way that makes sense for farmers.

« Alone we go faster, together we go further »

Although it improves the probability of buy-in and uptake, the involvement of all those actors in the innovation process and increases the **duration of the innovation process**. A clear balance should be found between « quality » of the innovation process and the speed of first results. In the duration of innovation process, Galileo staff should not neglect building trust and deconstruct what the farmers think we expect from them (the legacy of the popularization/awareness-raising messages that may have been sent out in the area, not always in line with reality). This data collection and analysis period have been the first interactions (in some cases) with the actors of the Living-labs (LLs). It is important to take time to interact with these actors including the local authorities and other institutions and organisations which have conducted activities in this area. These first interactions with the actors of the LL set the basis for the co-creation process in T1.3.

Co-creation is a collaborative process where multiple parties, often including businesses and customers, actively participate in the creation of value. It's a form of open innovation (where external stakeholders are brought into the innovation process. This can involve the development of new products, services, or even business models. Co-creation differs from traditional models where

innovation happens solely within an organisation. In co-creation, participants interact, share ideas and contribute with their expertise (scientific or not), leveraging diverse perspectives to achieve a shared goal. van Ewijk and Ros-Tonen (2021) demonstrate '*that knowledge co-creation play a central role in reducing the time lag between research findings and their translation into practical outcomes*'.

Task 1.1 aims at providing an overview of the context in the Living-labs (LLs). The objective is not to develop an in-depth contextual characterization and description. The amount of information available in the LL are not homogeneous. It depends on the level of research and development interventions, the degree of isolation of the area and the existence of statistical secondary data from public services. The approach used is described in the T1.1_Methodological guide : Guidelines for applying methodology and tools for characterizing the context of the Living Labs, which has been adapted in each country.

These activities enabled a comprehensive assessment of local knowledge, current agroforestry practices, community needs, adaptive capacities, and perceptions of trade-offs between ecosystem services. The research also mapped key stakeholders, innovation support systems, and policy mechanisms influencing AFSP management.

1.3 Methodological updates compared to the Grant Agreement to better endorse the co-creation dimension

In the implementation of T1.1, we have to mentioned a slide from the grant agreement about the number of focus group and the milestone 3 (Co-selection of species, breeds, farm types).

A) **The 25 interviews per LL has not been achieved:** The GA mentions 200 KII. We have conducted 155 KII within T1.1. Although the objective has not been reached; the scientific integrity of the data collected is not compromised
B) **The 1 focus groups per LL has not been:** The GA mentions 8 focus groups (1 per LL). In task 1.1 16 focus groups has been conducted in Embu (6) and Loum-Tombel LL (10). Methodologically wise, focus groups have been turned as optional, as inception workshops (Annex 2) (currently foreseen in T1.3) would be overlapping.
C) **The Milestone 3 has not been reached :** The GA mentions the milestone 3 on co-selection of species, breeds, farm types. T1.1 has identified the preferred species, breeds and farm types for each LL. The co-selection of the adequate species, breeds and farm types will definitely come within the co-creation process (T1.3).

These updates are due to methodological adjustments of the to the context constraints and also to better address the co-creation requirements. Meaning the need for more time dedicated to interactions and iterations within the LL (T1.3). The resources saved will be allocated to the inception workshops

1.4 About deliverable 1.1

This document is a synthesis of contextual data on each LL from the following four countries: Cameroon (2), Ghana (3), Kenya (1) and Senegal (2). The overall description (title, size, coauthors) of the 4 countries (8 LLs) documents is available in ANNEX 7 and the original files (anonymized) will

be shared in Zenodo. Each country team was intensively involved in the data collection and analysis activities. The country teams follow a harmonised but flexible methodology designed to facilitate fieldwork. This guide was available in English and French for the country teams. Two sensitisation sessions on the use of the methodology guide were organised by the task leader on 25 March 2025: one in English in the morning and one in French in the afternoon. The task leader also participates in country team meetings to support the implementation of activities. As mentioned in the Deviation section, the T1.1 Methodological Guide is integrative and includes a desk review and Key Informant Interviews (KIIs) in the first round, and an Inception Workshop and Baseline Survey in the second round. All these activities contribute to the development of an iterative diagnosis of the LL.

2. Overview of the methodological approach

Task 1.1 establishes a shared methodological framework to analyse the social, institutional, and ecological contexts of the GALILEO Living Labs (LLs) and to design co-creation processes for the development of promising management innovations in agroforestry and silvopastoral systems (AFSPs). This approach ensures that interventions are scientifically sound, context-sensitive, and co-owned by local stakeholders. The methodology is underpinned by the following principles: 1) Co-construction : Active involvement of stakeholders from the outset to foster ownership and relevance, 2) Multi-actor engagement: Integration of perspectives from farmers, researchers, policymakers, private sector actors, and civil society organisations ; 3) Interdisciplinarity: Combination of ecological, socio-economic, and institutional dimensions in the analysis ; 4) Context sensitivity: Adaptation of the approach to the specific agroecological and socio-institutional settings of each LL and 5) Comparability: Harmonised outputs across all LLs to facilitate cross-site learning and synthesis at the project level. The main output expected is a comprehensive LL context analysis integrating ecological, socio-economic, and institutional dimensions including stakeholder maps and tailored to each LL, and harmonised datasets facilitating cross-LL comparative analysis in subsequent project phases. The contextual analysis is a subset of the overall LL diagnostic, which will be updated as activities are implemented throughout the project.

2.1 Information collected

Task 1.1 provides an overview of the Living Labs (LLs) context. The objective was not to provide an in-depth characterisation and description of the context. The amount of information available in the LLs was not homogeneous. This depended on the level of research and development interventions, the degree of isolation of the area, and the existence of secondary statistical data from public services..

Different types of data will be collected:

1. The **Contextual data** refers to data that will help to establish the situational analysis. It includes (non in-depth) monographical data, the challenge and the opportunities in the area and the delimitation of the geographical area of intervention and action.
2. The **potential for innovation** includes the data on the new ideas to overcome existing or forthcoming challenges from the communities and from the researchers' perspectives. This list doesn't mean that we will work on all the existing ideas or one idea in particular. The co-creation process can bring some hybrid ideas.

3. The **mapping of actors and projects** in the LL gives an overview of all the actors in the area and an idea on with whom we should be partnering. The list of actors includes hybrid organisations as on going orprevious projects.

The table below summarises the type of data to be collected at the level of the LLs to have a clear understanding and characterisation of the area.

Table 1. Diversity of data to be collected in the LLs

Type of data	Dimension	Detail description
Contextual data	Monographical description of the area	1. Ecological data (Meteorological and Climatic data and past shocks and events for the last 10 years, soil type, vegetation type, Biodiversity hotspots and conservation activities) 2. Agricultural system (Project in the last 5 to 10 years, Agricultural dynamics, Typology of agroforestry system, prefered trees, Farming system, cropping system, animal) 3. Socio-economic data (Population density, poverty level, market access, main source of income/ opportunity cost of non-agricultural activities, firms, villages..) 4. Historical data (important past events in the LL, highlights) 5. Institutional data (Farmer organisation, Infrastructure, important regulations that can affect our work) 6. Data on legal and policy framework in Cameroon
	Challenges and opportunities for the agroforestry system	Identification of the main challenges related to agroforestrycropping and animal husbandary systems like climate variability and current or upcoming opportunities
	Delimitation of the action/field sites	Identification of actions sites (replication area) and the field sites (activities will take place) (incl. GPS coordinates)
Potential for innovation	Existing endogenous innovations	1. List of endogeneous innovations 2. Strengths of the innovation to overcome challenges in the LL including the dry season and climatic variability effects on crops, animals, trees and humans 3. Description of the innovation, geolocalisation and identification of farmers
	Knowledge/ideas/institutions of farmers on how to leverage some challenges observed in the LL	List of issues which farmers would love to discuss with the researchers

	Knowledge/ideas/intuitions of researchers on how to leverage some challenges observed in the LL	1. List of knowledge/ideas/ intuitions that researchers want to include in the discussion during the co-creation process
Mapping of actors and projects	Permanent actors in the area and functions[1]	1. Identification per type of actors (farmer organisation, public actors, extension agents, local authorities, supply providers, ..) 2. Identify main functions of actors (access to resources, Knowledge sharing, marketing, technical support, Institutional support) *Starting check out for innovator actors, target actors and Relay actors (WP2)*
	Project interventions in the last 5 years	1. Identify previous projects in the LL 2. Identify the legacy of the projects on which we can build on in Galileo
	Links among the identified actors	1. Map the actors and their interactions

The different types of data came from various primary and secondary sources (see Table 2 below for an extensive definition). In Galileo, primary data are defined as data collected directly by project members through surveys, interviews and observations. Secondary data are those generated by actors outside the Galileo project. This includes reports and databases.

2.2 Data collection and analysis

2.2.1 Main steps of the methodology

The methodology is based on a 1+ 4 steps including 1) data collection and data analysis, 2) desk review and field work, and 3) collection of primary and secondary data.

1. Step 0. Who is doing what for T1.1.
2. Step 1. Desk review. It mobilises secondary data. The source of data can come from previous project reports or deliverables, local and national statistical reports, and recent surveys in the areas.
3. Step 2. Key informant interviews. This is primary data collection. The key informant uses the expertise of the area and their knowledge to complete the information gathered from the desk review. Key informants can also provide additional documentation[2].
4. Step 3. Data analysis. This step aimed at compiling and organising the data collected. Secondly to contribute to the
5. Step 4. Writing of the LL report using the outilines provided in the methodological guidelines (see Annex 1)
6. Step 5. Compilation of the reports and cross-analysis of the LL characteristics

[1] In the case of Cameroon we talk of the actors in the cocoa value chain but also actors that work on agroforestry system, biodiversity conservation (agroecosystem services, climate change)

[2] In the case of Cameroon, primary data was collected in the two LL (Loum-Tombel and Ntui-Bokito). The number of actors (sample) chosen was based on expert knowledge, kind of information required, accessibility of actors, financial means, time, etc. Before the questionnaire is drawn, consider the context of the study (type of data needed).

Internal data collection has also been organised to identify the data that Galileo partners hold on the living labs, as well as the knowledge, ideas and intuitions of researchers on how to overcome some of the challenges observed in the LL.

The figure below summarises the 5 key methodological steps within T1.1.

Figure 2. A five-steps methodological approach to develop the deliverable 1.1

2.2.2 Data collection approaches and tools

Two types of data were collected, primary and secondary data, and mobilised different data collection approaches. The data collected in table 2 comes from various sources. It allowed triangulation[3] of data coming from different sources.

Table 2. Mobilised data collection approaches

Type of data	Data collection approaches	Data collected
Secondary	Desk review using, Project reports, Local and national statistics, Previous surveys	Contextual data Existing endogenous innovations Permanent actors in the area and functions Project interventions in the last 5 years Links among the identified actors
Primary	Key informant interviews	Contextual data Mapping of actors Existing endogenous innovations[4]
	Galileo online internal data collection	Knowledge/ideas/intuitions of researchers on how to leverage some challenges observed in the LL

In order to simplify the implementation, we have developed ‘’Methodological sheets” as annex of the methodological guideline of T1.1. These methodological sheets were developed to provide details on how the various methods and tools should be implemented. The methodological sheets gave details on how to collect the data and how to analyse it.

[3] Data triangulation involved using a variety of data sources, including time, space and people, in a study. This allows findings to be corroborated and any weaknesses in the data to be compensated by the strengths of other data, thereby increasing the validity and reliability of the results.

[4] To identify innovative practices, you first need to know the practices in the agrarian system, and these practices sometimes differ depending on the type of producer. This will prevent a practice from being classified as innovative if it is common for a well-defined type of producer (e.g. those who are from the village and reinvest, sometimes at a loss, in the village).

2.2.3 Secondary data: the Desk review

The desk review started started by the tracking of documents, survey that will help to characterise the context of the LL[5], identification of existing endogenous innovations and map the main actors in the area. For the missing data, two options have been used : first identify key informants to complete the missing data or second if the data doesn't exist, expert assessment has been mobilized.

2.2.4 Primary data

In addition to the secondary data, primary data were collected to identify the current potential farmers to work with and the relevant networks, value chains and institutions to consider (complete the secondary data and be used as a source for discussions during the co-creation process). The primary data collections included two approaches: the key informant interviews and the focus group discussions. Additional primary data has been conducted within Galileo project to collect their ideas/intuitions on how to overcome challenges identified in the LL.

As we collected data and personal information, we used the consent form in all primary data approaches, consistently with Ethics WP9. The full consent form was filled in by KII and every participant in focus groups.

Key informant interviews were used to supplement the desk review with missing information. Sampling was based on diversity among actors who could provide specific information about the LL area. The table below shows the distribution of interviews suggested by the methodological guidelines. Each country adapted the distribution based on their context..

Table 3. Suggested distribution of key informant

Type of key informant	**Number of interviews**
Farmers organisation representatives	2
Farmer leaders	2-5
Innovator farmers	7-10
Local authority	1
Administrative authorities	2
Organisations which conducted R&D activities in the area (2020-2025)	
- Research organisation	2
- NGO	2
Other key informant (context-based)	2
Total	**20-25**

Annex 2 provides the key informant interview guide, which has been adapted by each country. Annex 3 provides the discussion guide designed for focus groups.

[5] 1. Ecological data (Climate, soil type, vegetation type), 2. Agricultural system (Project in the last 5 to 10 years, Agricultural dynamics, Typology of agroforestry system, preferred trees, Farming system,), 3. Socio-economic data (Population density, poverty level, market access, main source of income, ..), 4. Historical data (important past events in the LL, highlights) and 5. Institutional data (Farmer organisation, Infrastructure, important regulations that can affect our work)

2.3 Data collected in the eight living labs

Data has been collected in eight living labs. The study combines desk research with extensive fieldwork including 155 key informant interviews, 16 Focus groups, observations in Cameroon and 25 Farmers interviews in Kenya. Table 4 provides detailed information on data collected in the frame of T1.1. The overall description (title, size, coauthors) of the 4 countries (8 LLs) documents is available in ANNEX 7 and the original files (anonymized) are shared in Zenodo.

Table 4. Data collected in the frame of task 1.1

Living Labs Methology used	Niakhar	Ouarkhokh	Embu	Ntui-Bokito	Lom-Tombel	Aponoapono-Suhum	Assi Fossu – New Edubiase	Goaso
DATA COLLECTION PLANNED IN THE METHODOLOGICAL GUIDE								
Desk rewiew (Number of documents identified)	***106***	***96***	***42***	***More than 100***	***More than 100***	***15***	***15***	***20***
Sources of the desk review	*Systematic document analysis of the PDCs (2018–2022, 2024–2028), DyTAEL 2024 report, the Niakhar MARP, FAIR Sahel and SustainSahel notes ; HOLPA and ISTOM studies*	*DUNDI Ferlo, RIPOSTES, SustainSahel ; scientific articles ; municipal and departmental development plans ; cartographic and regulatory documents (local agreements ; land policy ; forest code*	*scientific articles, book chapters, study reports, institutional documents, website*	*Documents reports, data from ongoing PhD thesis, Data from ongoing CANALLS project, field visits, masters students data, scientific articles*	*Documents in the intervention areas, the internet, personal and private libraries, expert knowledge was highly exploited wherein most partners of the project are quite verse with the intervention zones and had clear understanding of these areas*	*Mixture of reports, scientific publications and government documents*	*Mixture of reports, scientific publications and government documents*	*Mixture of reports, scientific publications and government documents*
Key semi-structured key informant interviews (KII)	**21**	**23**	**25**	**24**	**25**	**19**	**18**	**N/A**
Diversity of KII	producers, chiefs, elected officials, POs, technicians),	producers, chiefs, elected officials, POs, technicians),	Farm Africa's network, Embu County government and field knowledge.	Council, adminisitrative officers, project partners, cooperative		KKFU Representatives District Directors CHED officers Farmer leaders	KKFU Representatives District Directors CHED officers Farmer leaders	

				groups, farmers in different villages		Cocoa Agroforesters Organic Agroforesters Chiefs/Odikros NGOs Representatives Truck Drivers Agro-Input Dealers	Cocoa Agroforesters Chiefs/Odikros NGOs Representatives Truck Drivers Agro-Input Dealers LBC Managers	
Focus group *(Optional)*	*N/A*	*N/A*	6	*N/A*	10	*N/A*	*N/A*	*N/A*
LL inception workshop	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	1	1	*N/A*
COMPLEMENTARY DATA COLLECTION								
Farmer interviews	*N/A*	*N/A*	25	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
Additional sources of data	*Reports on ideotyping and transition path workshops (2024–2025), involving various local stakeholders in mapping possible agroecological scenarios ; Excel database from the qualitative survey, used to generate thematic tables triangulated with the results of the MARP*	*Data from MARPs and innovation platforms: The results of the participatory approaches carried out in 2021 (MARPs) and the action plans of the innovation platforms were integrated into the analysis to strengthen the territorial dimension of the assessment*		*7 experts Consulted. Field observations in the Ntui areas were done also, during the Cameroon Working Group inception meeting in April 2025 cocoa-based agroforestry systems, innovative agroforestry in Cameroon and legal instruments that influence agroforestry in Cameroon were brainstormed,*	*6 experts Consulted, Direct observations across selected villages in the Loum and Tombel Sub-Division; during the Cameroon Working Group inception meeting in April 2025 cocoa-based agroforestry systems, innovative agroforestry in Cameroon and legal instruments that influence agroforestry in*			

	and the market survey (July 2024); Local maps (DyTAEL, municipalities, watersheds) and infrastructure surveys enabling a spatial reading of the issues.			*leading to research topics to gain more insight to guide development of the LL.*	*Cameroon were brainstormed, leading to research topics to gain more insight to guide development of the LL*			

2.4 Cross-analysis of the eight living labs

The analysis involved a thoughtful combination of a comprehensive and analytical approach to the data collected from the LL, based on themes developed from the contextual analysis. AI was used to develop condensed comparative tables of the eight LLs. However, the description of each LL was synthesized manually to ensure data accuracy.

3. Results

The results section is organised into four subsections. Firstly, there is a condensed overview of the eight living labs, presented in four tables. The second subsection provides an overview of each living lab, covering the same themes as the first. This section aims to demonstrate the diversity of contexts in which Galileo operates. The overview of the eight living labs illustrates the variety of information available in each LL and is linked to the extent to which the country team was initially familiar with the LL. The overall description (title, size, coauthors) of the 4 countries (8 LLs) documents is available in ANNEX 8 and the original files will very soon be shared in Zenodo, after anonymisation and curation. The third subsection provides a cross-cutting analysis of the eight living labs, presenting priority observations with implications for Galileo interventions. The final section discusses the implications of the analysis for upcoming Galileo project activities.

3.1 Condensed overview of the 8 Living Labs

Tables 5,6, 7 and 8 give a quick overview of the characteristics of the 8 LLs organised by four themes: 1) biophysical context; 2) ecological data (climate, vegetation and biodiversity); 3) production systems (agriculture and livestock); and 4) stakeholders, projects, socio-economy, history, challenges, and innovations.

Table 5 : Condensed Overview of the 8 living labs _Biophysical context

Theme	Niakhar (SEN)	Ouarkhokh (SEN)	Embu (KEN)	Loum–Tombel (CMR)	Ntui–Bokito (CMR)	Aponoapono–Suhum (GHA)	New Edubiase (GHA)	Joabeso–Goaso (GHA)
Agroecological zone	Sudano–Sahelian (groundnut basin)	Sylvo-pastoral Ferlo (Sahel)	Highlands / mid-altitude (600-1280 m a.s.l) smallholder zone (agroforestry mosaic)	Humid forest (monomodal rains)	Forest–savannah transition	Semi-deciduous forest	Semi-deciduous forest	Semi-deciduous forest
Context	600–900 mm rainfall; water management & prudent intensification	300-600 mm rainfall. Pastoralism dominant; recurrent drought; land degradation	Diversified smallholdings; seasonal water stress	Cocoa–food corridor; historical erosion pressure on slopes	Diversification beyond cocoa; tenure & market constraints	Cocoa zone in transition; income restructuring	Cocoa + foods; local diversification	Cocoa under shade; land-use transition
Soils	Sandy, low organic matter	Sandy with low water-holding; wind erosion	Ferralsols/andosols; local water constraints	Volcanic/ferralitic (slopes, erosion history) and acidic acrisols	Highly weathered tropical soils; fertility decline	Forest soils; cocoa nutrition constraints	Forest soils; plot fatigue	Humid forest soils; shade & organic matter needs

Table 6 : Condensed Overview of the 8 living labs _ Ecological data (climate, vegetation, biodiversity)

Theme	Niakhar (SEN)	Ouarkhokh (SEN)	Embu (KEN)	Loum–Tombel (CMR)	Ntui–Bokito (CMR)	Aponoapono–Suhum (GHA)	New Edubiase (GHA)	Joabeso–Goaso (GHA)

Climate characteristics	600–900 mm/yr; increasing rainfall intensity	300—600) mm/yr; short wet season; high variability	Bimodal (MAM & OND), ~900–1500 mm; 18–28 °C	Monsoon-type; ~1,200–2,500 mm by area	Single marked season; increasing variability	Humid tropical (bimodal)	Humid tropical (bimodal)	Humid tropical (bimodal)
Vegetation & land cover	fields with scattered trees	savanna (c. 85%); cropland rare, near wells mainly	Agro-mosaic of crops–trees–hedges	Humid forest; cocoa agroforests	Forest–savannah mosaic; agroforests	Cocoa agroforests & home gardens	Cocoa + food crops and fallows	Cocoa under shade; timber patches
Biodiversity relevance for agroforestry	Useful native species (forage, soil stabilisation)	Key roles for Acacia, Balanites, Combretum (forage, gum)	Diverse fruit/hedge species for erosion control	Multi-species shade improves micro-climate & soils	Native trees for fertility & shade	Shade trees in cocoa; fruit trees	Shade trees in cocoa; fruit trees, agroforestry diversification	Enhancing microclimates, timber & NTFPs

Table 7 : Condensed Overview of the 8 living labs _ Production systems (agriculture & livestock)

Theme	Niakhar (SEN)	Ouarkhokh (SEN)	Embu (KEN)	Loum–Tombel (CMR)	Ntui–Bokito (CMR)	Aponoapono–Suhum (GHA)	New Edubiase (GHA)	Joabeso–Goaso (GHA)
Agricultural & livestock systems	Rainfed crop–livestock; water management focus	Pastoral / agropastoral; small food plots	Food crops + fruits + small ruminants; dairy common	Cocoa + food crops; backyard livestock	Cocoa + foods; small ruminants	Cocoa, home gardens, poultry/ruminants	Cocoa + foods; local diversification	Cocoa under shade; foods
Key cropping system	Pearl millet, groundnut, cowpea, watermelon	millet disappearing cowpea for forage; some watermelon/vegetables near wells	Maize–bean + legumes; fruit trees + cash crops (khat)	Cocoa + banana/plantain + staples	Cassava, maize, plantain (often with cocoa)	Cocoa + banana/plantain + staples	Cocoa + staples (plantain, cassava, maize)	Cocoa + staples

Type of agroforestry system	Parklands with scattered trees	Parklands / wooded rangelands (fodder trees)	Hedges, windbreaks, multistrata plots	Shaded cocoa agroforests	Multistrata trees–crops–livestock	Cocoa under shade + home gardens	Multilayered, shaded farms	Mixed cropping
Farm type	Small family farms	Family pastoral/agropastoral (≈2–4 ha)	Mainly small (≈2-6 acres) plus some medium	Small/medium cocoa growers	Smallholders; cooperatives	Small/medium; cocoa cooperatives	Small/medium	Small/medium
Practices & species	FMNR, organic manures	Transhumance; fodder collection; FMNR; manure; Acacia, Balanites, Ziziphus	Mulch, biopesticides, micro-water harvesting; Melia, Tithonia, neem	Diversified shade management; slope conservation	Indigenous fertility species (Leucaena, Tithonia); multistrata hedges	Cocoa shade; fruit trees	preserve soil moisture, pruning, composting using organic materials	mixed cropping (fruit & timber species)

Table 8 : Condensed Overview of the 8 living labs _ Stakeholders, projects, socio-economy, history, challenges, innovations, conclusion

Theme	Niakhar (SEN)	Ouarkhokh (SEN)	Embu (KEN)	Loum–Tombel (CMR)	Ntui–Bokito (CMR)	Aponoapono–Suhum (GHA)	New Edubiase (GHA)	Joabeso–Goaso (GHA)
Key stakeholders	Family farmers; local ag services & communes; research/NGOs	Pastoralists/agropastoralists; cooperatives; local authorities; research/NGOs	Smallholders; county/ward services; innovation groups	Growers (cocoa, staples), cooperatives, deconcentrated services	Farmer orgs; ag offices; local centres	Small cocoa planters; co-ops; services & NGOs	LBCs, Input dealer, NGOs, Extension, (co-ops; COCOBOD/ MoFA)	LBCs, Input dealer, NGOs, Extension, (co-ops; COCOBOD/MoFA)
Key projects	Water/soil programmes; local platforms	SustainSahel; DUNDI-Ferlo; CREATE; PDEPS;	Local SLM/water projects &	Cocoa programmes; actor mapping	Certification/co-ops; local innovation pilots	Cocoa rehabilitation;	Cocoa productivity, timber & fruit	Dynamic agroforestry (DaF)

			farmer innovations			diversification	tree distribution	
Socio-economic dynamics	Family agriculture; mixed incomes	Regional livestock markets; informal chains; milk mostly self-consumed	Mixed incomes (foods, cash crops, diversification)	Active ag trade; rural employment	Agriculture & trade; gathering/hunting/livestock as complements	Cocoa economy in transition	Cocoa economy in transition	Cocoa economy in transition
Historical & institutional data	Trajectories: intensification & water control	Pastoral mobility; customary + state governance	Shifts from historical cash crops to diversified systems and khad dominated cash crops	Erosion history (Tombel); protected areas	Colonial cocoa/coffee → staples; farmer orgs	Cocoa heritage; cooperative networks	blending conventional cocoa farming practices with traditional agroforestry systems	Forest loss from cocoa/timber; recent pressure from mining
Challenges & opportunities	Rainfall variability; water/soil management opportunities	Drought; declining rangelands productivity; limited transhumance options	Water stress; wildlife/termites; small-scale irrigation & diversification potential	Erosion; rainfall hazards; strong agroforestry potential	Soil fertility decline; market access; value-addition & NTFP opportunities	Aging orchards; prices; agroforestry opportunity	Aging orchards; prices; agroforestry opportunity	Low AF adoption (knowledge, finance, tenure); high potential for biodiversity/carbon/resilience
Innovations	FMNR; micro-water works	Water points, fodder banks, live fences; co-managed rangelands	Mulch; local biopesticides; maize transplanting; demi-lune woodlots; ponds	Diversified shade; anti-erosion practices	Multistrata tree–crop–livestock; biochar + manure; live hedges	Cocoa + fruit trees; shade management	Compost pits and mulching around cocoa stools	Legume intercropping; restoration practices

3.2 Individual Living Lab Snapshots

The description of the LL is organised by country from arid and semi-arid areas to humid areas : Senegal, Kenya, Ghana, Cameroon. All details per LL can be found in the original files that will be shared in Zenodo, after anonymisation and curation. The description is presented with the following outline :

- Physical data
  - Name of the Living lab, Country,
  - Location :
  - Agroecological zone
  - Context:
- Ecological data
  - Climate characteristics
  - Soils
  - Vegetation and land cover
  - Biodiversity relevance for agroforestry
- Agricutural system
  - Livestock farming system
  - Key cropping system
  - Type of agroforestry system
  - Farm type
  - Practices
  - species
- Socio-economic dynamics
  - Demographic trend
  - Livelihood source
  - Sources of incomes
- Socio-institutional dynamics
  - Key stakeholders
  - Key projects
  - Historical data
  - Institutional data
- Innovations
- Challenges and opportunities
  - Challenges
  - Opportunities
- Lessons learnt for Galileo upcoming activities

3.2.1 Description of Niakhar Living Lab

Physical data

Name of the Living Lab: Niakhar Living Lab
Country: Senegal
Location: Niakhar district, Fatick Region
Agroecological zone: Groundnut Basin (Sudano-Sahelian)

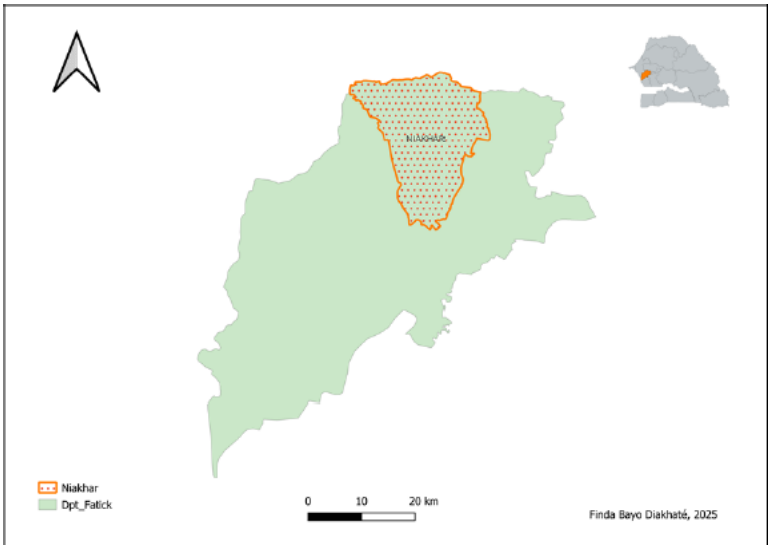

Figure 3 : Location of the Niakhar LL

Context: Niakhar is a representative rural area of Senegal's Groundnut Basin, with a semi-arid climate and strong seasonal variability. It is characterized by mixed crop-livestock systems, traditional agroforestry practices, and persistent land degradation challenges due to population pressure, reduced fallow, and climate change.

Ecological data

Climate characteristics: Semi-arid with a single rainy season (June–October) and a long dry season; annual rainfall ~500–800 mm; high interannual variability. Fatick (14°N), taken as the reference zone for the Niakhar LL, represents the central Sudanian zone with mean annual rainfall of 600–900 mm, while Dahra (15.5°N), taken as the reference zone for the Ouarkhokh LL, lies in the Sahelian transition zone with 400–600 mm/year (World Bank, 2022). This gradient creates distinct ecological zones : Fatick's rain-fed agriculture systems contrast with Dahra's pastoral livelihoods (Tappan et al., 2004). The 2010–2020 decade recorded 7 of Senegal's 10 wettest years since 1950, yet featured severe droughts. Mean temperatures increased by 0.73°C nationally (1981–2020), accelerating to +0.28°C/decade post-2000. Rainfall: 15% decline (1960–2000), but 8% recovery (2000–2020) with intensified late season downpours (events >50 mm/day up 25% (Diallo & Knudby, 2023). Increased wet-season intensity (+20% in 99th percentile events) but 15% reduction in rainy-season length. Seasonal Shifts: Monsoon onset delayed by 7 days since 1980, shortening growing seasons (Salack et al., 2011).

Soils: Soils are sandy with low fertility. The whole area also suffers from salinization. Mineral fertilisation is very limited. In Sob, it is estimated at 4.32 kg of nitrogen/ha (DUGY, 2016). Agriculture remains rain-fed and extensive, centred on millet and groundnuts, with the integration of cash crops (watermelon which is developing fast, cowpea, bissap) and a recent expansion of market gardening (onions, tomatoes). Fertility is limited, requiring organic amendments and soil conservation practices. The adoption of agroecological innovations (composting, RNA, mulching, legumes) remains limited.

Vegetation and land cover: A comparison of the 2014 and 2024 maps for Niakhar shows an increase in bare ground, with the landscape changing overall from lighter shades in 2014 to darker shades in 2024. This change, combined with an analysis of changes in non-photosynthetic vegetation (i.e. vegetation that is no longer active in photosynthesis, such as dead leaves) and photosynthetic vegetation, indicates a degradation of vegetation cover over the decade, with increasing soil exposure in the region. In Niakhar, the identified land use units are: tree cover, shrubland, grassland, cropland, built up areas, bare/sparse vegetation, permanent water bodies, herbaceous wetlands and mangroves. The landscape is structured and agricultural, with some remnants of natural vegetation. Floristic inventories in Niakhar (Sylla et al., 2025) have identified 60 woody species in 22 families. Taxonomic analysis reveals a strong predominance of the Fabaceae family, which alone accounts for 23 species, or nearly 40% of the species identified. The second most represented family is Moraceae (six species, mainly of the genus Ficus), followed by Combretaceae (five species, including Combretum glutinosum and Guiera senegalensis). Anacardiaceae and Malvaceae each have three species, including Mangifera indica and Adansonia digitata. The abundance rates of woody species in Niakhar indicate a high concentration around a few dominant species : Faidherbia albida alone accounts for 42.71% of the total, followed by Balanites aegyptiaca (9.79%), Anogeissus leiocarpa (9.26%) and Adansonia digitata (6.44%).

Biodiversity relevance for agroforestry: Tree cover provides fodder, fuelwood, and soil fertility benefits; parklands are habitats for birds and pollinators.

Agricultural system

Agriculture dynamics : Several phases have characterised the dynamics of production systems in the Groundnut Belt (Tab. 9). Watermelon was introduced to the area in the 1990s, particularly in the village of Sob. Watermelon is now part of the crop rotation with millet and groundnuts in distant fields (bush fields). Watermelon cultivation requires capital for investment in chemical inputs (seeds, mineral fertilisers, pesticides) and organic input. Market gardening is practised in low-lying areas where water is easily accessible through traditional wells. This highly intensive activity (use of mineral fertilisers, manure, pesticides, imported hybrid seeds, diesel) is mainly carried out by young men. However, through NGOs, women's promotion groups (GPF) have developed to establish market gardening areas (market gardening and fruit tree association) with modern wells where water is pumped using solar energy. One of the constraints of this activity is access to sufficient water of good quality (salt content). In the Niakhar area, soil fertility management currently relies mainly on the use of animal manure (paddocks, manure).

Table 9. Dynamics of production systems in the Groundnut Belt

Phase (period)	Systems	Dominant techniques	Main objectives
Before 1960	From the traditional indigenous cereal system (millet, sorghum) to the introduction of peanuts	Fallow land grazed and smoked by livestock, *Faidherbia albida* tree park. Collective management of crop rotation. Family labour using rudimentary tools (hoes, daba)	Self-sufficiency and local resilience
From independence to 1970	Resolutely "traditional" agriculture based on millet and groundnuts in rotation with fallow land, which is gradually disappearing.	Falling fallow land, collective management of crop rotation, family labour and still rudimentary equipment (hoes, daba, carts)	Self-sufficiency and local resilience
From 1970 to 1990	griculture geared owards modernity: use of nputs, animal traction and he beginnings of iversification	Fallow land virtually disappeared, large-scale horse-drawn transport and expansion of cultivated areas, crop rotation linked to climate deterioration and seasonal expulsion of herds, little land fumigated, soil degradation and striga development	Increase in production, revival of peanut exports in particular
From 1990 to 2010: crisis and questioning of the "modern" approach	Agriculture in "crisis" with the collapse of the peanut sector. Liberalisation and withdrawal of state support	Reduction or even elimination of input subsidies. Gradual return to local practices	Reducing dependence on inputs
From 2010 to the present	A dynamic towards an agroecological transition of territories resilient to climate change is being promoted.	Diversification (combination, rotation) based on legumes, compost, biofertilisers, agroforestry	Food security, income improvement, climate resilience and ecological sustainability

Agriculture vulnerability : Crop-water stress ; Soil degradation: Soil Salinization. 25% increase in erosion from high-intensity rains, threatening productivity ; Water resource stress : Groundwater recharge declines projected: -20% by 2050 due to reduced infiltration from intense, short rains.

Key cropping system : Rainfed millet–groundnut or millet-groundnut-watermelon rotations.

Livestock farming system : Two main farming approaches, depending on resources, management methods and levels of integration with agriculture :

1. *Vulnerable and constrained systems* : These are poorly integrated farms with small herds (often 3 to 10 head), limited access to water, limited access to veterinary care and rudimentary resources (no vaccination facilities, drinking troughs or carts). They depend mainly on mobility (transhumance) to feed their animals and are exposed to significant losses in the event of drought.
2. *Dynamic and open systems*: These farms have more diverse livestock and greater investment capacity. They practise forms of crop-livestock integration, particularly through grazing animals on fields (organic fertilisation), the use of crop residues, or the association with fodder hedges. They have access to advisory services and cooperative structures, and sometimes develop initiatives for fattening or selling milk. These systems are often driven by young people or innovative women's groups.

Livestock trade mainly takes place at weekly regional markets in Sob, Niakhar, Diouroup, Bambey and as far as Toubatoul. These markets play a crucial role in the economic liquidity of agropastoral households, However, access to these markets remains limited by several factors: the poor marketing infrastructure (lack of waiting areas, sorting yards and certified scales), logistical difficulties linked to

the remoteness of the sales locations for some livestock farmers, seasonal price variability and the absence of structured commercial intermediation. These constraints affect the competitiveness and profitability of livestock trade in the area.

Transhumance is an essential component of the livestock farming system in Niakhar. The interregional mobility plays a key role in regulating pressure on natural resources and managing animal production cycles. However, this traditional practice is increasingly under threat. The gradual closure of passageways, sometimes reduced to less than 30 metres, is leading to growing conflicts of use with farmers. The expansion of cash crops such as watermelon, cowpea and groundnut in traditionally pastoral areas is exacerbating competition for resources. In addition, the increasing salinisation of water sources, particularly wells and seasonal ponds, is reducing the availability of quality water, making some transhumance routes impassable. Pastoral infrastructure remains largely inadequate or in poor condition: there are few functional vaccination parks, secure watering places are rare, and there are no facilities for receiving or providing health care for herds. This situation makes livestock farmers particularly vulnerable to epidemics, livestock exhaustion and loss of animal capital. Furthermore, the lack of concerted local governance on livestock mobility and the weak roots of inter-community regulatory frameworks exacerbate tensions between users.

Type of agroforestry system: Existing agroforestry systems based on the following potential criteria for distinguishing between types. Ten main type incorporate trees in Fatick region :

- *Traditional agroforestry parks* : In the Niakhar region, Faidherbia albida is often the dominant species. F. albida is a nitrogen-fixing legume with reverse phenology and phreatophytic behaviour. Their canopy provides shade where livestock grazing freely in the fields can shelter during the dry season. The proximity of trees has generally had a positive effect on associated crop yields and soil fertility
- *Guiera senegalensis parks* : Guiera senegalensis is often the main tree species present. Thanks to its deep root system and resilience to water stress, it grows strongly during the dry season and manages to maintain itself
- *Hedgerows and windbreaks :* Living shrub hedges are used to enclose fields house gardens or protect market garden perimeters. Hedges go very well with livestock farming, as they allow animals to be included or excluded as desired.
- *Alley cropping* : This agroforestry system involves growing strips of annual crops alternating with rows of nitrogen-fixing trees or shrubs spaced at regular intervals. This system is less suitable for livestock farming than hedges
- *Assisted natural regeneration (ANR)* : ANR is a formalisation of a traditional farming practice: it consists of sparing and caring for young tree seedlings that grow naturally in fields (from seeds or suckers) instead of destroying them during weeding. These approaches, recommended for adaptation to climate change, are considered effective in restoring fertility and increasing useful tree cover
- *Agroforestry home gardens (or family gardens) :* In this type, fruit trees (mango, papaya, citrus) are planted around the dwelling, along with useful trees (moringa, neem, kapok for shade) and food or medicinal crops along the edges. These traditional multi-layered gardens contribute to food security and are particularly well developed in villages with wells
- *Silvopastoral systems in livestock grazing areas* : The bush trees are used for gathering and grazing (neré fruit, baobab leaves, pods, etc. harvested to feed people and animals)
- *Village woodlands (sacred woods or community forests) :* These can be considered as agroforestry on the margins when managed by the community in combination with other uses (e.g. wild fruit gathering, beekeeping under tree cover, etc.). The Niakhar living lab has its own community forests
- *Sacred conservation of useful trees :* Historically, certain species are protected by cultural and religious beliefs.

Improved tree-crop combinations (intercropping orchards) : In addition to the traditional parks mentioned above, modern tree-based systems integrated into crops have been introduced. These involve planting fruit trees or other perennial species in or around cultivated plots. These trees provide marketable fruit and shade, while intercropped crops benefit from the improved microclimate and soil fertility

Farm type: The majority manage areas of 1 to 3 hectares, which are often fragmented. Fragmentation is exacerbated by land pressure and the return of migrants wishing to access land (Fig. 4)

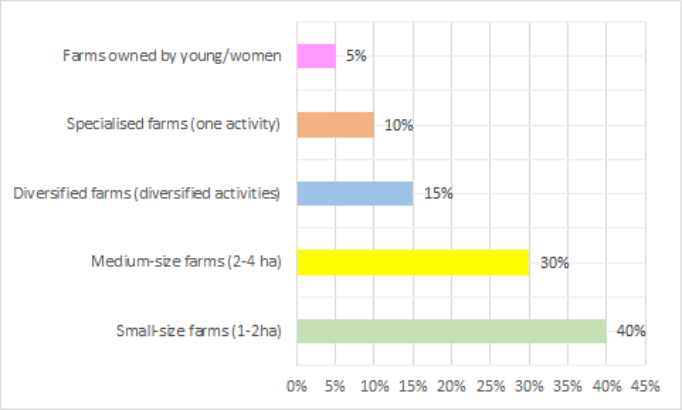

Figure 4 : Type of farms in the Niakhar region

Source : triangulated data _ transcrits from key informants galileo (2024-2025), Nikhar MARP (2024), DyTAEL 2024 report, Niakkhar PDC 2024

Finally, the purpose of production remains mixed: food self-sufficiency (millet, sorghum, cowpeas), sale of surpluses (peanuts, watermelons), and income generation from commercial activities (market gardening, processed products, livestock, salt). This versatility reflects a logic of resilience rather than economic performance.

Practices : Millet-groundnut rotation, tree protection, manure application, micro-dosing of fertilizer, soil and water conservation techniques.

Species: Preferred species and valued tree species in Niakhar : Firstly, Faidherbia albida (locally known as "Kad") is the most valued species. It is recognised for its key role in natural soil fertilisation, its favourable shade for crops, its forage leaves and its ability to coexist with cereals in fields. The second most common species is *Balanites aegyptiaca* (Soump), an extremely drought resistant tree whose fruits and leaves are used for food and traditional medicine. *Ziziphus mauritiana* (jujube) is also valued, particularly in hedgerows or for domestic consumption of its fruits. The baobab tree (*Adansonia digitata*), highly respected in the social imagination, is mainly used for its leaves (mboum), which are used for food. Finally, other species such as *Acacia spp., Neem (Azadirachta indica)*, *Combretum glutinosum* and *Prosopis spp*. appear sporadically, mainly for fodder, medicinal or firewood uses.

Socio-economic dynamics

Demographic trend: The literacy rate is estimated at between 35% and 40%. Estimated household access to drinking water and sanitation (91%). Vulnerability : Women and young people are most exposed to poverty. Women, although active in market gardening and processing activities, face difficulties in accessing land, inputs, credit and decision-making autonomy. Young people suffer from

structural unemployment, a lack of appropriate vocational training and future prospects, which encourages them to leave or become marginalised. These vulnerabilities are exacerbated by limited access to basic social services.

Livelihood source : Household income is mainly based on rain-fed agriculture (millet, groundnuts), subsistence livestock farming, small-scale trade, crafts, as well as remittances from migrants and project aid. Very few households have formal or regular income. Disposable income remains low and unstable. Watermelon has recently become an important cashcrop.

Access to Market : In the Niakhar LL, market access is a key issue for agroforestry, agricultural and pastoral livelihoods. It reflects a triple vulnerability: logistical (isolation of villages, lack of storage and processing facilities), economic (lack of bargaining power of isolated farmers) and institutional -no contract), which limits the value added of local products and the transformation of production systems.

Sources of incomes: Most income comes from agriculture, particularly food and cash crops. Peanuts are frequently cited as the main income-generating crop, both for the direct sale of seeds and for the use of the leaves as livestock feed. Livestock farming is also an important source of additional income. In addition to this agricultural income, there are non-agricultural income-generating activities (IGAs). Small-scale trade, particularly among women, handicrafts (sewing, carpentry, food processing), and seasonal or migrant jobs provide essential diversification. Women also earn income from the sale of processed products (roasted peanuts, oil, juice, artisanal dairy products). In summary, income in the Niakhar LL is divided between cash crops (groundnuts, watermelon), market gardening, livestock farming, AGRs and external support. This diversity of sources provides some resilience to shocks, but remains exposed to structural constraints such as poor access to credit, climate dependency and fragmented economic circuits. It is an area in transition with real levers for development. Despite strong demographic pressure, household poverty and a marked dependence on migration, the youth of its population and its agricultural resources are favourable factors for the development of the area.

Socio-institutional dynamics

Key stakeholders: Farmers and their organizations, rural municipalities, national agricultural research institutes (ISRA), extension services, NGOs, local traders, and development projects. Grassroots community organisations (economic interest groups (EIGs), forest producer groups (FPGs) and village associations), local plateforms and networks (Sustain Sahel innovation platform, agricultural cooperatives, DyTAEL), local authorities (local authorities of Niakhar, Patar Sine, Ngayokhème and Diarère), decentralised government services (ANCAR, the Water and Forestry Service, the Livestock Development Service, the CPDT and ANACIM), NGOs (World Vision, Caritas, Agrisud and ANPDI), development, research institutes (ISRA, IRD and CIRAD) and Private economic actors (Bana-Bana = traders), Formal and informal Microfinance

Key projects on agroforestry

Table 10 : Key projects implemented in Niakhar in the past 10 years

Projects	Duration	Topics/ main activity
Galileo	2025-2029	Improve climate resilience and livelihoods through the integration of trees, crops, people and livestock. Establishement of living labs
SustainSahel	2020-2025	Integrate crops, shrubs and livestock to strengthen the resilience of production systems in the Sahel. Innovation platforms have been created to experiment with agroecological practices
Fair-Sahel	2020-2025	FAIR-Sahel (Fostering an Agroecological Intensification to improve farmers' Resilience in Sahel). Co-construction of future agroecology scenarios

RAMSES-II	2018-2023	Ecosystem services of agroforestry systems
PIAD	2017-2018	Promote sustainable agriculture, increase productivity and create local jobs.
COSTA		Combining groundnuts with Faidherbia albida and vegetable crops with fruit trees.
RIPOSTE		Strengthen the resilience of agricultural systems by promoting agroecology and agroforestry
AGROPOLE-CENTRE	2022-2025	Increase agricultural production and integrate it into agro-industrial processing and marketing
MAHDIA	2024-2026	Mêler Agroécologie et résilience Hydrique pour des systèmes alimentaires Durables en Afrique

Several projects on agricultural development and infrastructure programmes such as PROVALE-CV project on water development project for Value chain Development or PCEAL on Competitiveness in Agriculture and Livestock in Senegal.

Historical data: Long-term demographic, agricultural, and environmental monitoring by research institutions (notably since the 1960s by IRD and partners). Adoption of the land law on national property (1964) : it is a major turning point in the country's land management. By replacing customary ownership with a system of state land management governed by local authorities. The droughts of 1970, 1982 and 1984 : collapse of the agricultural model based on peanut monoculture. Rain-fed agriculture, which dominates the Niakhar region, could no longer guarantee food security, prompting farmers to change their farming strategies: resorting to subsistence crops (millet, sorghum), reducing the area under cultivation, gradually adopting seasonal market gardening and experimenting with short-cycle crops. A key event is the Establishment of DyTAES Dynamique pour une Transition Agroécologique locale de Fatick (DyTAEL) (2022). The 2024 action plan of the DyTAEL in Fatick includes tracking agroecological innovations and co-designing systems. This DyTAEL works in the capacity building for producers, land security for women and young people, structuring agroecological value chains, territorial governance and local advocacy, and adaptation to climate change

Institutional data: Fatick exemplifies Senegal's climate dichotomy: Fatick contends with increasing rainfall intensity requiring water management. Adaptation Plan is critical for food and water security : National Adaptation Plan: Targets 30% irrigated agriculture by 2035 and drought-resilient seeds. Recently, a dynamic for agroecological transition has been initiated with the creation of DyTAES (Dynamique pour une Transition Agroécologique au Sénégal) in 2019. This initiative brings together various stakeholders, coordinated between the government (Ministry of Agriculture, Food Sovereignty and Livestock), technical services (ISRA, ANCAR, etc.), DyTAES, technical partners (FAO, AFD, CIRAD, IRD, etc.) and actors in the field, and is now in place. The objective is to institutionalise agroecology in Senegal, anchor its practices locally, strengthen climate resilience and improve food sovereignty. National Domain Law (LDN, 1964) remains a cornerstone It assigns land management to local authorities through deliberations. The Forest Code, revised by Law No. 2018-25 of 12 November 2018, introduces major constraints on the use of forest resources. It strictly prohibits the cutting, pruning and sale of protected species, including those from assisted natural regeneration (ANR), without authorisation from the Water and Forestry Department.

Innovations

Warning : Some technical innovations cannot be implemented without changing the context: fodder crops, the retention (even partial) of crop residues, RNA, etc., without revising the rules governing access to common grazing land.

The table below describes the endogeneous innovations identified and the suggestions of change from researchers.

Table 11 : Technical and organisational innovations in Niakhar

	Endogeneous innovation	Researchers suggestions
Technical innovations	In particular, they stopped slash-and-burn practices to preserve vegetation cover; integrated fertiliser-producing trees such as Faidherbia albida directly into cereal plots (agroforestry park); established protected areas to transform groves into sustainable conservation zones; they mulch crop residues and compost local organic matter (millet stalks, dung); they transport domestic waste and manure to at least the fields near their homes; they diversify their crop rotations by integrating watermelon, millet and groundnuts over four years; they develop companion crops (millet/groundnuts, intercrops); practise assisted natural regeneration (ANR) and protect forest groves; manage community nurseries and arboretums; experiment with integrated farming systems combining market gardening, arboriculture and livestock farming; seek to adopt improved varieties of millet and groundnuts when available; integrate peanut shells and eucalyptus mulch to combat salinisation and improve soil structure; and establish fodder crops. Finally, they are moving towards fish farming combined with market gardening.	Installation of deep-rooted perennial hedges combined with fences to limit erosion and manage animal mobility diversify plot production, produce during the dry season (access to groundwater), increase organic matter stocks, feed animals and ultimately regenerate soil organic matter and productivity (example of TERRE VERTE, Galileo's partner in Burkina Faso); • Plant water requirements: confirmation of the effects of IRRIGASC and development of gravity-fed retention basins (half-moons); • Development of fodder crops and agroforestry corridors to feed animals during transhumance, reducing pressure on field trees in order to limit land use conflicts between livestock farmers and crop farmers; • Solutions for land rehabilitation against salinisation (soil mapping, water treatment, planting of tolerant species dedicated to wood energy production in particular, thereby reducing pressure on field trees); local groundwater desalination stations using evaporation to provide water for livestock; • Diversification towards high value-added crops and practices (mushrooms, herbalism with the company VALDA, solar drying, etc.); • Improvement of soils and productivity through mycorrhizal inoculants (VAM) already available locally and inputs for soil liming; • Increased millet sowing density to increase yields and improve soil cover • Regeneration of the Faidherbia plantation by focusing more on protecting suckers (already connected to the water table) th ed seedlings from nurseries; • Valorisation of tree-shaded areas for shade-tolerant crops (chilli peppers, squash) • Combined densification of Faidherbia and Guiera in rows to facilitate soil cultivation and mulching;

		• Comparative studies of compost vs bokashi to optimise energy and carbon yield in soils; • Development of integrated farm networks (Naatangue network) to share tools and know-how; • Assessment of the economic viability of carbon sequestration at the village level (see successful example in Kenya). • Launch of the "J'élève mon mouton à la campagne" (I raise my sheep in the countryside) app, a Galileo sub-project to create a modernised short supply chain between urban buyers and rural farmers
Organisational innovations	Community nurseries and local innovation platforms to coordinate projects and actions ; • Informal microcredit schemes providing advances of millet or cash during the lean season; • Rental contracts and regulated land management to secure access to land; • Clubs for young agricultural entrepreneurs trained in market gardening and livestock farming (AGRIJEUNE/our partner Jardins d'Afrique-Kaydara); • Organisation of tea debates and village conferences to discuss practices and advocate with the authorities; • Competitions and recognition of the best producers to stimulate innovation and promote women's initiatives; • Use of WhatsApp and social media groups to disseminate weather forecasts, technical advice and market access information; • Establishment of local development agreements (CLDs) bringing together 32 villages for protection and promotion • Support for conflict resolution (meeting points for transhumant herders, securing grazing land);	• Strengthening innovation platforms • Creation of a broader consultation forum (NGOs, neo-rural dwellers, religious leaders, government) to bring together stakeholders and donors and better channel government aid • Greater partnerships between rural and neo-rural communities to finance agroforestry and irrigation infrastructure • Revitalising urban-rural exchanges by taking advantage of the recent increase in the number of neo-rural dwellers and commuters, for example for the production and consumption of local organic products. • Development of agricultural insurance covering climate risks; • Establishment of a collaborative geographic information system ; • Develop YouTube channels and localised e-learning modules for continuing education; • Support for the structuring of housing cooperatives to improve access to sustainable housing and reduce pressure on arable land; • Development of citizen empowerment and advocacy programmes (sociological theories of influence networks); • Promoting regional fairs and events to showcase local innovations at the national level to attract funding and partnerships.

Challenges and opportunities

Challenges : In terms of agroecology, declining soil fertility (linked in particular to exports and erosion), increasing salinisation and deforestation are threatening agricultural yields and the sustainability of production systems. Constraints on access to quality agricultural inputs, modern equipment and processing infrastructure reduce the value added of production. Sales prices remain low, exacerbated by poor storage capacity and poorly organised marketing. Young people and women, although very active, struggle to access land, credit and specialised training. Rural exodus and illegal migration among young people reflect growing disillusionment with local opportunities. The lack of harmonisation between the strategic, operational and community levels is also identified as an obstacle.

Opportunities : The Niakhar region offers many opportunities to strengthen integrated agroforestry systems combining trees, crops and livestock. In terms of agroforestry, farmers' knowledge of useful species (Faidherbia albida, Guiera senegalensis, neem, jujube) is an important lever for developing assisted natural regeneration (ANR) practices, village reforestation, and the valorisation of wood and non-wood products. Community nurseries set up in several localities are evidence of a growing momentum driven by the producers themselves. Introduction of resilient varieties, rotation with legumes (fodder cowpeas) and soil conservation under tree cover.

Lessons learnt for Galileo upcoming activities

The results reveal a territory facing multidimensional challenges : land pressure, natural resource degradation, household economic vulnerability, weak rural infrastructure, and climatic, institutional and organisational constraints. However, this contrasting reality is also marked by numerous dynamics of resilience: diversification of activities, community mobilisation, farmer innovations, and the active presence of development projects geared towards agroecological and agroforestry transition.The gradual structuring of a network of farmer organisations, the promotion of local knowledge, the emergence of initiatives led by young people and women, and communal planning efforts offer important levers to support transition pathways. Agroforestry, understood here as the functional combination of trees, crops and livestock farming in a logic of ecological and economic sustainability, represents a strategic pathway to strengthen food security, improve soil fertility, diversify incomes and mitigate the effects of climate change.

3.2.2 Description of Ouarkhokh Living Lab

Physical data

Name of the Living Lab: Ouarkhokh Living Lab
Country: Senegal
Location: Ouarkhokh, Louga Region
Agroecological Zone: Sylvo-pastoral zone of the Ferlo

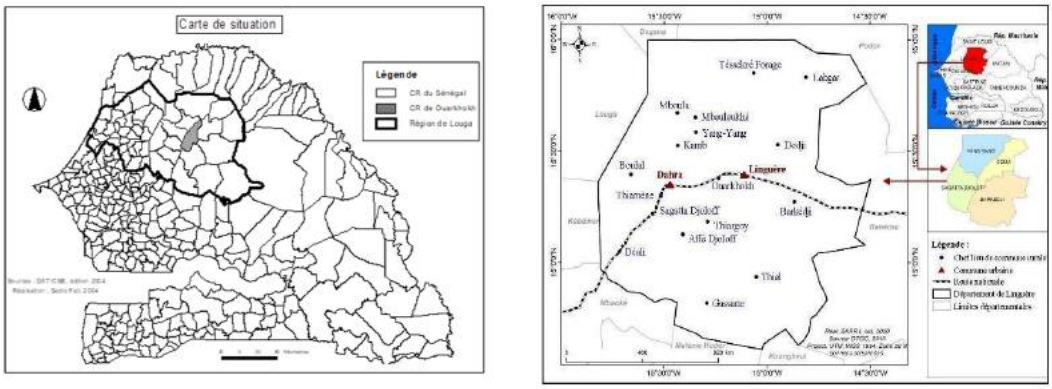

Figure 5 : Location of the municipality of Ouarkhokh

Context : Ouarkhokh is situated in the semi-arid pastoral zone of northern Senegal, where livestock farming is the primary livelihood. The area is characterized by limited rainfall, recurrent droughts, and land degradation. Agroforestry and rangeland management are central to sustaining livelihoods in this fragile ecosystem.

Ecological Data

Climate Characteristics: Fatick (14°N) represents the central Sudanian zone with mean annual rainfall of 600–900 mm, while Dahra/Ouarkokh (15.5°N) lies in the Sahelian transition zone with 400–600 mm/year (World Bank, 2022). Nocturnal warming exceeded daytime increases (+0.92°C vs. +0.54°C), elevating heat stress risks (Nakalembe et al., 2025; IPCC, 2022). Fatick recorded stronger warming (+1.1°C) than Dahra/Ouarkokh (+0.8°C) due to localised feedback from agricultural expansion (Nakalembe et al., 2025). Drought: 50% longer dry spells and +3°C warming amplifying evapotranspiration losses (Diakhate et al., 2022; Dosio et al., 2021). Some Effects of the climate variability on :

- Agriculture vulnerability (Pastoral System Pressures due to forage deficit and water scarcity) : Extended dry spells reduce biomass by 15–40%, forcing longer herd migrations and ephemeral ponds (mares) dry 20–30 days earlier, increasing livestock mortality (rises 15% during drought years, threatening pastoralist incomes (Mbow, 2017))
- Policy frameworks for adaptation strategies to face the drought :
    - National Adaptation Plan: Targets 30% irrigated agriculture by 2035 and drought-resilient seeds.
    - Great Green Wall: Restoring 150,000 ha in Dahra/Ouarkokh's Ferlo to enhance moisture retention (Mbow, 2017).

Fatick and Dahra/Ouarkokh exemplify Senegal's climate dichotomy: Fatick contends with increasing rainfall intensity requiring water management, while Dahra/Ouarkokh faces aridification demanding pastoral adaptation.

Soils: Sandy, low fertility, prone to degradation

Vegetation and Land Cover: Dominant species: Acacia senegal, Balanites aegyptiaca, Combretum glutinosum. Seasonal pastures with annual and perennial grasses. Comparative observation of bare soil, dry vegetation and photosynthetic vegetation (i.e. vegetation that is no longer active in photosynthesis, including dead leaves) maps between 2014 and 2024 in Ouarkhokh reveals a significant decrease in the percentage of active vegetation. In Ouarkhokh, the identified land cover units include tree cover, shrubland, grassland, cropland, built-up areas, bare/sparse vegetation, permanent water bodies, and herbaceous wetlands. The 2021 map reveals an overwhelming dominance of grassland, covering approximately 85% of the territory. Cropland appears in scattered patches around villages, and built-up areas along roadways . Tree cover and shrub vegetation remain only in isolated fragments.

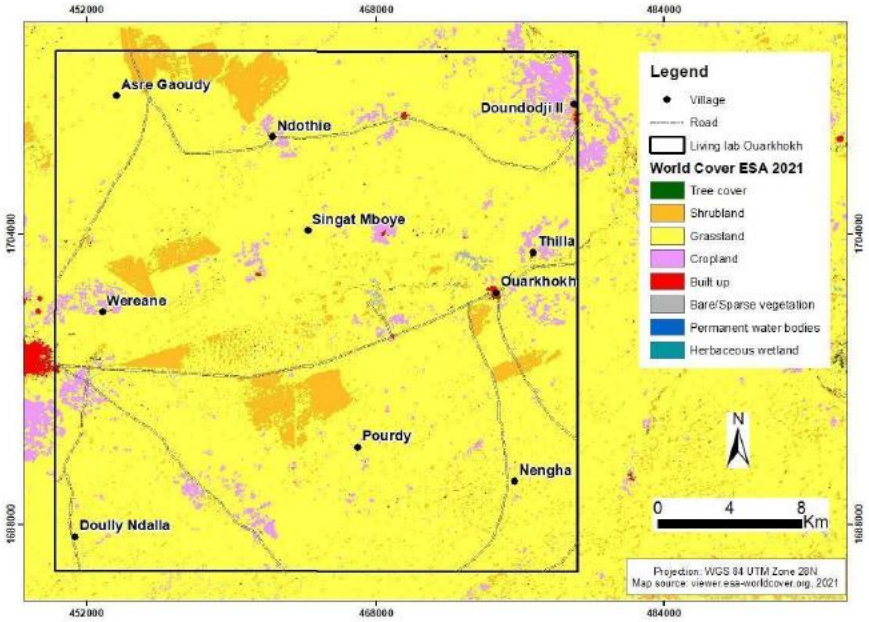

Figure 6 : Land use map in the Ouarkhoh living lab

Biodiversity Relevance for Agroforestry: Analysis of floristic diversity in Ouarkhokh highlights the marked dominance of three main families in terms of species number: Zygophyllaceae, Fabaceae and Combretaceae. Together, these families represent the vast majority of the specific diversity studied. The relative abundance graph by species reveals the overwhelming dominance of *Balanites aegyptiaca*, accounting for nearly 47% of the relative importance and confirming its status as a major structuring species of the landscape (Fig. 7).

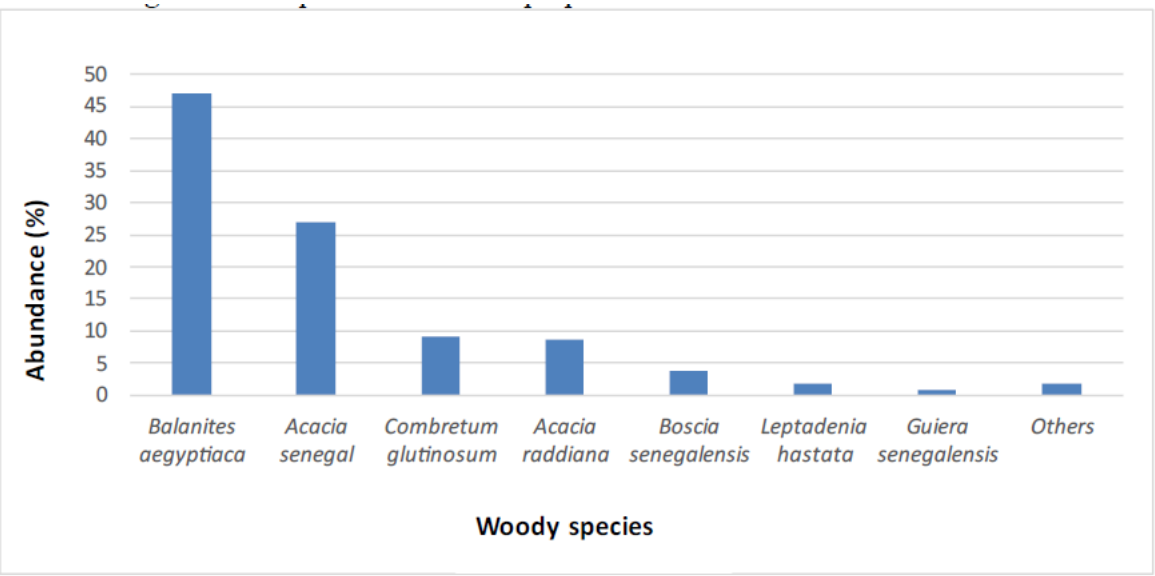

Figure 7 : relative abundance of the main woody species in Ouarkhokh

Agricultural System

Livestock Farming System: According to Wane (2006), pastoralism is the main production system, characterised by mobility and the use of natural resources. Agriculture, in the strict sense (crop production), is marginal.The typological analysis of agro-sylvo-pastoral farms in the Ouarkhokh Living Lab highlights two main types of livestock farming systems: traditional extensive systems and emerging integrated systems (Tab. 12).

Table 12 : Typology of livestocks farminsystems in Ouarkhok

Traditional systems	Emerging systems
Extensive pastoral farming	Integrated agro-silvo-pastoral systems
Seasonal mobility (transhumance)	Paddock and semi-sedentary
Low mechanisation	Adoption of agroecological practices
Unsecured natural resources	Fencing, boreholes, fodder crops
Indirect role of women	Direct involvement of women and young people
Little connection with the formal market	Link with markets and projects/NGOs
	Cattle and sheep fattening
	Stabling (especially sheep)

This comparative table highlights the coexistence of highly mobile forms of extensive livestock farming and more sedentary practices incorporating innovative agroecological and economic elements. Livestock trade in Ouarkhokh is a fundamental pillar of the local economy, particularly for pastoral communities. It mainly involves cattle, sheep and goats, which are raised extensively and sold at weekly or seasonal markets in the region. The busiest markets for livestock sales are located in Dahra, Touba, Louga and Linguère, but also in the peri-urban areas of Dakar during major religious festivals. In Ouarkhokh itself, the lack of a structured livestock market limits local trading capacity, often forcing livestock farmers to resort to itinerant traders or to travel to other municipalities, such as Dahra.

This trade relies heavily on informal channels dominated by "bana-bana", intermediaries specialising in the purchase, collection and transport of animals to consumption centres. These actors control the

trading networks and often dictate prices, leaving little room for manœuvre for producers, particularly those who are not organised into cooperatives.
Transhumance is a key adaptive strategy in pastoral resource management in Ouarkhokh. It compensates for the spatial and temporal variability of pastures and water points during the dry season, while reducing pressure on overexploited. Two types of transhumance are observed: local, intra-communal or intra-departmental transhumance (towards Barkedji, Sagatta, Labgar), and interregional transhumance towards more humid areas in the south or towards the Sine Saloum region.

The scarcity of pastoral resources, exacerbated by environmental degradation and climate change, limits transhumance options.

In Ouarkhokh, the livestock product market is still in its infancy and largely dominated by household consumption. Milk is sold fresh in villages or directly in towns by women, the main constraints in livestock farming : reduction in pasture productivity

Key Cropping System: The trend is towards diversification. Watermelon, a cash crop, plays a very important economic role. It is grown in basins and sold in large markets (Dahra, Touba, Louga). In addition, bissap (Hibiscus sabdariffa), once grown exclusively by women, is now also cultivated by men (Sarr et al., 2021). Furthermore, peanuts and millet, which once dominated the Linguère department, are in decline (DAPS, 2017): peanuts accounted for 58.1% of crops in 1960, compared with 40.4% in 2017, a decrease of 32.5%; millet 48.4% in 1980 compared to 38.3% in 2017, a decline of 52.5%. This trend has been offset by the expansion of land devoted to cowpeas (3.5% in 1960 compared to 19.1% in 2017). The development of cowpea has been favoured by the shortening of the rainy season. It is used for forage, home consumption and sale.

Type of Agroforestry System: These are mainly livestock farming areas. As a result, agroforestry systems in the Dahra– Ouarkhokh area are best characterised by a combination of pastures with trees and shrubs. However, different types of parks can still be distinguished in this region (Tab. 13).

Table 13 : Typology of agroforestry system in Dahra/Ouarkhorkh area

Type of agroforestry system	Main tree species	Location in Dahra–arkhokh Ou	Origin
Traditional agroforestry park (field with scattered trees)	Acacia tortilis/raddiana, Balanites aegyptiaca, Faidherbia albida, Acacia seyal, baobab, etc.	Millet and peanut fields around villages (e.g. Ouarkhokh); also tree-lined pastoral areas (southern and northern Ferlo)	Traditional
Hedge (vegetable fence, windbreak)	Euphorbia balsamifera, wild jujube (*Ziziphus*), opuntia/cactus, thorny acacias (planted densely or intertwined).	Market garden perimeters (gardens in Dahra), field edges and village concessions (fences against livestock)	Traditional & Introduced (improved)
Orchards and fruit tree plantations	Cashew trees (cashew nuts), improved jujube trees ("Sahel apples"), sometimes Moringa, papaya trees (if water available).	In pilot plots near villages (Ouarkhokh, Dahra) and service centres (schools, post offices) – generally fenced and irrigated by project.	Introduced/ supported by projects (NGOs, dev.)
Assisted natural regeneration (ANR)	Natural regrowth of *Guiera senegalensis*, young *Balanites*, *Faidherbia*, *Combretum*, etc., preserved in situ.	Wherever spontaneous seedlings appear: in rain-fed fields (millet, cowpea) and bush areas near pastoral camps	Traditional (local knowledge) revived through projects
Reforested protected plot	Acacia senegal (gum tree) often planted in the majority; other regenerated local species (Balanites, various acacias, Boscia, etc.).	Degraded areas agreed with the community, e.g. Nguith communal forest (500 ha, Ouarkhokh); pilot plantations in Dahra, Boulal, Kamb, etc.	Introduced/ supported by projects (NGOs, dev.)

Farm Type: Predominantly pastoral and agropastoral family units. The size of farms in Ouarkhokh is generally small to medium, between 2 and 4 ha per farming household. These are therefore small-scale, low-intensification farms (traditional seeds, little or no mineral fertilisers) that are mainly geared towards self-consumption. However, there is a transition towards more diversified and, in part, market-oriented systems (watermelon, market gardening). Access to equipment, labour, water and inputs remains a determining factor in farm size.

Practices : Seasonal herd migration (transhumance). Fodder harvesting and storage. Assisted natural regeneration (ANR) of trees. Use of livestock manure to enrich cropped fields

Species : Trees are seen as an essential source of resources, both for human and animal consumption (fruit, leaves, fodder), for traditional medicine (bark, roots), and for domestic use (firewood, fencing, tools). Among the most common and valuable species in the Ouarkhokh area are trees typical of the Ferlo pastoral areas: *Balanites aegyptiaca* (soump), prized for its fruit and wood; *Sclerocarya birrea* (sidème), used for its edible fruits and medicinal properties; various species of acacia, including *Acacia senegal* (source of gum arabic), *Acacia seyal* and *Acacia raddiana,* recognised for their resilience and fodder value.

Socio-Economic Dynamics

Demographic Trend: Low population density but high dependence on livestock. Youth outmigration during dry season in search of work

Livelihood Sources: In Ouarkhokh, living conditions reflect a combination of vulnerabilities characteristic of Sahelian pastoral areas. Access to drinking water relies mainly on a few motorised boreholes and traditional wells, which are often remote and poorly maintained.
The nutritional situation is considered to be worrying. Dependence on millet, milk and NTFPs (baobab leaves, jujube, gums) is not sufficient to meet needs. Cases of moderate to severe child malnutrition have been reported by community health workers, exacerbated by a lack of dietary diversity and the remoteness of health posts.
In Ouarkhokh, rural women, young people and transhumant herders are the groups most exposed to precariousness. Women face structural exclusion from land ownership, very limited access to finance and a high domestic workload that is often not fully recognised.

Sources of Income: The results of interviews show that most households sell some of their livestock (sheep, goats), milk or non-timber forest products (such as gum arabic, baobab leaves or jujube) on an opportunistic basis. However, these transactions are often loss-making due to a lack of structure, price information and storage capacity. The dairy sector, in particular, remains under-exploited due to a lack of local collection and processing facilities. The household economy in Ouarkhokh is based on a diverse income basket (cattle, sheep and goats), centred on three main activities: pastoral livestock farming, non-timber forest products (baobab leaves, sideme, soump, gum arabic, wild fruits, honey) and small-scale agricultural and commercial activities. Finally, agricultural activities (millet, cowpeas, watermelons, okra), limited by the scarcity of rainfall and fertile land, generate little marketable surplus. Agriculture is mainly practised for subsistence purposes, with the exception of watermelons and peanuts.

Socio-institutional dynamics

Key Stakeholders

Table 14. Key stakheholders in Ouarkhokh

Type of stakeholders	Stakeholders in Ouarkhokh
Producers	Farmers, herders and charcoal burners
Community-based organisations	DIRFEL (Dispositif de Renforcement des Femmes en Leadership)
Platforms, umbrella organisations and local networks	FairSahel innovation platform
Local authorities and decentralised state services	Traditional leaders (village chiefs, imams, community leaders) play a key role in social governance Mayor of Ouarkhokh ANIDA (National Agency for Agricultural Integration and Development) CNDN (National Council for Nutrition Development) ANCAR (Agricultural Council),
Non-governmental organisations (NGOs) and development projects	
Private commercial actors	

Key Projects

Table 15 : Project over the last 10 years in Ouarkhokh

Project	Duration	Topics/ main activity
SustainSahel	2020–2025	Introduction of a local innovation platform in Ouarkhokh, promotion of integration of crops, shrubs and livestock. Co-development of innovations with producers, particularly around the agroecological use of Guiera senegalensis and the development of a 400-hectare fenced communal farm
DUNDI-Ferlo		Introduction of market gardening areas, promotion of trees as a resource and improvement of sustainable management practices. Deployment of solar irrigation systems, integrated farming activities and reforestation using techniques such as bokashi.
CREATE		Supported drip irrigation in a women's cooperative garden, doubling yields and reducing the drudgery of work. It is a benchmark for women's empowerment and local food security.
PDEPS		Sustainable Livestock and Pastoralism Development Programme in Senegal : strengthening transhumance, concerted management of grazing land, pastoral infrastructure and access to water.
GALILEO	2025-	Agroforestry integration. builds on the achievements of existing platforms and implements field surveys, participatory mapping and dynamic co-innovation around the triptych of trees, crops and livestock

Historical Data : The major droughts of 1972–73, 1982, 1984 and 2011 : these droughts were indirectly mentioned by key informants as critical moments in the transformation of pastoral systems: mutual aid practices, straw storage, and income diversification.The National Domain Law (1964) defines the national domain as "all land not classified as public property, not registered and whose ownership has not been recorded with the Land Registry on the date of entry into force of this law »

Institutional Data : Interviews conducted in June 2025 in the Ouarkhokh territory reveal a significant lack of basic infrastructure. The road network is particularly poor. There are no secondary schools or vocational training centres in the municipality, forcing young people to travel long distances. The Forest Code, which is perceived as restrictive in terms of access to natural resources (firewood, NTFPs, grazing land). Several interviewees lamented a lack of information on legal exploitation procedures and repression that is sometimes considered arbitrary by Water and Forestry officials. Livestock farmers report increasing restrictions in grazing areas, linked to the fencing of agricultural plots, land pressure and the rigid application of certain local rules. This generates tensions between communities or between villages.

Innovations

Table 16. Technical and organisational innovations in Ouarkhokh

	Endogenous innovations	Ideas from researchers
Technical innovations	Reuse domestic organic matter (manure), experiment with market	Close links with the Great Green Wall Initiative (GGWI) to benefit from effective

	gardening thanks to boreholes on which they are highly dependent, diversify crops (cowpea, fonio, market gardening, watermelon) and fodder crops (fodder cowpea, maralfalfa). They practise arid farming much more extensively. Finally, livestock farming benefits from new practices (paddling, artificial insemination, crossbreeding, natural practices to maintain sheep health).	reforestation training that has already been tried and tested in this area. Develop community nurseries. Also strengthen perennial hedges, agroforestry (*Acacia senegal* in village plantations for gum arabic, in partnership with local industrial plantations of AZILA Gum Company), and agroecological systems combining retention basins, half-moons, and infiltration. Use of fertiliser species (*Guiera senegalensis* , *Acacia seyal,* Balanites, Jujube, Baobab), optimised mulching and RNA practices (foxholes), as well as protected community forestry and collective nurseries,
Organisational innovation	Set up cooperatives (GIE, GPF, DIRFEL), innovation platforms (SustainSahel), village units and informal microcredit initiatives. developed backyard vegetable gardens.	formalising innovation platforms by involving NGOs, scientists, local leaders and neo-rural or migrant workers, and establishing a global round table. They recommend the implementation of interactive GIS, mobile applications for livestock farming, participatory monitoring and evaluation, and targeted advocacy with decision-making in . Finally, they recommend developing climate insurance mechanisms, strengthening rural citizenship, and experimenting with adaptive governance models.

Challenges and Opportunities

Challenges : Limited access to basic infrastructure : impassable roads, lack of functional water points, absence of sanitation, inadequate health, education and storage facilities. Climate variability and drought/ climate instability. Degradation of pastures. Land-use conflicts

Opportunities: Wealth of local knowledge: the populations have valuable traditional expertise in rangeland management, seed selection and the use of local plants for food, medicinal or commercial purposes. Valorisation of gum arabic and other non-timber products. Improved water harvesting and storage systems.

Lessons learnt for Galileo upcoming activities

Ouarkhokh represents a critical example of the challenges and adaptive strategies in Senegal's sylvo-pastoral zone. Its Living Lab approach fosters collaboration between pastoralists, researchers, and policymakers to co-develop innovations that enhance ecological resilience and livelihood security in a climate-stressed environment.

3.2.3 Description of Embu Living Lab

Physical data

Name of the Living Lab: Embu Living Lab
Country: Kenya
Location: Embu County, Eastern Kenya, located on the south-eastern slopes of Mount Kenya.
Agroecological Zone: Upper Midland and Lower Highland zones (arid and semi-arid areas).

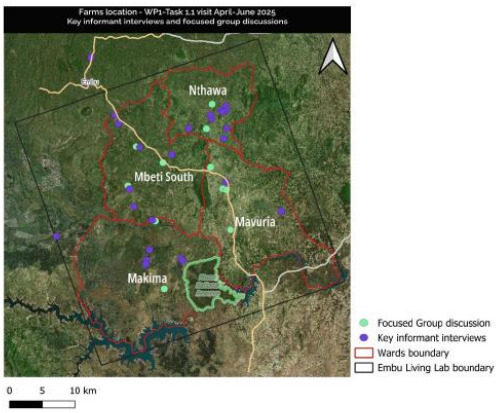

Figure 3: A general map for the 39 key informant interviews (purple dots) and focused group discussion (green dots) visited on 9-10th April 2025, 19-23th May 2025, 11-18th June 2025 and 1st-8th July for diagnostic purposes under WP1, task 1.1. Individual farmers and key informant interviews and group discussions of 15-20 peoples have been conducted.

Figure 8 : A general map for the 39 key informant interwiews (purple dots) and focus groups discussion (green dots)

Source : Diagnosis purpose under WP1_task 1.1

Context : The Embu Living Lab is situated in a high-potential agricultural region characterized by smallholder mixed farming systems. The area supports intensive crop-livestock-agroforestry integration, benefitting from fertile volcanic soils. However, land fragmentation, soil fertility decline, climate variability, and access to irrigation water pose significant challenges. The Embu County can be divided into a mountainous and a lowland part. The latter one is covered mainly by the sub-county Mbeere South (Fig. 9). Mbeere South is therefore a classical semi-arid area and was selected for Galileo as it represents dry areas to test and promote agroforestry systems.

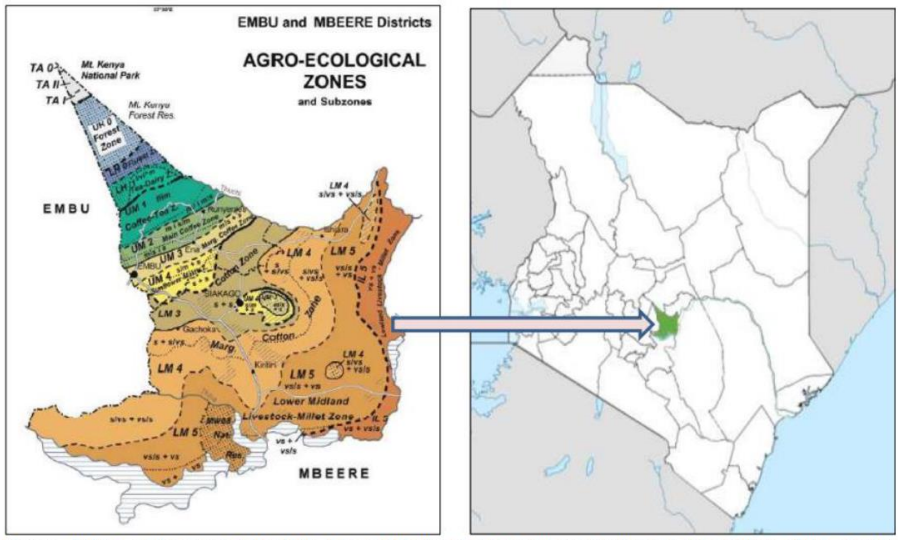

Figure 2: Map of the agroecological zones of Embu County and surroundings and position of the county inside Kenya (more details on the agroecological zones below) (Source: Ndirangu, 2021)

Figure 9 : Map of the agroecological zones of Embu county and surrondings

Ecological Data

Climate Characteristics : Climatic conditions in the region are characterized by mean annual temperatures ranging from 21 to 23.9°C alongside a bimodal rainfall pattern with total annual precipitation ranging from 700 to 1100 mm mainly during the March-May and October-December seasons. The rainfall duration ranges from 50 days in the March-May season to 40 days in the October-December season.

- **Nthawa Ward:** frequent droughts occur annually and typically last for around three weeks. Over the past 10 years climatic patterns have changed and are now more unpredictable than a few years ago. Rainfall remains generally low to moderate but is characterized by high variability and unreliability, creating significant challenges for rainfed agricultural systems.
- **Mavuria Ward : r**ainfall has been especially erratic for the past five years, favouring the emergence of new pest challenges
- **Mbeti South Ward :** faces similar ecological challenges characterized by highly erratic and unreliable rainfall patterns that create significant agricultural uncertainties. The ward experiences low rainfall throughout the year with high variability that makes agricultural planning extremelychallenging.

Soils : The Embu soils are heterogeneous comprising Ferralsols, Lithosols, humic Cambisols, ferralic Arenosols, Vertisols and ferralo-orthic Luvisols. High natural fertility but susceptible to erosion under intensive cultivation. Organic matter decline due to reduced fallow periods. The intervention area spreads on elevations ranging from 600 to 1280 meters above sea level contributing to the generally undulating landscape in the region.

- **Nthawa Ward:** Groundwater resources are accessible but require drilling to depths greater than 20 feet. In Nthawa ward, farmers reported that soil conditions require consistent nutrient inputs through fertilizer or manure applications to achieve optimal yields.

- **Mavuria Ward :** The soil composition consists primarily of Ferrosols characterized by low fertility levels, requiring consistent application of manure with fertilizers even when adequate rainfall is available.
- **Mbeti South Ward :** Soil conditions require farmers to apply manure or fertilizer for optimal harvest results, even when sufficient rainfall is available, indicating underlying fertility limitations. Some farmers purchase water from vendors for irrigation needs, particularly for khat cultivation, at a cost of KES 3,500 for 6,000 liters.

Vegetation and Land Cover: Agroforestry landscapes with coffee, macadamia, grevillea, and fruit trees intercropped with food crops.Patches of natural forest on hilltops and riparian zones.

- **Mavuria Ward :** The vegetation history of Mavuria Ward reveals that the area was sparsely populated with trees when settlement was intensified in the 1960's. Farmers subsequently initiated comprehensive land management practices including fencing and conservation of existing natural vegetation, followed by systematic tree planting programs featuring species such as Grevillea robusta. Farmers report that planting trees have helped local climate conditions, resulting in improved harvests despite ongoing water shortage challenges

Table 17. Summary of the key features of the agroecological zones (AEZ) within the Embu Intervention area

AEZ in intervention area	Description
Upper Midland zone 4	Upper midland zone with two short cropping seasons. Good yield potential for early maturing maize (*Zea mays*), sorghum (*Sorghum bicolor*), millet (*Pennisetum glaucum*), beans (*Phaseolus vulgaris*), and sunflower (*Helianthus annuus*). Perennial crops include cassava (*Manihot esculenta*), macadamia, bananas (*Musa sapientum*), citrus (*Citrus* spp.), and pawpaw (*Carica papaya*). Characterized by short growing seasons as in Gachoka, Karurumo and Nthawa.
Lower Midland zone 3	Lower midland zone with two short cropping seasons. Good yield potential for early maturing maize, millet, sorghum, beans, green grams (*Vigna radiata*), cowpeas (*Vigna unguiculata*), and sunflower. Characterized by hot and dry semi-arid climate as in Mavuria, Mwea, Evurore and Makima.
Lower Midland zone 4	Transition zone with short to very short cropping seasons. Crop potential similar to LM3. Good yields for pulses (edible seeds of legumes), millet, and groundnuts (*Arachis hypogaea*). Characterized by hot and dry semi-arid climate as in Kiambere, Evurore, Makima and Muminji.
Lower Midland zone 5	Dry lowland zone with very short to short cropping seasons. Well suited for drought-tolerant crops like millet, sorghum, cowpeas, mung beans (*Vigna radiata*) and green grams. Livestock and pasture are important. Low maize potential; Characterized by Hot and dry semi-arid climate as in Kiambere, Muminji, Makima and Evurore.
Inner lowland zone 5	Very dry zone with two very short cropping seasons as in Machanga. Suitable for early-maturing millet, pulses, and drought-tolerant legumes such as green grams, cowpeas, mung beans. Potential for dryland maize and sorghum on better soils. Pasture is extremely limited due to overgrazing, with degraded short grass bushland and thorny scrub dominating.

Biodiversity Relevance for Agroforestry: Multipurpose tree species for fodder, timber, fruits, and soil fertility enhancement.

Livestock Farming System: Zero-grazing dairy cattle, small ruminants, and poultry.

Key Cropping System: Agriculture is the main professional activity in the region. Smallholders cultivate different food crops such as maize, beans, green grams, cowpeas, pigeon peas (*Cajanus cajan*; Embu County Integrated Development Plan 2023-2027, 2023). The most predominant cash crop in the living lab is Khat (*Catha edulis*, with the most preferred "Muguka", a highly potent variety; (Kiunga, 2015), which tends to be valuable during dry periods when temperatures are higher.

Type of Agroforestry System: Agroforestry is integrated into these systems in several ways: boundary tree belts, homestead plantings, scattered trees in farm plots, fodder banks, and woodlots

Farm Type: These systems are mostly smallholder-based and combine both crop and livestock production on relatively small landholdings ranging from half an acre to 5 acres in the drier zones. Farms with 5 to 30 acres in our intervention area can be considered as middle-sized1; and if over 30 acres they are considered large scale farms in the county. Both middle and large size farms are very rare in our intervention area due to high land pressure, demographics and relatively unattractive soil conditions of the land (hence, for historical reasons). Farm size tends to increase in the drier lowland zones, where population density is lower and land is more available. In Nthawa, Mbeti South, and parts of Mavuria, households typically grow cereals (maize, millet,sorghum) alongside legumes and keep cattle, goats, and poultry. Further south in Mavuria and toward Makima, the dominant systems shift to livestock-cereal systems, with a stronger emphasis on drought-resilient legumes such as green grams, pigeon peas and cowpeas. The main cash crop is khat, having replaced cotton (*Gossypium* spp.) and tobacco (*Nicotiana tabacum*) about 20 years ago. Its cultivation requires significant irrigation and labor, affecting land and water allocation, and frequently competes with agroforestry.

Practices: Increasing adoption of water harvesting and solar-powered irrigation reflects farmers' responses to increasing droughts. Labor-demanding practices like biomass transfer recommended by Mugendi et al. (2004) are rare, likely due to limited labor availability**.**

Species: Common species include *Grevillea robusta*, *Calliandra*, *Acacia spp*., *Leucaena spp*., *Artriplex nummularia, Acacia albida, Tithonia diversifolia, Sesbania sesban, Chamaecrista cassia rotundifolia, Senna siamea, Gliricidia sepium*; all valued for shade, fodder, nitrogen fixation, and soil protection

Table 18. Description of the agricultural system in three ward

	Nthawa Ward	Mavuria Ward	Mbeti South Ward
Type of farms	small-scale farms of 2 to 6 acres and few middle-scale farms of around 10 acres	farm sizes ranging from small-scale operations of 1.5, 4, and 5 acres to some few middle size farms of maximum 15 acres. The average farm size is around 2	farm sizes including small operations of less than 3 acres, medium farms of 5 to 13 acres, and relatively large operations of 20 to 40 acres.
Staple Crops	maize, beans, banana, green grams, sorghum, arrow roots (*Maranta arundinacea*), pigeon peas, papaya, cassava,	Staple crops include maize, beans, pigeon peas, green grams, cowpeas, millet, sorghum, oranges, cassava, and papaya	maize, beans, sorghum, millet, cowpeas, cassava, sweet potatoes, arrow roots, banana, pumpkins, and *Dolichos* sp.,

	mangoes, avocado, and cowpeas		
Cash crop	khat, green gram, pigeon pea, papaya, cassava, sweet potatoes (*Ipomea batatas*), banana, mangoes, avocado, stevia (*Stevia rebaudiana*), hibiscus (*Hibiscus rosa-sinensis or H. sabdariffa*) and cowpeas	Cash crop production focuses primarily on khat as the main source of income, followed by green grams and cowpeas, with additional income from papaya, passion fruits, and dragon fruits	khat, watermelons, butternut, pigeon peas, tomatoes, and avocado.
Transition	moving from tobacco (*Nicotiana tabacum*) cultivation in the 1970s and 1980s under British American Tobacco to khat production beginning in the 2000s	from cotton and tobacco cultivation starting in the colonial time (1920's) until the end of the 1990's to khat production beginning in the 2000s.	transitions from cotton cultivation starting before the 1950's. Cotton was the dominant cash crop for many families through the 1970's–1990's, and the crop's significance continued into the early 2000's before serious decline due to pest problems, market failures and low yields. Khat production has replaced cotton in the 2000s
New sources of diversification of incomes	mangoes, watermelons (*Citrullus lanatus*) and butternuts (*Juglans cinerea*),		
Livestock system	Goats, cattle, ducks, geese, donkeys, pigeons, and poultry	cattle, poultry, goats, rabbits, and donkeys	goats, chicken, cattle, donkeys, and fish production
Tree cultivation	Grevillea robusta, Melia volkensii, Senna siamea, African teak (Amblyomma hebraeum), Moringa oleifera, pawpaw, mangoes, avocado, oranges, cashew nuts (*Anarcadium occidentale*), Gliricidia sepium, Calliandra spp., neem (Azadirachta indica) and Ailanthus altissima.	Tree species cultivation includes *Grevillea sp, Melia volkensii*, pawpaw, mangoes, jacaranda (*Jacarada mimosifolia*), oranges, *Senna siamea*, African mahogany (*Khaya sp.*), cedar (*Cedrus libani*), *Moringa oleifera*, *Leucaena sp*., avocado, Guava (*Psidium guajava*), cashew nuts, *Gliricidia sepium*, *Calliandra sp.*, *Euphorbia sp*., and *Gmelina arborea*	*Grevillea*, Avocado, *Melia volkensii*, Eucalyptus (*Eucalyptus campestris*), pawpaw, mangoes, oranges, Acacia (*Acacia mearnsii*), *Croton megalocarpus*, *Senna siamea*, neem, cashew nuts, tamarind (*Tamarindus indica*), pomegranate (*Punica granatum*), citrus, guava, mulberry (*Malus alba*), white sapote (*Casimiroa edulis*), *Vitex keniensis*, and *Sophora affinis*

Indigenous tree			milaba, mukinengav (knob wood) (*Zanthoxylum chalybeum*), muvuti (red hot poker tree; *Erythrina abyssinica*), muthata (Africa wild olive tree; *Olea europea*), mithuthi (African dog wood; *Maytenus senegalensis*), and mutoo (snot apple; *Thespesia garckeana*)
Function of trees			firewood, shading, microclimate creation, soil mulching, income generation
Practices	Beekeeping in the area mainly utilizes traditional log beehives	Beekeeping represents a widespread practice with the majority of farmers maintaining traditional log beehives ranging from one to over 50 hives per farm.	Beekeeping is practiced by many farmers maintaining one to over 20 log hives per farm
Agroforestry system	Agroforestry is integrated into these systems in several ways: boundary tree belts, homestead plantings, scattered trees in farm plots, fodder banks, and woodlots	boundary planting and live fencing, woodlots, homestead planting for visual appeal and shade, scattered trees within croplands, and fodder banks	boundary planting and live fencing, woodlots, homestead planting, scattered trees within croplands, alley cropping and hedgerow cropping, and fodder bank establishment
Input management	use of inorganic fertilizers and pesticides as well as mixed tithonia and pepper extracts as biopesticides against aphids, red spider mites, and whiteflies	use of agrochemicals for fruit flies, whiteflies, and spider mites, aphids and fall armyworm, and various other pest challenges. Herbicide use remains minimal due to high manual labour costs associated with application. Farmers also state using both fertilizer and manure although access is a challenge for them	organic foliar feeds and biopesticides
Pest and disease management		scales and crabs affecting khat, citrus greening disease, termites damaging *Grevillea*, unknown pests affecting *Croton megalocarpus*, and maize weevils causing post-harvest losses	thrips, aphids, cutworms, Maize dwarf mosaic virus, fall armyworm in maize, and whiteflies in common beans.

Collective action		Farm organization demonstrates strong cooperative tendencies, with many farmers participating in multiple groups	
Land ownership		Land ownership is secured via title deeds inheritance and purchase. Land rental for cultivation rarely occurs due to sufficient individual land holdings	Land ownership is secured through title deeds, Land rental for cultivation rarely occurs due to sufficient individual holdings, though some farmers lease land to migrants including Asian communities
Labour		Farm labour systems combine collaborative household labour with available hired casual labour at rates of KES 400 per day.	

Socio-economic Dynamics

Market access varies across the region, with farmers having access to various local and larger markets, though market dynamics present ongoing challenges. Price instability remains a persistent concern, with farmers frequently facing situations where buyers set prior market terms rather than receiving fair negotiated prices.

Table 19. Description of socio-economic dynamics in Embu LL

	Nthawa Ward	Mavuria Ward	Mbeti South Ward
Demographic Trend	High population density resulting from significant immigration	high population density due to substantial immigration rural-to urban migration of youth despite these opportunities, the number of young people actively engaged in farming remains concerningly low	high population density resulting from high immigration Rural-urban migration among youth has declined since the introduction of khat farming, though youth engagement in khat cultivation
Income generation	Income generation relies primarily on farming, supplemented by diverse businesses such as online employment, basketery, weaving, and crafting		Income generation relies primarily on farming supplemented by various business enterprises including basketry, hair salons, weaving, crafting, and small-scale enterprises
Market access	Siakaga, Muchonoke, and Embu markets, providing	Nearby market access center is Kiritiri market, providing a primary outlet for	

	farmers with multiple options for selling their produce. However, price dynamics remain challenging, with generally low prices that fluctuate frequently	agricultural produce as well as buying farm inputs.	

Socio-instititutional dynamics

Key Stakeholders

Table 20. Key stakeholders in Embu

Type of stakeholders	Stakeholders in Embu
Farmers organisations	Village-Based Advisors (VBAs) Mavuria ward : New Mbeere SHG, Khat SACCO, KFA, Window Group, and JoyTwo Farmers Group
Social groups and networks	Savings and Credit Cooperatives (SACCOs), women in agribusiness network, self-help groups,
Community based organisation	
Research institutions	Centre for International Forestry Research and World Agroforestry (CIFOR-ICRAF), international centre for insect physiology (ICIPE), Kenya Forestry Research Institute (KEFRI), and Kenya Agriculture and Livestock Research Organization (KALRO)
NGO	Farm Africa, CARITAS
Development partners	ADS Kenya, Good Neighbours from Korea, Rainforest Alliance, One Acre Fund, and JICA
Private sector	Bayer Crop Science
Government agency	MoA, KCEP-CRAL, NARIGP

Gender consideration : Men primarily grow cash crops such as sugar cane (Saccharum officinarum), yams (Dioscorea alata), cotton, and bananas, while women focus on a range of crops, including various potatoes, cassava, millet, and legumes like cowpeas, pigeon peas, garden peas, beans and lentils (Vicia lens).

Key Projects

Table 21. List of projects implemented in Embu LL area in the past 5 years

Recent project Interventions/Organization (2020-2025)	Description
Kenya Cereal Enhancement Programme-Climate Resilient Agricultural Livelihood (KCEP-CRAL)	Promoting climate-resilient cereals and pulses, minimum tillage practices, crop rotation, farm inputs, certified seeds, and tree planting initiatives
The regenerative agriculture program by Farm Africa	Promoting regenerative agriculture program, carbon credits, agroforestry, etc
Japan International Cooperation Agency (JICA)	Promoting *Melia volkensii,* tree nursery establishment and farmers field schools
Agriculture and Food Authority (AFA)	Cashew nuts promotion
Financing Locally-Led Climate Action (FLLoCA)	Maintains ongoing activities in climate adaptation and tree planting across all wards
ICRAF-CIFOR's	Advocating minimum tillage and organic farming practices
National Agricultural Value Chain Development Project (NAVCDP)	Promotes green grams, millet, mangoes, oranges, avocado, indigenous crops and dairy goats
Climate-PAL	Supports growth of fruits trees such as mangoes, oranges, and other trees like *Senna siamea,*
Rain Forest Alliance along with Embu County government and KFS	Supports climate change resilience programs, agroforestry trees such as *Gravelia, Senna siamea*, and *Terminalia brownii* and food crops like maize, green grams, cow peas, pigeon peas, and citrus.
Project by CARITAS (FBO)	Promoting, training and supporting planting of trees, crops, and water harvesting
Project by Action-Aid (NGO)	Advocating water harvesting, resilience against climate change, livelihood empowerment, soil management and sensitization of youths on climate changes through training.

- **Mavuria's** interventions have focused more on climate resilience and food security
- **Mbeti South** has seen the most intense intervention density, with Farm Africa, Bayer, University of Nairobi, AFA, ICRAF, and NARIGP all active. The diversity of programs reflects the area's strategic importance and institutional connectivity.
- **In Makima ward,** NGO support has been especially visible. CARITAS (since 2014) and ActionAid (since 2011) have promoted tree planting, rainwater harvesting, and youth climate training

Historical Data : Longue tradition of coffee farming since colonial period, Adoption of agroforestry in the 1980s to combat soil erosion.

Institutional Data : Due to lack of policy on land use, land fragmentation and conversion to urban land uses, especially of fertile agricultural land, has been ongoing in the County. In the previous government regime (2013 - 2022), agroforestry policy reform initiatives majorly focused on the national target of achieving 10% tree cover across the country. On the other hand, the current regime (2022 - present) has adopted a 15 billion tree planting initiative, aiming to achieve this target by year 2032 by reaching a tree cover of 32% from the current 12%. The National Climate Change Action Plan (NCCAP) outlines the guidelines for engagement by different stakeholders at the national level.

At the County level, the policy direction with regard to climate change in Embu County is outlined with specific goals and objectives (Embu County Climate Change Action Plan 2023-2027, 2023).

Innovations

Several innovations have been identified. Some of them are project-driven and other are endogenous innovations.

1. Integration of fodder shrubs into zero-grazing systems.
2. Biogas use from livestock manure.
3. Digital extension services for market and weather information.
4. Farmers developing systems for water harvesting using dams, boreholes, and man-made wetlands
5. Mulching to manage weeds and conserve water is practiced
6. A notable innovation involves germinating maize in trays and transplanting seedlings to fields, which reportedly results in higher yields compared to direct seeding method
7. Farmers have developed locally prepared biopesticides including "Foliar Dasim" combining *Lantana camara*, tithonia, neem, and *Melia volkensii* for termite control
8. install a fishpond, which functions as well as a water harvesting pond from road runoff
9. planting trees in V-shaped or semi-circular bunds in order to hold the run-off.

Challenges and Opportunities

Table 22. Challenges in opportunities in the Embu LL

	Nthawa Ward	Mavuria Ward	Mbeti South Ward
Challenges	Water shortage from climate change, pest problems with scales in khat and fall armyworm in maize, lack of certified seeds, insufficient funds for inputs, and limited knowledge of soil fertility testing and fertilizer application Specific agroforestry challenges include inadequate knowledge, late disbursement of tree seedlings that should arrive before rains, *Grevillea* dieback from unknown pests, ant attacks on mangoes and oranges causing tree death, and monkey raids from nearby trees.	Water shortage and pest problems, along with lack of certified seeds, insufficient funds for inputs, and limited knowledge of soil fertility and fertilizer management. Agroforestry challenges include lack of clear and supportive policies, pest infestations particularly termites affecting *Grevillea sp*, tree-crop competition, and certain trees like *Melia volkensii* harbouring diseases transmissible to khat	Water shortage from climate change, pest and disease problems such as scales in khat, shortage and expensive certified seeds, lack of technological access and information related to agroforestry and agriculture, and postharvest losses from maize weevils. Competition for nutrients between crops and trees. Resource access problems include lack of capital, certified seeds, and water shortage, while labour shortage and high costs necessitate hiring immigrants from Uganda
opportunities	opportunities exist in apple and cashew nut farming development, avocado cultivar	regenerating large land tracts through	Opportunities exist in training on grafting for

	propagation, improved water access through runoff harvesting and groundwater development, enhanced pest and disease diagnosis and training, carbon credits from trees with four farmers already receiving compensation, and value addition for farm products, especially fruits like mangoes	regenerative agriculture, improving soil microbial communities, providing farm inputs closer to farmers, training on germination and maintenance of *Melia volkensii* and *Moringa oleifera*, grafting fruit trees particularly avocado, and comprehensive training on agroforestry practices	oranges, avocado, and mangoes, Promotion of preferred fruits including avocado, pixie apple, and mango, and development of goat and poultry farming. Farmers specifically link agroforestry practices to consistent harvests

Lessons learnt for Galileo upcoming activities

The Embu Living Lab is a dynamic hub for agroecological innovation, fostering smallholder resilience through integrated crop–livestock–tree systems. It demonstrates how diversified agroforestry landscapes can sustain livelihoods while conserving the environment under changing climatic and socio-economic conditions.

Delimitation of Emu LL : To account for this heterogeneity, we propose the Embu Living Lab (LL) to be structured into two sub-Living Labs (sub-LL): (1) Nthawa/Mbeti South and (2) avuria/Makima. This division groups together wards with comparable environmental and socio-economic conditions, thereby ensuring more homogeneous and operational clusters for experimentation and co-design. The grouping of Nthawa with Mbeti South (sub-LL 1) versus Mavuria with Makima (sub-LL 2) thus aligns with these climatic zones: sub-LL 1 covers the somewhat less arid, uppermidland zone portions of the area, while sub-LL 2 encompasses the drier lower-midland to inner lowland zones (Fig. 10).

A key emerging incentive for tree planting is **carbon credit programs** run such as Acorn which empowers smallholder farmers by supporting them to transition to sustainable agroforestry practices and measure the resulting biomass increase, issuing carbon credits accordingly. The programs work with local implementing partners such as Farm Africa and Trees for Kenya. They facilitate carbon credit payments to farmers through the sale of Carbon Removal Units (CRUs). Farmers participating in these projects receive a guaranteed minimum price per tonne of CO2 removed for each CRU sold with the prices ranging from €20 to €31.

Figure 10. Google map showing the two sub-Living Lab of Embu (area demarcated in red)

3.2.4 Description of Loum Tombel Living Lab

Physical data

Name of the Living Lab: Loum Tombel Living Lab
Country: Cameroon
Location: Loum and Tombel districts, Littoral and South-West regions
Agroecological Zone: Humid Forest Zone (monomodal rainfall regime)

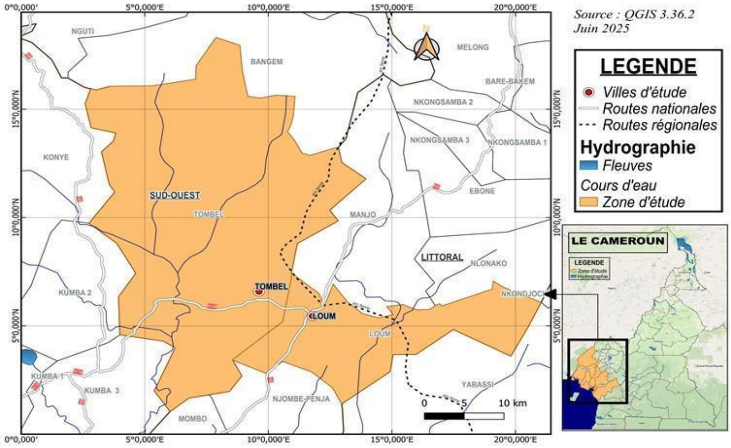

Figure 11. Map of Lom and Tombel villages

Context

The Loum Tombel Living Lab operates in a major agro-industrial zone known for both large-scale plantations and smallholder farms of very important cash crops of cocoa, penja white pepper, rubber, rubusta coffee and banana. The area is a hub for cocoa, oil palm, and banana production, but faces environmental degradation, land-use conflicts, and socio-economic disparities. The LL seeks to co-develop sustainable land management and agroforestry-based livelihood strategies. . The Council of Loum is located on the border not only of two regions but also, and more importantly, of the French-speaking and English-speaking parts of Cameroon. The coordinates of this city are 4°71 North and 09°72 East. This Commune is bordered to the north by the sub-divisions of Manjo (via NLOHE) and Eboné, to the south and east by the sub-divisions of Penja-Njombé (via Njombé) and Yabassi (via Solé), and to the west by the subdivision of Tombel.

The Tombel council is found in the South West region of Cameroon, situated between 4 ° 16 'to 5 ° 15' north and longitude 09 ° 13 'to 09 ° 15' East latitude. It lies on the western side of the Kupe Mountain. The municipality has a surface area of 1007 km^2. Its population is Estimated at about 110,178 Inhabitants according to the 2005 census.Tombel council area is bounded: in the North by the Bangem Council (Kupe Manengouba Division) in the East and by the LOUM MANJO Councils (Mungo Division), in the West by the KUMBA III and Konye Councils (Meme Division) and in the South by the NJOMBE and Penja Councils (Mungo Division.

Ecological Data

Climate Characteristics : The Tombel-Loum corridor in Cameroon's Meme-Mungo region experiences a tropical monomodal rainfall climate, characterized by a long rainy season from March to November and a short dry season from December to February (IRAD & GDA, 2025). Annual rainfall varies significantly across the zone: 1,800–2,500 mm in Tombel, decreasing to 1,200–1,500 mm in Loum due to its proximity to semi-arid zones. Temperatures remain relatively stable year-round, ranging from 24–32°C, with peaks reaching 35°C in March–April. Climate risks include erratic rainfall patterns

Soils : The soils of the locality of Loum are of volcanic origin with a black texture on the majority of the surface covered by the commune. The soil of the commune of Tombel, composed of volcanic ash, is extremely fertile. Since the 19th century, soil erosion by water was a critical problem, greatly affecting the economic life of the population of Tombel. Dominant soils include deep, well-drained ferralitic soils prone to nutrient leaching (common in Tombel), acrisols which are clay-rich, acidic and low-fertility (predominant in Loum), alluvial soils along riverbanks (e.g., Nkam River), suitable for intercropping and old volcanic soils: Fertile but increasingly degraded. Relief: Loum is located in an area dominated largely by mountains, hills and plateaus.

Vegetation and Land Cover: Over the past decade, 40% of topsoil has been lost due to deforestation and unsustainable land use since 2010. Organic matter content is below 2%, primarily due to monoculture practices and excessive agrochemical use, which negatively impact soil macro-fauna such as earthworms, ants, and termites which are key contributors to soil fertility (Tsufac *et al*., 2021).

The municipalities of Loum and Tombel are located in the heart of the tropical rainforest, with a wide variety of tropical trees. Current land use includes:

- Cocoa agroforestry systems covering approximately 50% of the land, integrating *Theobroma cacao* with shade trees such as *Gliricidia sepium*, *Terminalia superba*, *Albizia* spp., and *Dacryodes edulis*.
- Degraded forest patches harboring remnant native species like *Milicia excelsa* (African teak) and *Entandrophragma cylindricum* (sipo mahogany).
- Secondary grasslands resulting from slash-and-burn agriculture

Biodiversity Relevance for Agroforestry: Cocoa agroforestry shelters diverse shade trees; habitat for pollinators and wildlife.

Agricultural System

Livestock Farming System: Small-scale poultry, goats, pigs integrated into household farms and in some cocoa plantations.

Key Cropping System: Agricultural Potential: Suitable for a wide range fo food, cash and vegetable crops like rubber, palm, cocoa, cassava, plantain, maize, groundnuts, oil palm, agroforestry and mixed cropping and mixed farming systems.

Type of Agroforestry System: Based on field observations and classification frameworks, agroforestry systems in the area can be categorized as follows:

- Agrosilvicultural systems: Integration of trees and crops (e.g., cocoa + *Dacryodes edulis*, plantain, cassava).
- Agrosilvopastoral systems: Combination of trees, crops, and livestock (e.g., cocoa farms with pigs and goats, as observed in Bulutu and Ehom) (IRAD & GDA, 2025).

- Home gardens: Multistorey systems around homesteads with diverse crops and trees (e.g., *Persea americana*, *Citrus spp.*, *Cola acuminata*) (IRAD & GDA, 2025).
- Alley cropping: Growing crops between rows of nitrogen-fixing trees like *Gliricidia sepium* (IRAD & GDA, 2025).

Scattered trees on croplands: Retention of native trees during land clearing for shade and soil improvement

Farm Type: The farming system is dominated by smallholders with average farm sizes of 2–5 hectares (IRAD & GDA, 2025). Most practice low-input, rain-fed agriculture, relying on traditional knowledge. There is increasing interest in grafted and hybrid cocoa varieties (e.g., CCN-51, Trinitario) to shorten maturity periods and improve yields .

Practices: There is a growing shift toward climate-resilient and diversified agroforestry systems, driven by climate stress, declining soil fertility, and market demands for certification (Assobo & Oyono, 2025). However, adoption remains constrained by infrastructure gaps and limited access to inputs and finance (Tchouamo *et al*., 2022).

Species: Based on observations and literature, farmers generally prefer multi-purpose trees:

- *Gliricidia sepium*: Nitrogen fixation, shade, and fodder.
- *Dacryodes edulis* (Safou): Fruit and timber.
- *Irvingia gabonensis*: Condiment, medicinal use, and shade.
- *Grevillea robusta*: Timber, windbreaks, and fodder.
- *Terminalia superba*: Timber and canopy shade.

Hietet (2005) observes a preference for *Dacryodes edulis*, *Ricinodendron heudelotii*, *Irvingia gabonensis* and various exotic fruit species of the citrus genus among the plants that accompany the cocoa tree.

Socio-economic Dynamics

Demographic Trend: The region has a high rural population density, with significant youth involvement in cocoa farming. Outmigration from the Northwest and nearby Southwest regions due to the Anglophone Crisis (2017–2022) disrupted cooperative activities and delayed implementation of some projects, and has led to migration into the area. Producers who are members of cooperatives or certified generally benefit from privileged access to markets and premiums, unlike those who are excluded. Although women and young people are involved in production, they generally have limited access to the income it generates, due to social norms and land ownership structures

Livelihood Source: Generally speaking, economic activity in the Loum-Tombel living lab is characterized by the practice of small income-generating activities to cope with persistent youth unemployment and persistent poverty. Despite the income generated by the sale of cocoa, the daily search for the satisfaction of physiological needs remains the primary concern of families.

Sources of Incomes: Primary Economic Activities are the production of cash crops such as cocoa, coffee, and rubber. Food crops include cassava, plantain, corn, and some vegetables. These activities are carried out by the CDC, the PHP, some GICs, cooperatives, and individuals, loggers, and quarry operators. Secondary economic activities include agricultural machinery; the presence of the agro-industrial company Plantation du Haut Penja – Société de Bananeraie du Moungo (PHP-SBM) strongly affects industrial activity. Rural poverty is moderate to high, with cocoa serving as the primary cash income source for over 70% of households. Income instability due to volatile cocoa prices and climate shocks exacerbates vulnerability (Gockowski *et al*., 2001). Cocoa farmers in these areas have more income than other producers, even though their activities are important.

Market access : Incentives have been put in place (by projects and certification), to strengthen market access by cooperatives and buyers, but the structure of the market (coxeurs and 2 or 3 larger traders) mean there is generally limited access and farmers and cooperatives are price takers. Main markets are Loum and Nkongsamba which serve as local trading hubs. Export links are through Kribi and Douala via SOCAPALM, Barry Callebaut, and Olam partners. Agroforestry products are mainly sold via local and regional markets. Farmers' organizations play a role in product marketing, but their access to markets is hampered by poor infrastructure and a lack of coordination. Barriers: Poor feeder roads limit access, increasing input costs by 30–50% and causing post-harvest losses. Agriculture is the main activity in these districts (Food crops: Maize, cassava, plantain, groundnuts and yams are grown for self-consumption and local sale and livestock such as small ruminants, poultry and pigs are raised for home consumption and sale) with cocoa a major source of income for the majority of producers.

Socio-institutional dynamics

Key Stakeholders : Farmers' organizations have a role in production. They aim to increase buying prices and production (ie via training and supply of inputs) and are the main vehicle for certification – which many large traders use to secure their supplies and to channel training and information. Rainforest Alliance is the major certification standard in Cameroon and the area (Ingram et al 2025).

Table 23. Main stakeholders in Loum-Tombel

Stakeholders	TYPES	Function
Smallholder Farmers	Cooperative	Primary producers; manage cocoa farms and agroforestry systems.
MINADER	Government organization	Support a productive, profitable and competitive agriculture
MINFOF	Government organization	Formulates and executes policies related to forest and wildlife management ensuring sustainable practices
MINEPDED	Government organization	Developing and implementing environmental policies, protecting nature and promoting sustainable development
PCP-ACEFA	Government organization	Aim at improving the competitiveness of family farms by providing agricultural and pastoral advisory services
OFI	Government organization	Grouping farmers in cooperative and follow up certification, sensitization and capacity building
FODECC	Public organization	Manage and distribute funds derived from a levy on cocoa and coffee export aiming to improve production, quality and market access for producers.
RAINFOREST ALLIANCE	Certification organization	Drive more sustainable agricultural production and responsible supply chains.
Farmer Cooperatives (COHOPCOOP, UNIFACOOP, MBOA)	Cooperative	Input supply, collective marketing, nursery management, training.
IRAD (Institute of Agricultural Research)	Government organization	Research, nursery upgrades, tissue culture, agroforestry trials.
TELCAR COCOA	Private company	Promoters in certification of cocoa

SOCAPALM, Olam, Barry Callebaut (Sic Cacao)	Private companies	Private exporters; provide warehousing, drying, and export logistics.
ONCC (National Cocoa & Coffee Board)	Government organization	Regulation, quality control, warehouse modernization.
MINADER (Ministry of Agriculture)	Government organization	Policy implementation, extension services.
GIZ, WWF, AFR100, WFP	International NGOs	Funding, technical support, training, conservation programs.
CIRAD, Wageningen University (WUR)	Research	Research partners in GALILEO; innovation testing and capacity building.
Local NGOs (e.g., Cameroon Ecology)	NGO	Community mobilization, wildlife monitoring, advocacy.
Microfinance Institutions (MFIs)	Private companies	Potential providers of credit for agroforestry investments.

Key Projects

- GIZ Cocoa Sector Support Program (2020–2023): Promoted grafted cocoa seedlings and agroforestry training for smallholders.
- IRAD Agroforestry Research (2021–2023): Tested intercropping models such as cocoa + *Dacryodes edulis* to enhance income diversification
- AFR100 Tree Planting Initiative (2019–2023): Supported community nurseries for native tree species, aligning with biodiversity and restoration goals .
- BNCC Warehouse Modernization (2022–2023): Upgraded two warehouses in Loum to reduce post-harvest losses
- WFP Climate-Smart Agriculture Pilot (2021–2023): Introduced drought-tolerant crops and agroforestry practices to enhance resilience.
- GALILEO Living Lab Establishment (2025–present): Co-designed agroforestry innovations with communities, integrating local knowledge and scientific research.

Historical Data : Cocoa introduced in early 20th century; oil palm industrial expansion in the 1960s. Plantation agriculture reshaped land use patterns and livelihoods.

Table 24. Key historical events in Loum-Tombel

Event	Impact on Agroforestry Development
Loum-Douala Road Upgrades (2015–2020)	Improved regional transport but neglected rural feeder roads, limiting agroforestry input distribution.
Deforestation (2005–2020)	Loss of native shade trees increased reliance on artificial shading and reduced biodiversity.
Climate Change (2010–2023)	Erratic rainfall and droughts necessitated shift to drought-tolerant species.
Anglophone Crisis (2017–2022)	Insecurity disrupted cooperatives and delayed nursery and infrastructure projects.
PNACC Adoption (2018)	Created policy space for agroforestry but lacked localized implementation.

Institutional Data : Active producer cooperatives and community-based organisations. Collaboration between local councils, research institutions, and private sector. The commune of Loum is home to a protected area created by decree No. 162 of 12-06-1932 with an area of 1100 ha even if today nearly 310 ha are exploited for agriculture (PNDP, 2012). Cameroon is party to international agreements related to sustainable agriculture, climate change, and environmental protection which it is unliterally subject to which will soon be implemented, such as the EU Deforestation Regulation, influencing the legal framework for the Living Lab

- National Climate Adaptation Plan (PNACC): Prioritizes climate-smart agriculture and post-harvest technologies.
- AFR100 Commitment: National pledge to restore 12 million hectares of degraded land by 2030.
- Cocoa & Forest Initiative (CFI): Promotes zero-deforestation cocoa production.
- REDD+ and VCS Standards: Enable carbon credit generation from agroforestry

Innovations

Innovation observed in the LL :

1. Use of *Gliricidia sepium* as living fences and shade trees: Enhances soil fertility and reduces erosion.
2. Intercropping cocoa with Safou (*Dacryodes edulis*) and Bush Mango (*Irvingia gabonensis*) to diversify income and improve canopy cover.
3. Samoa Ovens for drying cocoa: Locally adapted wood-fired drying platforms. Disadvantage is smokey smell in cocoa and poor flavor quality, advantage is reduction of moisture content in beans, also a trade norm for sale and export.
4. Community-based nursery management: Cooperatives run nurseries for cocoa and agroforestry trees.

5. Grafting techniques adopted by around 50% of cooperatives to shorten maturity period (3 years vs.4 to 5 year normal first harvest).
6. Traditional knowledge of shade management: Farmers use native trees to regulate microclimate.

Innovation from the literature :

1. Combining fruit trees has provided regular additional income (Mopi et al. 2024 ; Snoeck et al. 2020; Ngnogue et al. 2012).
2. Improved microclimate and cocoa yields thanks to certain shade species(Wu et al. 2016 ; Snoeck et al. 2013).
3. Strong adoption of diversified systems by motivated farmers.

Challenges and Opportunities

Challenges :

- Infrastructure Deficits: Poor roads, inadequate warehouses, and lack of drying facilities.
- Climate Risks: Erratic rainfall, droughts, and flooding affect production and storage.
- Low Genetic Diversity: Over-reliance on few cocoa clones (e.g., CCN-51) increases pest vulnerability.
- Deforestation and Land Degradation: Annual deforestation rate of 20% in Tombel; loss of native shade trees.
- Market Volatility: Low cocoa prices discourage investment in improved practices.
- Limited Access to Finance: Cooperatives lack funds for nurseries, dryers, and tools.
- Socio-political Instability: Anglophone crisis disrupted project continuity.

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Opportunities:

- Growing Global Demand for certified, sustainable cocoa (EU, U.S. markets).
- Carbon Credit Markets (REDD+, VCS): Agroforestry systems can generate dual income.
- Policy Alignment: PNACC and AFR100 provide funding and institutional support.
- Digital Agriculture Tools: GIS mapping (e.g., UjuziKilimo) for monitoring and planning.
- Regional Trade (AfCFTA): Improved market access for Cameroonian cocoa.
- Climate Resilience: Adoption of drought-tolerant species and solar dryers.

Lessons learnt for Galileo upcoming activities

The Tombel-Loum area presents a high-potential but vulnerable context for cocoa agroforestry development. While rich in biodiversity and traditional knowledge, the region faces critical infrastructure deficits, climate risks, and socio-economic constraints

Recommentdation for Galileo next step : To mitigate these external threats, the Loum tombel Lab should consider:

- Developing (and testing impacts) of diversified farming systems and climate-resilient agricultural practices and supporting local farmers in adapting to climate change
- Supporting farmer organisations to diversify partnerships and funding sources to reduce dependence on a single market or donors
- Engaging with policymakers and stakeholders to advocate for supportive policies and regulations
- -Monitoring and addressing environmental degradation, particularly deforestation, through sustainable practices and community engagement, and partnering with traders and the government who are geomapping farms.
- Implementing robust cybersecurity measures, such as firewalls, intrusion detection systems, and employee training

By understanding and addressing these external threats, the Living Lab can enhance its resilience and effectiveness in promoting sustainable agriculture and development in Cameroon.

3.2.5 Description of Ntui Bokito Living Lab

Physical data

Name of the Living Lab: Ntui–Bokito Living Lab
Country: Cameroon
Location: Ntui (Mbam-et-Kim Division) and Bokito (Mbam-et-Inoubou Division), Centre Region
Agroecological Zone: Forest–Savannah Transition Zone, humid forests with bimodal rainfall.

Context : The Ntui–Bokito Living Lab is located in a landscape that transitions between forest and savannah, with diverse farming systems combining food crops, cash crops, and tree-based systems. The LL's work focuses on enhancing agroforestry, soil restoration, and climate-resilient livelihoods in areas affected by land degradation and variable rainfall.

[map, incl. info on distance to Loum Tombel LL]

Ecological Data

Climate Characteristics: This locality obeys the Cameroonian type equatorial climate with four seasons. We have a long dry season, from mid-November to mid-March, during which rural activities come to a standstill and populations are subject to famine; a short rainy season, from mid-March to mid-June, a short period during which rural activities are devoted to growing short-cycle plants, such as corn, citrus fruits, etc: A short dry season, from mid-June to mid-August, during which field activities are, for the most part, devoted to preparing the land to receive the next crops; and long rainy season, from September to mid-November, during which there is a lot of rural activity and cocoa harvesting. The annual annual rainfall is 1,500 to 2,000 mm, Humidity is high (generally 70%–90%). There is increasing weather and climate variability, The landscape is subject to the classic Guinean sub equatorial climate with two rainy seasons (corresponding to the growing seasons) and two dry seasons (Abela, 2016). The average temperature in the region fluctuates around 26ºC with a temperature range varying between 18 and 35ºC. The hot season lasts 3 months, from January to April, with an average daily maximum temperature above 31ºC. According to the Municipal Development Plan, the landscape of Ntui is watered by the Sanaga, a river with a permanent flow characterized by its very rapid falls. According to the Municipal Development Plan, several rivers irrigate the landscape of Bokito, including the Mbam and Sanaga rivers, the most important, whose banks, fertilized by a permanent supply of alluvium, which favours market gardening.

Soils : According to the Municipal Development Plan, the soils are lateritic in nature, heavily leached by metamorphic rocks consisting of gneiss and quartz formations, for the most part. This soil structure is characteristic of fertile lands, suitable for food and cash crops such as cocoa.

Vegetation and Land Cover: Ntui is located in a forest-savannah contact zone. Its ecological landscape is a forest-savannah mosaic of varied extent. While tree cover is over 75% of the area, the proportion of agroforests to natural forests is unknown. Bokito landscape is mainly composed of savannah areas located in the southern part of the landscape in which we already note conflicts between indigenous populations and cattle breeders who come in search of pastures. There are, along a density gradient, some forests with species of high economic value such as sapeli, bibinga, iroko, mongossi, athui, and many other types of wood. This is a transition zone between forest and savanna with semi-deciduous forest and forest tree species like *Terminalia superba, Milicia excelsa (iroko), Entandrophragma spp*. This area has had dynamic changes in landcover change from forest

to agriculture, increasing population densities and increasing prevalence of cocoa based agroforestry systems over the period 1910–2010.

Biodiversity Relevance for Agroforestry: Multipurpose indigenous species (e.g., *Albizia*, *Irvingia*, *Dacryodes*) support pollinators, soil cover, and food production. Current land use includes:

- Derived savanna: result of deforestation and farming, dominated by grasses and shrubs
- Gallery forests: along rivers and streams, agroforestry systems are common: mixing of cocoa, plantain, cassava, oil palm, fruit trees (mango, avocado), and forest trees.
- Rich floral biodiversity due to mix of forest and savanna species and wildlife such as monkeys, birds, rodents and reptiles, but which is declining due to habitat disturbance.

Trees in cocoa agroforestry system as follows:

- *Gliricidia sepium:* Nitrogen fixation, shade, and fodder.
- *Elaeis guineensis* Oil palm ; palm oil palm wine
- *Mangifera indica* Mango fruits
- avocado,
- *Ricinodendron heudelotii* (Njangsang) seed kernels and bark
- Citrus (orange, lemmon, lime) fruits
- *Dacryodes edulis* (Safou): Fruit and timber.
- *Irvingia gabonensis*: Condiment, medicinal use, and shade.
- *Terminalia superba*: Timber and canopy shade.

Agricultural System

Livestock Farming System: More specialized systems include agro-pisciculture integrating fish farming with crop production through nutrient cycling, and apiculture systems that incorporate bee colonies to enhance pollination and honey production. These integrated approaches demonstrate how cocoa farms can be designed as multifunctional landscapes, where agricultural byproducts like animal manure become fish feed, while pond sediments serve as crop fertilizer, creating closed-loop systems that enhance food security and environmental conservation. As well were cocoa related farming system and animal rearing - cocoa agrosilvopastoral farming systems with livestock enhance farm productivity, improve soil health, and contribute to the livelihoods of farmers for various benefits (Farrant et al. 2021). Animal manure has been used as a fertilizer to improve soil structure and nutrient content, which is crucial for cocoa tree health and yield. Livestock, particularly goats and sheep, can graze in cocoa farms after harvest, helping to manage weeds and utilize crop residues with a main pitfall being that they will destroy the seedlings of cocoa or other shade trees. The integration of animal production into cocoa-based agroforestry systems offers numerous benefits, including increased productivity, diversification, and sustainability (Turcios and Papenbrock 2014; Chi et al. 2020). However, careful planning and management are needed to ensure the successful and sustainable integration of livestock with cocoa farming.

Key Cropping System: Cocoa plantations are often ‘planted shade’ (Sensu Rice & Greenberg 2000), intensively managed cocoa gardens (Bisseleua & Vidal 2008) Shade trees, comprising a mixture of forest and planted domesticated trees species, occur at lower density, and are less diverse, than at the other sites. Plantations are regularly weeded and treated with pesticides.

Type of Agroforestry System: Based on field observations and classification frameworks, cocoa agroforestry systems in the area can be categorized as follows:

- Agrosilvicultural systems: Integration of cocoa, trees and crops (e.g., cocoa + Dacryodes edulis, plantain, cassava).

- Agrosilvopastoral systems: Combination of trees, crops, and livestock (e.g., cocoa farms with pigs and goats, as observed in Bulutu and Ehom)
- Home gardens: Multistorey systems around homesteads with diverse crops and trees (e.g., cocoa, Persea americana, Citrus spp., Cola acuminata)
- Scattered trees on croplands: Retention of native trees during cocoa farms land clearing for shade and soil improvement. Natural regeneration and planting of selected (mainly exotic) species ensure the reproduction of agroforestry resources. When clearing land, farmers generally preserve certain trees for various uses, such as shade, fruit, timber, medicinal purposes, etc. This practice promotes biodiversity conservation and ensures the sustainability of agroforestry systems.

Farm Type: Predominantly smallholder mixed farms (1–5 ha). [no commercial farms?]

Practices: Existing practices of domestication of cocoa and agroforestry trees species and constraints : Farmers typically use vegetative propagation to maintain desirable traits in tree species, while cocoa itself is propagated from seeds extracted from mature pods (150-170 days after pollination).

Species: Some species are common to both villages, while others are specific to the production zone. In Mbam et Kim (Ntui), some specific forest species are present (*Terminalia superba, Newboudia laevis, Pygnanthus angolensis, Ficus sp, Sterculia rhinopetala*); common species include Persea americana, Ricinodendron heudelotii, Cola sp., Ceiba pentandra, Dacryodes edulis, Citrus reticulata and Milicia excelsa) and other species, notably exotic fruit trees, found only in Bokito (C. sinensis). Cocoa plantations in Ntui are mainly composed of forest species (58%) and native NTFPs (27%). There are very few exotic fruit trees (15%). In the Bokito cocoa farms studied here, 50% are exotic fruit trees and 31% native species (fruit trees, NTFPs). Forest trees represent only 19% of associated species. Generally speaking, cocoa plantations in Bokito are more diverse than those in Ntui, with Shannon diversity indices of around 2.03 and 1.55 respectively (Ndje Mbile et al., in revision).

Table 25. Main fruit trees in cocoa agroforestry systems in Cameroon

Common names	Scientific names	Uses	Location/Cameroun
Mango	*Irvingia gabonensis/ Irvingia wombolu*	Food, source of income, medicinal, timber, firewood	South-West
Safoutier	*Dacryodes edulis / Dacryodes klaineana*	Food, source of income, medicinal, timber, firewood	Centre, Littoral, South-West
Caïmite africaine	*Chrysophyllum albidum*	Food, source of income,	
Djansang	*Ricinodendron heudelotii*	Food, source of income, medicinal, timber, firewood	Centre, Littoral, South West
Bitter cola	*Garcinia kola /G. afzlii*	Food, source of income	Littoral

Source : Franzel et al., 1996

Socio-economic Dynamics

Demographic Trend: Predominantly rural; youth outmigration to cities is common.

Livelihood Source: Its economic activities are based primarily on agriculture, trade, fishing, hunting, crafts, and quarry products.

Market access : This agriculture is largely based on the production of food for household consumption and marketing to resellers commonly called " bayam -sellams". Farmers' organizations play a role in product marketing, but their access to markets is hampered by poor infrastructure and a lack of coordination. The markets of Obala and Ntui are local trading hubs.

Sources of Incomes: Agriculture is the main activity marked by food crops (cassava, macabo, peanuts, plantain, corn), and cash crops (oil palm, cocoa and coffee). Agriculture is the main activity in these districts (Food crops: Maize, cassava, plantain, groundnuts and yams are grown for self-consumption and local sale and livestock such as small ruminants, poultry and pigs are raised for home consumption and sale) with cocoa a major source of income for the majority of producers. In Ntui, Fishing occupies a prominent place in the supply of animal protein to households. Fishing is the primary lucrative activity for Malian non-natives living in Ndji and Nachtigal. The economy of Bokito is based mainly on agriculture and trade. These activities are generally carried out by all social classes, men, women or young people. Alongside these, activities such as hunting, gathering and livestock farming are also carried out.

Socio-institutional data

Key Stakeholders : Farmer organizations in the Ntui-Bokito living lab play a role in promoting sustainable agriculture and improving the livelihoods of farmers.

Table 26: Main stakeholders in Ntui-Bokito LL

ACTORS	TYPES	ROLES
Smallholder Farmers	Cooperative	Primary producers; manage cocoa farms and agroforestry systems.
MINADER	Government organization	Support a productive, profitable and competitive agriculture
MINFOF	Government organization	Formulates and executes policies related to forest and wildlife management ensuring sustainable practices
MINEPDED	Government organization	Developing and implementing environmental policies, protecting nature and promoting sustainable development
PCP-ACEFA	Government organization	Aim at improving the competitiveness of family farms by providing agricultural and pastoral advisory services
OFI	Government organization	Grouping farmers in cooperative and follow up certification, sensitization and capacity building
TELCAR COCOA	Private company	Promoters in certification of cocoa
SIC CACAO	Private company	Training and capacity building of farmers and promotion of agroforestry systems, buying and transformation of Cocoa
COOKO	Private company	Revolutionizing cocoa industry by though a pilot project where buy wet beans at similar prices to dried beans, at farm gates, and fermenting at their central facility outside of Ntui focusing on traceability, high bean quality and sustainability

ECODEV	Private company	Management of community forests, dissemination of agroecological practices and capacity building of farmers
RAINFOREST ALLIANCE	Certification organization	Drive more sustainable agricultural production and responsible supply chains.
FODECC	Public organization	Manage and distribute funds derived from a levy on cocoa and coffee export aiming to improve production, quality and market access for producers.
GICPRO	Cooperative	Bringing farmers together and facilitate the market for the sales of their products
GIC BIBI	Cooperative	Bringing farmers together and facilitate the market for the sales of their products
COFDA	Cooperative	Bringing farmers together and facilitate the market for the sales of their products
SOCOOPEC	Cooperative	Bringing farmers together, facilitate the market for the sales of their products and capacity building
GIZ, WWF, AFR100, WFP	International NGOs	Funding, technical support, training, conservation programs.
CIRAD, Wageningen University (WUR)	Research	Research partners in GALILEO; innovation testing and capacity building.
Local NGOs (e.g., Cameroon Ecology)	NGOs	Community mobilization, wildlife monitoring, advocacy.
Microfinance Institutions (MFIs)	Private sector	Potential providers of credit for agroforestry investments.

Key Projects

Table 27. Key projects implemented in Ntui-Bokito the last 5 years

Project/Intervention	Implementing Organization	Type of Intervention
GIZ Cocoa Sector Support Program	GIZ	Grafted cocoa nurseries, agroforestry training
IRAD Agroforestry Research	IRAD	Intercropping trials (cocoa + fruit trees)
AFR100 Tree Planting Initiative	AFR100	Community nurseries for native species

ONCC Warehouse Modernization	BNCC	Storage infrastructure upgrade
WFP Climate-Smart Agriculture Pilot	WFP	Drought-tolerant crops, agroforestry promotion
GIZ Cocoa & Forest Initiative	GIZ	Zero-deforestation training, HCV mapping
WWF Agroforestry Corridor Project	WWF	Shade tree planting for habitat connectivity

- Roadmap to Deforestation-free Cocoa: a public-private partnership aimed at ending cocoa-related deforestation in Cameroon, led by the Ministry of Agriculture and Rural Development
- Grand Mbam cocoa landscape is part of the Green Commodity Landscape Program, and aims to protect forests and improve sustainable cocoa production and farmer livelihoods in the Grand Mbam region of Cameroon. This initiative is co-led by IDH, the Sustainable Trade Initiative https://www.idhsustainabletrade.com/ and WWF, and brings together stakeholders to jointly implement actions that benefit both the environment and the local communities in Ntui and Mbangssina. Key Goals include to protect forests, promote sustainable cocoa farming practices, and improve the livelihoods of cocoa farmers and surrounding communities. It takes a collaborative approach between various stakeholders, including IDH, WWF, local communities, and the private sector, to co-design and implement solutions via Compacts made between mayors and the partners. Activities include Sustainable Cocoa Production: Encouraging and supporting farmers in adopting sustainable farming practices to increase yields and reduce environmental impact. Forest Protection: Implementing measures to protect and restore forests within the landscape. Livelihood Improvement: Working to enhance the economic well-being of farmers and their communities. The project aligns with the broader Green Commodity Landscape Program and contributes to the goals of the Central African Forest Initiative (CAFI). Payment for Environmental Services (PES): A feasibility study for a PES scheme is also being developed within the Grand Mbam landscape as part of this initiative. This scheme aims to incentivize the private sector to invest in deforestation-free commodity production.
- CANALLS Project: addressing critical challenges related to shade management for cocoa trees in the Ntui Agroecological Living Lab
- Rikolto International Association: working with farmer organizations, private sector, and governments to achieve food system change
- Cameroon is a member country of the OIF and participates in activities, particularly in the areas of economic and cultural cooperation. The OIF supports local initiatives, such as cocoa production in Cameroon, in order to promote sustainable development

Historical Data : Cocoa and coffee introduced during colonial periods ; recent shift towards cassava and maize due to market trends and climate variability.

[arrival/development of commercial farms?]

Institutional Data : Active farmer organisations; support from local agricultural offices; collaborations with research and development agencies.There is a government (ONCC) Centre of Excellence at Ntui, but it doesn't seem very operational. Certification – which many large traders use to secure their supplies and to channel training and information. Many farmers, even when certified and increasing

due to European Union Deforestation Regulation are having their farms geomapped, are not aware of all the details of certification. Rainforest Alliance is the major certification standard in Cameroon and the area (Ingram et al 2025).

Innovations

Innovation from farmers

- Local farmers often mix trees, crops, and sometimes livestock in the same plot in layers that mimic forest structures.
- Use of Indigenous Tree Species for Soil Fertility
- Composting and Biochar from Farm Residues: The innovation is mixing biochar with poultry or goat manure and incorporating it into planting pits is becoming popular among innovators
- Live Fencing and Windbreaks with Economic Trees: Instead of building fences, farmers use rows of thorny or fast-growing trees
- Integration of Small Ruminants with agroforestry: Some households rear goats or sheep in rotational systems within agroforestry plots
- Local Water Harvesting and Soil Conservation Structures:
- Propagation and Grafting of Indigenous Fruit Trees
- Knowledge Sharing through Local Farmer Groups
- Cultural Land-Use Practices Supporting Agroforestry
- Use of Bio fertilizers and bio pesticides to treat cocoa trees and adoption of proper shading and agroecological/agroforestry practices.

Innovation in the literature

- Combining fruit trees has provided regular additional income (Mopi et al. 2024).
- Improved microclimate and cocoa yields thanks to certain shade species(Wu et al. 2016 ; Snoeck et al. 2013).
- Strong adoption of diversified systems by motivated farmers.

Challenges and Opportunities

Challenges : Market access is difficult, incentives have been put in place (by projects and certificaiton), to strengthen market access by cooperatives and buyers, but the structure of the market (coxeurs and 2 or 3 larger traders) mean there is generally limited access and farmers and cooperatives are price takers

Opportunities: Snail farming can offer farmers an additional income stream and diversify their agricultural activities. Cocoa farming can generate waste materials, such as cocoa husks, which can be used as food for snails. Expanding agroforestry value chains, promoting soil-regenerating tree species, community-based seed and seedling systems.

Lessons learnt for Galileo upcoming activities

The Ntui–Bokito Living Lab serves as a critical testing ground for integrating agroecology into the forest–savannah transition zone. Through participatory innovation, it addresses soil degradation, boosts farm resilience, and supports sustainable livelihoods.

To address these barriers, experts propose several solutions. Collective action through farmer cooperatives could improve access to resources and markets (Ogunsola et al., 2023). Comprehensive training programs covering forage selection and rotational grazing (Jara-Rojas et al., 2020) would build technical capacity. Policy interventions such as targeted subsidies and smallholder-friendly credit programs could help overcome financial constraints. These multi-pronged approaches aim to make integrated systems more accessible and viable for farmers facing complex adoption challenges.

3.2.6 Description of Aponoapono–Suhum Living Lab

Physical data

Name of the Living Lab: Aponoapono–Suhum Living Lab
Country: Ghana
Location: Aponoapono community, Suhum Municipality, Eastern Region
Agroecological Zone: Semi-deciduous forest zone

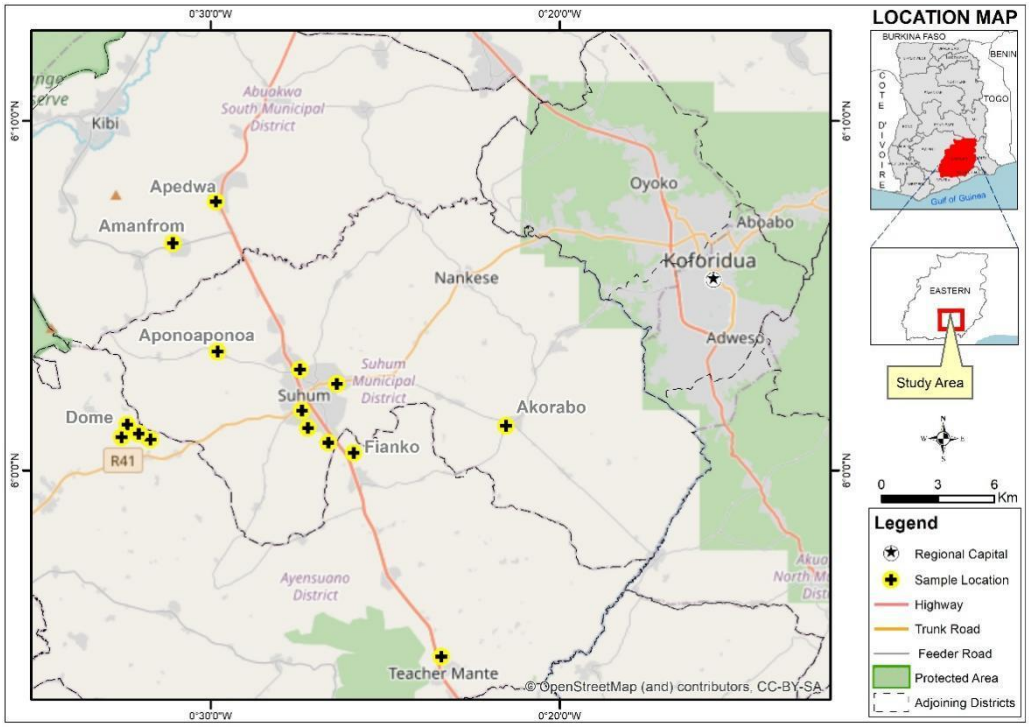

Figure 12. Location of key informant interviewed in Aponoapono-Suhum Living Lab

Context : The Aponoapono–Suhum Living Lab is located in Ghana's Eastern Region, and lies within a diverse agroecological zone characterised by mixed food and cash crop production. The area presents significant potential for tree–crop integration, offering a strategic entry point for advancing sustainable land-use models. It aims to promote sustainable agroforestry practices, improve soil fertility, and enhance farm resilience to market and climate shocks. As a participatory research and innovation platform, the Living Lab seeks to develop, test, and scale context-appropriate agroforestry practices that enhance soil fertility, improve farm productivity, and diversify livelihood options. By fostering farmer-led experimentation and knowledge exchange, the initiative aims to strengthen the resilience of local farming systems against climate variability, environmental degradation, and market volatility, thereby contributing to long-term food security and sustainable rural development.

Ecological Data

Climate Characteristics: Suhum Municipality, covering 400 km², lies about 60 km north-north-west of Accra at 6°05′ N and 0°27′ W. It is located in the Semi-deciduous Forest Zone, though much of the original vegetation has been replaced by secondary forests due to agricultural expansion. Mean annual temperatures range from 23–32°C and annual rainfall from 1,270–1,651 mm. Relative

humidity averages 48–52% in the dry season and 87–91% in the wet season. Rainfall is bimodal, with a major season from March–mid-July, a short dry spell in July–August, a minor season in September–October, and a long dry (harmattan) period from November–March. These patterns provide generally reliable moisture for agriculture, especially cocoa, but climate variability is increasing. Droughts can depress yields, while intense rains may trigger flooding and soil erosion, particularly in degraded or deforested areas.

Soils : The Aponoapono–Suhum Living Lab is situated on soils predominantly classified as Ferric Acrisols, which possess good water-holding capacity but are prone to nutrient depletion when subjected to continuous or intensive cultivation without adequate replenishment. The area also contains sandy loam to loamy soils, which, while moderately fertile, require careful organic matter management to maintain productivity. To safeguard and enhance the long-term health of these soils, effective fertility management strategies are essential. This includes the application of organic amendments, the adoption of cover cropping, and the integration of agroforestry-based nutrient cycling systems. Such practices not only improve soil structure and nutrient availability but also contribute to building climate-resilient and productive farming systems within the Living Lab.

Vegetation and Land Cover : Suhum lies within Ghana's moist semi-deciduous forest belt, once dominated by rich forest cover. Over the past decades, agricultural expansion, particularly cocoa cultivation, alongside logging and settlement growth, has driven extensive deforestation. Much of the original forest has been replaced by secondary forests, regrowth thickets, and degraded lands. Satellite imagery shows that between 1990 and 2000, forest and plantation cover declined, replaced by agricultural land, forest gardens, and open areas. The mean forest patch size has shrunk, while the number of patches and overall landscape diversity have increased, indicating growing fragmentation. Although afforestation and shade-tree integration in cocoa farms are being promoted, forest loss remains a persistent challenge.

Biodiversity Relevance for Agroforestry: Suhum was once covered by semi-deciduous forest, but cultivation, logging, and fuelwood extraction have drastically reduced the original vegetation. The landscape is now dominated by secondary forests and regrowth thickets, with elephant grass common on degraded farmlands. Reduced fallow periods and erosion have lowered soil fertility. Despite the loss of primary forest, secondary forests and agroforestry systems in Suhum still support notable biodiversity, especially in cocoa farms. Agroforestry practices integrate indigenous fruit trees, timber species, and shade trees within cocoa and perennial cropping systems. Such systems maintain ecological functions, enhance biodiversity, and provide nutrition and income diversification.

Agricultural System

Livestock Farming System: In Suhum, small-scale livestock rearing is a common complement to crop production. Farmers typically keep poultry, goats, sheep, and, in some cases, pigs alongside cocoa and food crops, forming integrated crop–livestock systems. These systems create mutual benefits: manure from livestock enriches soils, while crop residues serve as feed. Livestock farming provides regular income through the sale of animals and animal products, such as eggs, and enhances household food security. The integration of livestock with crops supports diversified livelihoods and reduces economic dependence on seasonal cocoa sales.

Key Cropping System : Agriculture in Suhum is dominated by smallholder mixed-crop farming, with cocoa as the principal cash crop and primary source of household income. Cocoa is often cultivated under agroforestry systems, intercropped with plantain, cassava, maize, and other food crops, creating a diversified farming structure that supports both income generation and food security. Farmers also grow yams, cocoyams, and vegetables, such as leafy greens and garden crops, for subsistence and sale in local and regional markets. These integrated crop systems combine perennial

cash crops with seasonal food crops, optimising land use while maintaining soil fertility and providing multiple revenue streams.

Type of Agroforestry System : The dominant agroforestry system in Suhum is the cocoa-based shaded system, where cocoa is grown under a canopy of native and exotic shade trees. Common shade species include Milicia excelsa (odum), Khaya ivorensis (mahogany), Terminalia spp., Albizia ferruginea, and Gliricidia sepium, alongside fast-growing species such as Cedrela odorata. These trees provide ecological functions such as microclimate regulation, soil fertility improvement, and biodiversity conservation, while also yielding timber, fruits, and non-timber forest products. Cocoa plots are often intercropped with plantain (as a nurse crop during establishment), along with cassava, maize, cocoyam, and yam in the ground layer, creating a diverse cassava–maize–tree cropping mix. In addition to cocoa farms, some households maintain home gardens where fruit trees, vegetables, and medicinal plants are cultivated for household use and supplemental income.

Farm Type: Smallholder farms (0.5–3 ha)

Practices: Farmers integrate several crop and soil management practices into cocoa-based systems to improve productivity and resilience. Intercropping is widespread, with plantain, cocoyam, and cassava grown alongside cocoa to diversify income and enhance food security. Mulching around cocoa trees is used to preserve soil moisture, especially during dry periods, while composting helps improve soil fertility and organic matter content. Although contour farming was not explicitly mentioned in the observations, the described soil and water conservation practices, such as mulching and the low-cost “bottle irrigation” system, demonstrate farmers’ commitment to adopting sustainable land management methods.

Species: Farmers commonly plant Terminalia superba (Ofram), Albizia zygia (Emeri), and other valuable timber species such as Mahogany within cocoa farms because they are compatible with cocoa, provide effective shade, and offer long-term economic returns. Cola nitida (Cola) was not directly mentioned in the observations, but fruit trees like orange are sometimes integrated, though mistletoe infestations are a concern. Cocoa is often intercropped with cassava, maize, and plantain to diversify production and income sources. Palm and coconut trees are also used as boundary crops, though seedling access remains a challenge.

Socio-economic Dynamics

Demographic Trend : The area is dominated by farming households, with active involvement from both men and women, although men generally control land-use decisions. Youth migration away from farming is common, driven by the appeal of alternative livelihoods, particularly motorbike transport (“Okada”) for young men, which offers faster and more reliable income than farming. This shift has resulted in a decline in agricultural labour availability and rising labour costs, forcing farmers to hire workers from other towns. Only a small number of youths remain in farming, often motivated by visible benefits from niche practices such as organic cocoa farming. Young women tend to pursue petty trading, seamstress work, and marketing rather than migrate for “Okada."

Livelihood Source : Agriculture is a major livelihood source, with crop farming, particularly cocoa and food crops, dominant in rural areas. Over three-quarters of rural households (77.4%) engage in crop farming, while tree planting and livestock rearing are also widely practised by more than 80% of rural agricultural households. In contrast, agricultural engagement is significantly lower in urban areas.

Sources of Income: Primary income comes from the sale of cocoa beans, complemented by earnings from food crop sales (plantain, cassava, maize, yam, cocoyam, vegetables), livestock

rearing (sheep, goats, poultry, pigs), and petty trading. Additional income is generated from processing agro-products (palm oil, gari, shea butter), and a smaller share from formal employment in public services, agribusinesses, NGOs, and extension work.

Socio-institutional dynamics

Key stakeholders : Effective development and sustainable management of cocoa agroforestry systems in Suhum depend on the active involvement and collaboration of a diverse range of actors operating at different levels.

Table 28. Main Stakeholders in Aponoapono Suhum LL

Actor group	Key institutions	Key functions
Government/Public Institutions	Ministry of Food and Agriculture (MoFA), Municipal Assembly, Forestry Commission, COCOBOD	Policy development, extension services, regulation, technical assistance, funding, coordination
Farmer-Based Organizations (FBOs)	Cocoa farmer cooperatives, producer associations, women's groups	Collective marketing, training, advocacy, adoption of innovations, access to inputs and certification
Private Sector	Input suppliers, aggregators, processors, traders, financial institutions	Input supply, aggregation, processing, marketing, finance, value addition
NGOs/Civil Society	Local NGOs, international NGOs, certification bodies (e.g., Rainforest Alliance, Fairtrade)	Capacity building, advocacy, project implementation, technical support, promoting sustainability
Development Partners (DPs)	Donor agencies (e.g., World Bank, GIZ, USAID)	Funding, technical assistance, policy dialogue, project support
Traditional Institutions	Chiefs, traditional councils, family heads	Land tenure governance, dispute resolution, community mobilization, cultural stewardship
Research and Academia	Universities, research institutes (e.g., CRIG, UG, CSIR)	Research, innovation, policy advice, training
Government/Public Institutions	Ministry of Food and Agriculture (MoFA), Municipal Assembly, Forestry Commission, COCOBOD	Policy development, extension services, regulation, technical assistance, funding, coordination

Key Projects : In the past five years, Suhum has hosted major sustainable cocoa initiatives that strengthen agroforestry, forest restoration, and sustainable supply chains:

- Cocoa & Forests Initiative (CFI) (2018–2025) – Restoring over 200,000 ha of forest, rehabilitating 11,000 ha of cocoa farms, increasing yields, and strengthening community resource management to halt deforestation and promote sustainable cocoa in Hotspot Intervention Areas.
- Full Sun to Shaded Cocoa Agroforestry Systems (SCAFS) (2016–2021) – Rehabilitated old cocoa farms, introduced improved agroforestry models, produced 2.4 million seedlings in community nurseries, developed land-use plans for 29,000 ha, trained 1,800+ farmers, and piloted deforestation traceability systems.
- From Full Sun to Shaded Cocoa Agroforestry Systems (IKI-funded) (2016–2021) – Rehabilitated degraded cocoa farms and forest ecosystems, established CREMAs,

implemented land-use planning and remote sensing for forest monitoring, and supported deforestation-free cocoa supply chains.

Together, these projects have shifted Suhum from monoculture cocoa farming toward diversified shaded agroforestry systems, improved landscape planning, and enhanced ecological resilience.

Historical Data : Cocoa farming in Suhum dates back to the early 20th century and has since become the dominant agricultural activity. Over time, market volatility and increasing land pressure have driven farmers to gradually diversify into food crops. Suhum also pioneered certified organic cocoa farming, with some communities practicing organic methods decades before formal certification in 2005. Historically covered by semi-deciduous forest, the area has undergone extensive deforestation due to cocoa expansion, food crop cultivation, logging, and settlement growth, resulting in secondary forests, regrowth thickets, and degraded lands.

Institutional Data : Farmer cooperatives in Suhum are closely linked to district agricultural extension services provided by the Ministry of Food and Agriculture (MoFA) and to cocoa marketing and regulatory functions coordinated by COCOBOD. These cooperatives benefit from support programmes such as CODAPEC and the Cocoa High Technology Programme. Partnerships with local and international NGOs (e.g., Solidaridad, Tropenbos) and research-oriented agencies provide training, capacity building, and opportunities for testing innovations, particularly in sustainability, climate-smart agriculture, and market access.

Innovations

In Suhum, farmers are adopting innovative cocoa agroforestry practices, including using organic compost and biochar from local materials to restore soil fertility, integrating diverse shade and food crops, and applying climate-smart techniques for resilience. Farmer-led platforms promote peer learning and knowledge sharing, while agroecological systems enhance biodiversity and productivity.

Table 29. Promising innovation in Aponoapono-Suhum LL

Type of innovations	Promising innovations
Tree-based systems	**Coconut and Oil Palm Plantations**: Widespread planting providing both economic benefits (yields) and environmental benefits (afforestation), aligning with national policies. **Neem-based products**: Production of soaps, creams, organic fertilizers, and insecticides from neem, offering diversified income and natural solutions. **Mushroom cultivation** using cocoa and plantain leaves Exploring **banana fiber for hair braiding** **Cocoa Pod Husk Utilization**: Transforming waste cocoa pod husks into valuable products like briquettes for cooking fuel (reducing reliance on firewood), biochar for soil improvement, and liquid soap with essential oils. **Cocoa Sweat Distillation**: Producing alcohol or juice from the cocoa fruit's sweet liquid. **Wood Vinegar**: Distillation of wood to produce a potent insecticide.
Water management and soil health	**Bottle Irrigation**: A low-cost method for young seedlings during drought periods. **Mulching and Composting**: Common practices to conserve soil moisture, improve fertility, and reduce external input needs. **Biochar**: An emerging practice to enhance soil health and reduce fertilizer use.

	Fish Culture for Compost: Using fish to create a culture that accelerates compost decomposition, making it more efficient and cost-effective.
Crop and livestock management	**Intercropping**: A traditional and effective practice, integrating food crops like plantain, cocoyam, and cassava with cocoa. **Hybrid Crop Varieties**: Adoption of drought-tolerant and high-yielding varieties to enhance productivity and resilience. **Midget Population Enhancement**: Strategies to increase natural pollinators for cocoa, crucial given declining insect populations. **Beekeeping and Black Soldier Fly Rearing**: Diversifying livelihoods and supporting biodiversity (pollination, waste management).
Community and market-based initiatives	**Cottage Industry Model**: Centralizing processing of raw materials (e.g., neem, palm oil) to create value-added products, benefiting women farmers. **Market-driven Production (Backward Integration)**: Prioritizing securing markets before production to ensure profitability and farmer buy-in. **Community of Practice (Living Labs)**: Platforms for stakeholders to share experiences, learn, and co-create solutions to common challenges. **School and Traditional Authority Involvement**: Schools planting trees and chiefs partnering with assemblymen to encourage tree planting among subjects, fostering a long-term mindset for agroforestry.

Challenges and Opportunities

Challenges : In Suhum, farmers face several challenges that affect their livelihoods. Soil fertility is declining due to deforestation, soil erosion, and land degradation, while erratic rainfall patterns make farming less predictable. Cocoa production is further threatened by pest and disease outbreaks, and poor market infrastructure limits access to bigger markets, contributing to unstable prices for their produce.

Low productivity.

Opportunities: Suhum has strong potential for agricultural growth through modern farming methods, agroforestry, and climate-smart practices that boost productivity and sustainability. Improved market access, value addition, and targeted support for youth and women can further enhance incomes, create jobs, and promote inclusive development.

Lessons learnt for Galileo upcoming activities

Suhum faces climate, land, and socio-economic challenges but has strong potential for resilient rural livelihoods through innovative, community-led agroforestry. The Aponoapono–Suhum Living Lab serves as a participatory platform for testing and scaling these innovations in Ghana's semi-deciduous forest zone, building local capacity, enhancing ecological resilience, and diversifying farmer incomes. Success depends on ensuring economic benefits, access to technology, labour solutions, and collaborative support to drive adoption and sustainability.

3.2.7 Description of New Edubiase Living Lab

Physical data

Name of the Living Lab: New Edubiase Living Lab
Country: Ghana
Location: New Edubiase, Adansi South District, Ashanti Region
Agroecological Zone: Moist semi-deciduous forest zone

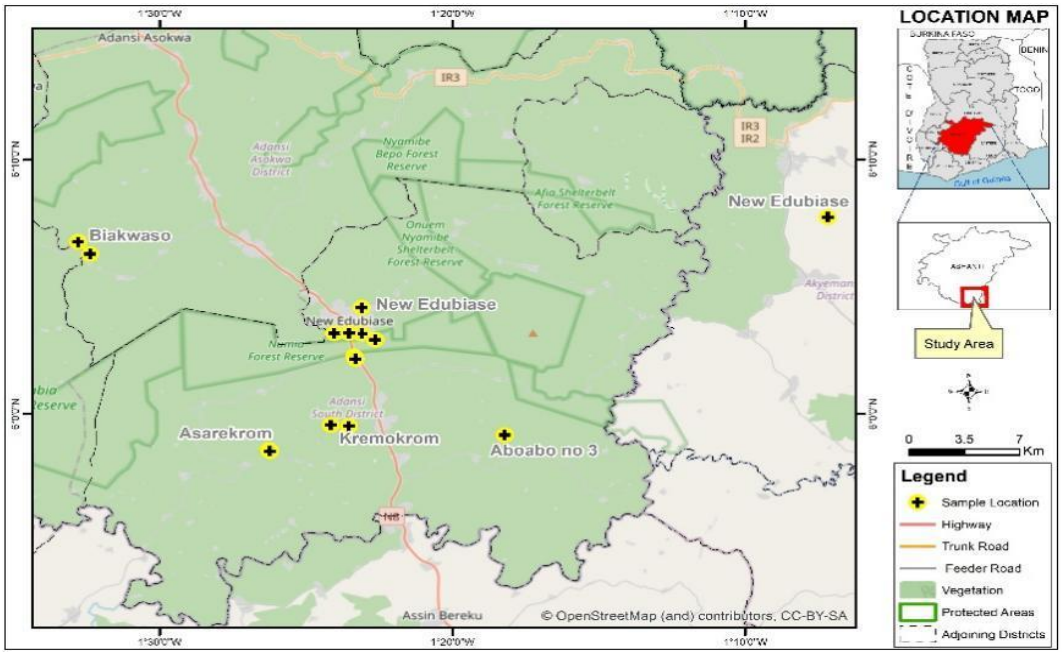

Figure 13. Location of key informant interviewed in New Edubiase Living Lab

Context : The New Edubiase Living Lab is situated in Ghana's cocoa belt, a region within the Moist Semi-Deciduous Forest and Forest-Savannah Transition zones, where cocoa production underpins local livelihoods. Ghana's diverse agro-ecological zones influence rainfall, temperature, and soil conditions, shaping agricultural productivity and seasonal labor movements. The Lab seeks to enhance agroecological resilience by promoting shade-grown cocoa, crop diversification, and improved soil management. These practices aim to mitigate climate change impacts, prevent further deforestation, support biodiversity, and sustain the livelihoods of smallholder farmers amid increasing environmental pressures and land-use challenges

Ecological Data

Climate Characteristics: Assin Fosu New Edubiase, located in the Ashanti Region within the tropical forest ecological zone, experiences a tropical rainforest climate. Average annual rainfall ranges between 1,600 mm and 1,800 mm, with a bimodal pattern peaking from May to June and September to October. Mean monthly temperatures range from about 26°C to 29°C. These climatic conditions support the year-round growth of perennial tree crops, including cocoa, oil palm, and various fruit trees, although farmers increasingly face challenges from erratic rainfall, droughts, and rising temperatures.

Soils : The soils in the New Edubiase area are predominantly forest ochrosols, with associations such as Juaso-Morso and Bekwai-Oda, characterised by loamy to clay-loam textures and moderate to high natural fertility due to rich organic matter. These well-drained soils are highly suitable for perennial tree crops like cocoa, oil palm, and citrus, as well as staple food crops such as cassava, plantain, and rice in valley bottoms. However, continuous and shifting cultivation practices have contributed to soil

fertility decline and increased erosion risks, particularly on slopes. While fertilizer use is rising, especially on improved cocoa varieties, many farmers continue to rely on traditional soil management practices.

Suitability for Tree-Based Systems : New Edubiase provides a highly favorable ecological and climatic environment for tree-based agricultural systems, particularly cocoa agroforestry. Its suitability arises from a combination of consistent climate, fertile soils, diverse vegetation, and adaptive socio-ecological practices. The area experiences a bimodal rainfall pattern, averaging 1,600–1,800 mm annually, and stable temperatures around 26°C–29°C, supporting year-round growth of perennial crops such as cocoa, oil palm, and fruit trees. The gently rolling landscape ensures good drainage but requires soil conservation on slopes to prevent erosion. Additionally, fertile valley bottoms with alluvial soils create opportunities for complementary cropping systems, including rice cultivation, enhancing both productivity and livelihood resilience.

Vegetation and Land Cover: New Edubiase lies within the moist semi-deciduous forest zone, characterized by a mix of indigenous tree species such as Milicia excelsa (odum), Khaya ivorensis (mahogany), and Terminalia spp., alongside fruit, medicinal, and native shade trees. While substantial portions of natural forest remain within reserves, much of the original vegetation outside these areas has been degraded or converted to secondary forests and farmland, dominated by cocoa and food crops. Secondary growth forests typically contain a mix of pioneer and indigenous species, reflecting regrowth after human disturbance.

Biodiversity Relevance for Agroforestry: New Edubiase vegetation includes high-value timber trees (Milicia excelsa, Khaya ivorensis, Terminalia spp.) and various fruit, medicinal, and shade trees. These species support cocoa agroforestry by providing shade, enhancing soil fertility, regulating microclimate, and diversifying farmer incomes.

Agricultural System

Livestock Farming System: Livestock farming in New Edubiase is predominantly small-scale and managed at the household level. The main species reared include poultry, goats, and sheep, providing supplementary income and contributing to household food security. Livestock rearing is integrated with crop production systems, supporting mixed farming practices among both indigenous and migrant households.

Key Cropping System: About 78.5% of the workforce in New Edubiase is engaged in agriculture, practicing mixed cropping systems that combine both cash and food crops. Key crops include cocoa, oil palm, maize, cassava, rice, cocoyam, and plantain. Cocoa, the primary cash crop, is often intercropped with plantain, cassava, and maize to optimize land use and improve household food security. Livestock rearing, particularly poultry, goats, and sheep, complements crop production by providing supplementary income and nutrition.

Type of Agroforestry System: Cocoa-based agroforestry systems dominate in New Edubiase, characterized by the integration of shade trees, food crops, and timber species. Farmers maintain multilayered, shaded farms that balance ecological functions with productivity. Multipurpose trees, including indigenous hardwoods, fruit trees, and oil palm, are commonly planted to provide shade, timber, and income diversification. Cocoa is frequently intercropped with food crops, and farm management practices include manual land preparation, staggered planting, and variable fertilizer use depending on cocoa variety.

Farm Type: Smallholder farms (1–4 ha).

Practices : Farmers in New Edubiase employ a variety of sustainable cocoa and agroforestry practices. Key practices include mulching around cocoa trees to preserve soil moisture, pruning to maintain tree health, and composting using organic materials such as poultry manure, rice husks, cocoa husks, banana peels, and cassava peels. Alley cropping and cover cropping are also practiced to enhance soil fertility, reduce erosion, and support integrated crop-livestock systems. Additional

innovations include basic irrigation methods, experimental drip irrigation, and encouraging naturally occurring beneficial insects, such as red ants, to control pests.

Species: The agricultural and agroforestry systems in New Edubiase feature a mix of crops and tree species that support both productivity and ecological functions. Key species include cocoa (Theobroma cacao) as the primary cash crop, intercropped with plantain (Musa spp.) and cassava (Manihot esculenta) for food security and diversified incomes. Important tree species include Albizia zygia and Milicia excelsa (odum), which provide shade, timber, and ecological benefits such as soil enrichment and microclimate regulation. These species are commonly selected based on their multifunctional roles in cocoa-based agroforestry systems.

Socio-economic Dynamics

Demographic Trend: As of 2020, the projected population of New Edubiase was approximately 92,800, with a near-even gender distribution, 52.6% males and 47.4% females. The majority of residents live in rural areas (83.6%), while 16.4% reside in urban centers. Farming is the dominant occupation, and youth outmigration is common, driven primarily by the search for agricultural employment opportunities in both local and neighboring areas. Migrants constitute about 45% of the population, including groups such as Ewes, Fantes, Ga Adangbes, Akwapims, and Northerners.

Livelihood Source: Agriculture is the main livelihood for the majority of residents in New Edubiase, with approximately 78.5% of the population engaged either as a primary or supplementary occupation. Cocoa farming serves as the primary economic activity, often integrated with other crops such as oil palm, rice, cassava, plantain, maize, cocoyam, and vegetables in mixed cropping systems. Small livestock rearing, including goats, sheep, pigs, and poultry, complements crop production by providing additional income and enhancing household food security. The district's road networks facilitate trade, enabling farmers to market cocoa and food crops in nearby towns.

Sources of Income: Cocoa farming is the primary source of income for most households in New Edubiase. Other significant livelihood activities include oil palm cultivation, food crop farming, petty trading, and artisanal mining. Farmers generate income through the sale of cocoa beans, food crops, and small livestock, while petty trading, particularly by women and youth in daily and weekly markets, provides supplementary earnings. A small portion of the population earns regular income from public sector employment or private services, but these opportunities are limited compared to farm-based livelihoods.

Socio-institutional dynamics

Key Stakeholders

Table 30. Main stakeholders in New Edubiase LL

Actor group	Organization	Roles and functions
Licensed Buying Companies (LBCs)	Cargill, Abrabopa Cocoa Association	Purchase cocoa beans directly from farmers, provide training on good agricultural practices, quality control, and input use awareness. Critical in linking farmers to markets and facilitating premium price access via certification.
Agro-Input Dealers	B. Kaakyire Agrochemicals	Supply essential agricultural inputs such as fertilizers, pesticides, herbicides, and seedlings to farmers, enabling proper farm management and productivity.

Non-Governmental Organizations (NGOs) and Development Partners	Solidaridad (previously active), Winrock International (training), CARE International (women's empowerment), SNV (district collaboration)	Provide technical training, capacity building, promote sustainable cocoa agroforestry practices, gender inclusivity, and community development. Support certification processes and environmental sustainability.
Government Extension Services	Ministry of Food and Agriculture (MoFA - Adansi South), Cocoa Health and Extension Division (CHED)	Deliver regular farm visits, pest and disease control advisory, agroforestry training, and input dissemination. While MoFA staff numbers are limited (6 officers for 20 zones), extension officers remain key contacts for technology transfer
Community-Level Extension Agents	JICA-trained farmer-extension agents	Serve as local-level facilitators of agroforestry and good cocoa farming practices, enhancing adoption through peer-to-peer learning and localized advisory services.

Key Projects : The table below summarises key agricultural, environmental, and livelihood support projects implemented in the New Edubiase area. It highlights each project's main focus and the period of implementation, illustrating the range of interventions aimed at enhancing cocoa production, agroforestry practices, climate resilience, and farmer livelihoods.

Table 31. Key project in New Edubiase in the past 5 years

Project	Focus	Year
PEP – COCOBOD & CHED	Cocoa productivity: pest control, farm rehabilitation, pruning, and hand pollination	2017
GLRSSMP	Composting, soil fertility restoration, timber & fruit tree distribution	2022
Green Ghana Project	Tree and fruit seedling distribution	Annual
Minerals Commission Tree Distribution (under PERD)	Oil palm & coconut seedlings for new or interplanted fields	Annual
PERD	Tree cropping, focus on oil palm	2018–2021
Solidaridad PROP	Capacity building and pest management for oil palm farmers	2022–Present
Windrock International	Farmer training support	2025
CARE International	Support for women farmers	–
GPSNP	Road construction & coconut/oil palm plantations for LEAP households	–
VSL	Financial inclusion and farmer support	–

Historical Data : New Edubiase's environment historically supported dense primary forests dominated by high-value indigenous hardwoods, including Milicia excelsa (Odum), Khaya ivorensis (Mahogany), and Triplochiton scleroxylon (Wawa). Over time, these original forests have largely been transformed into secondary forests and agricultural lands due to persistent slash-and-burn farming, clearing for cocoa plantations, timber harvesting, and fuelwood collection. Cocoa cultivation was established in the early 20th century and has intensified in recent decades in response to market demand and COCOBOD support. Despite these changes and periods of formal encouragement for monoculture, the majority of farmers in New Edubiase have retained shade trees, blending conventional cocoa farming practices with traditional agroforestry systems to maintain ecological and livelihood benefits.

Institutional Data

- **Farmer-Based Organizations and Cooperatives**

  Farmer-Based Organizations (FBOs) and cooperatives in New Edubiase play a crucial role in promoting sustainable cocoa production, supporting agroforestry practices, and enhancing farmer livelihoods. Among these, the New Edubiase Cocoa Cooperative stands out as a prominent platform for smallholder farmers, facilitating collective access to inputs such as improved seedlings, fertilizers, and pesticides through support from COCOBOD and MoFA. The cooperative also organises collective spraying and pruning services, as well as training sessions on best agricultural and agroforestry practices, enabling farmers to adopt improved management techniques and benefit from shared resources and expertise.

- **Traditional Institutions and Customary Governance Structures**

  The area is organised as the Edubiase Traditional Area, with New Edubiase serving as its capital. This traditional area forms part of the larger Adansi Traditional Council, headquartered at Fomena, which coordinates customary affairs across multiple divisional and sub-traditional councils. Traditional authorities in New Edubiase are the primary custodians of customary lands, which constitute the majority of land tenure in the district, overseeing allocation for residential, farming, including agroforestry, and communal purposes. The Edubiase Traditional Council works closely with the Adansi South District Assembly and other governmental agencies, facilitating integrated development planning, natural resource management, and the implementation of agroforestry and environmental conservation projects. Farmers also benefit from strong extension support from COCOBOD and the Ministry of Food and Agriculture, while partnerships with NGOs enhance climate adaptation strategies and market linkages, contributing to improved livelihoods and sustainable cocoa production.

Innovations

Innovative Practices by Farmers & Organizations: Farmers in New Edubiase practice mixed cropping, integrating cocoa with food crops such as plantain, cassava, cocoyam, and maize, alongside shade and nitrogen-fixing trees to balance food security with cash crop production. Soil fertility is enhanced through the use of organic inputs including farmyard manure, crop residues, and leaf litter, reflecting traditional biomass recycling practices. Farmers also implement compost pits and mulching around cocoa stools to conserve soil moisture and improve nutrient cycling. Indigenous trees such as Milicia excelsa (Odum), Khaya ivorensis (Mahogany), Albizia ferruginea, and Gliricidia sepium are selectively retained or planted to provide shade, regulate microclimate, and fix nitrogen. Periodic pruning of cocoa trees, often combined with undergrowth clearance and shade management, is widely practiced to increase flowering and fruiting. Farmers actively engage through cooperatives and informal groups to share innovations and jointly adopt improved practices. Training sessions on microbial fertilizer production, organic amendments, and climate-smart practices, often facilitated by cooperatives and NGOs, build on indigenous knowledge and encourage experimentation and local adaptation.

Innovative practices suggested by Galileo researchers

Table 32. Innovative practices suggested by Galileo researchers

Improved AFSP management to be tested	Expected impact
Local shade trees (Ceiba pentadra, Alstonia boonei etc.)	Improved water functions Forest conservation Natural regeneration and drought resilience for cocoa seedlings
Seasonal cover crops for mulch	Improved water Improved cocoa productivity (ratio fruit bearing/vegetative growth) SOC build up, soil erosion control
In-situ biomass generation for household needs	Income diversification (fuelwood, secondary products, carbon farming)
Association with drought-resilient crop species for mutual benefits (e.g. successional cocoa/cashew/cocoa)	Improved cocoa productivity (ratio fruit bearing/vegetative growth)
Drought-tolerant new cocoa populations	Resilience to drought Improved cocoa productivity (ratio fruit bearing/vegetative growth)
Carbon farming opportunities	Forest conservation
Certification schemes opportunities (organic, FairTrade, RainForest)	Increased access to market through certification

Challenges and Opportunities

Challenges: Farmers in New Edubiase face several challenges that affect cocoa and agroforestry productivity, including cocoa diseases such as black pod and swollen shoot, soil degradation, and climate variability, which manifests as erratic rainfall and drought. These factors, combined with limited land tenure security and financial constraints, hinder long-term investments in tree planting and farm management. Despite these challenges, there are notable opportunities for enhancing cocoa agroforestry systems. Government initiatives promoting climate-smart cocoa, premium markets for certified products, and local knowledge in agroforestry practices provide avenues for improving productivity, sustainability, and farmer livelihoods.

Opportunities: Agroforestry systems in New Edubiase offer significant potential for climate resilience and ecosystem services, including soil moisture retention, microclimate regulation, carbon sequestration, and biodiversity conservation. Farmers demonstrate strong interest and indigenous knowledge, maintaining native and introduced tree species and showing willingness to adopt improved practices when supported. The integration of timber, fruit, and nitrogen-fixing trees, such as Milicia excelsa (Odum), Khaya ivorensis (Mahogany), Albizia, and Gliricidia, provides diversified income streams, reducing vulnerability to market fluctuations and enhancing food security. Additionally, emerging carbon markets and financial incentive schemes create opportunities for upfront investment and sustained support, encouraging the adoption and expansion of agroforestry systems.

Lessons learnt for Galileo upcoming activities

The New Edubiase/Assin Fosu Living Lab is a key platform for promoting sustainable cocoa agroforestry, enhancing ecosystem services, and improving farmer livelihoods. While facing challenges such as climate variability, soil degradation, deforestation, and labor constraints, farmers are adopting innovative practices like composting, livestock integration, and water management. Support from institutions, including CHED, MOFA, the Forestry Services Division, and NGOs, helps build capacity and provide inputs, though gaps remain in infrastructure, market access, and technical support. Leveraging diverse income sources and strong women's participation, the Living Lab focuses on scaling proven innovations, improving access to organic inputs, and empowering youth, aiming to make farming both sustainable and profitable.

3.2.8 Description of Joabeso Goaso Living Lab

Physical data

Name of the Living Lab: Joabeso Goaso Living Lab
Country: Ghana
Location: Joabeso and Goaso area, Ahafo Region
Agroecological Zone: Moist semi-deciduous forest zone

Context : The Joabeso–Goaso Living Lab is situated in Ghana's Ahafo Region, within the Moist Semi-Deciduous Forest agro-ecological zone—an area known for its rich biodiversity, fertile soils, and high annual rainfall. This climate supports cocoa-dominated farming systems but also exposes the region to climate variability, land use changes, and biodiversity loss from deforestation, unsustainable farming, and settlement expansion. Like other forest zones in Ghana, the area faces growing pressure from declining cocoa productivity, seasonal labour shifts, and increasing competition for land. Against this backdrop, the Living Lab serves as a participatory platform to test and scale sustainable agroforestry innovations that maintain ecosystem balance, improve soil fertility, and strengthen farmer livelihoods. By integrating climate-resilient practices, promoting biodiversity conservation, and ensuring equitable land use, the Lab aims to enhance the long-term sustainability and economic viability of cocoa landscapes while safeguarding the wellbeing of forest-dependent communities.

Ecological Data

Climate Characteristics: Goaso, in Ghana's mid-climatic cocoa belt, has a bimodal rainfall pattern (1,250–1,750 mm annually) with wet seasons from May–July and September–October, supporting medium-shade cocoa agroforestry. Temperatures average 25–26 °C, with highs up to 35 °C, creating favorable but increasingly vulnerable conditions for cocoa due to droughts (Nov–Feb) and flooding during peak rains. Climate change projections indicate rising temperatures, altered rainfall, more frequent extreme events, and ecological shifts from forest to savanna, requiring adaptation in crop and agroforestry practices.Vegetation and Land Cover**:**

Soils: Goaso's soils, mainly forest ochrosols of the forest–savanna transition zone, are slightly acidic to near neutral and suitable for crops like cocoa and oil palm. However, they have low inherent fertility from long-term weathering and nutrient leaching, with notable nitrogen and phosphorus deficiencies. Limited organic matter replenishment, residue burning, and seasonal erosion during heavy rains further reduce soil quality and increase degradation risks.

Suitability for tree-based systems: Goaso's forest ochrosols are moderately fertile, well-drained, and slightly acidic, making them suitable for cocoa agroforestry with shade trees that conserve moisture and prevent erosion. While pasture development is limited by soil fertility and climate, some adapted grasses can be grown, and sandy soils along river basins offer localised potential for vegetables and grazing.

Biodiversity Relevance for Agroforestry: Goaso's semi-deciduous forests contain diverse native trees, such as Ofram and Mahogany, used in cocoa agroforestry for shade, timber, and soil fertility. This biodiversity strengthens system resilience by improving microclimates, soil health, pest control, and conserving genetic resources and ecosystem functions.

Vegetation and land cover : Goaso, in Ghana's High Forest Zone, is dominated by moist semi-deciduous forest interspersed with cocoa farms, fallows, secondary forest, and other crops like oil palm, citrus, plantain, maize, and cocoyam. Covering about 578.63 km², the area lies in the dry semi-deciduous zone transitioning to savannah, with mixed forest species and open land. Recent years have seen closed forest cover decline from 97% to 92%, replaced by open forest and built-up areas due to farming, logging, and settlement expansion. Despite conservation efforts, deforestation continues, threatening biodiversity, ecosystem services, and agroforestry sustainability.

Biodiversity relevance for agroforestry: Goaso's semi-deciduous forests host diverse native trees, including Ofram and Mahogany, used in cocoa agroforestry for shade, timber, and soil fertility. This

biodiversity boosts resilience by enhancing microclimates, soil health, pest control, and conserving genetic resources and ecosystem functions.

Agricultural System

Agricultural Production Dynamics : Agriculture is the main economic activity in Goaso, employing about 63% of the population (~50,146 people) on 518.84 km² of arable land, nearly half of which is cultivated. Farming is mostly subsistence-based, with small average farm sizes (1.1–12.5 ha), and cash crops like plantain occupy the largest areas. Cocoa dominates the agricultural system, primarily grown in shaded agroforestry systems intercropped with food and shade trees. This diversification enhances soil health, biodiversity, and income stability. Initiatives like the Cocoa & Forests Initiative have helped reduce deforestation, restore degraded forests, and improve cocoa yields from ~450 kg/ha to 500 kg/ha through sustainable practices.

Typology of agroforestry system : Agroforestry in Goaso is mainly cocoa-based, with smallholder farmers practicing mixed cropping with food crops and retaining native timber and fruit trees. Key species like Ofram, Mahogany, and Emire provide shade, improve soil fertility, and offer timber and non-timber products. About 81% of farms use mixed cropping, enhancing biodiversity, microclimates, soil health, and diversified farmer incomes.

Type of Agroforestry System: Goaso's agroforestry is mainly cocoa-based, with smallholder farmers practicing mixed cropping with food crops and retaining native timber and fruit trees. Key species like Ofram, Mahogany, and Emire provide shade, improve soil fertility, and offer timber and non-timber products. About 81% of farms use mixed cropping, enhancing biodiversity, microclimates, soil health, and diversified farmer incomes.

Farm Type: Smallholder farms (average 1–3 ha).

Practices: The farming system in Goaso is characterized by smallholder cocoa agroforestry, where cocoa is the principal cash crop intercropped with food crops such as plantain, cassava, and cocoyam. Mixed cropping is the dominant practice, accounting for about 81% of farming systems, with plantation and monocropping making up smaller proportions. Farmers employ agroforestry practices to maintain shade cover, improve microclimates, and sustain soil health. The integration of timber and fruit trees within cocoa farms supports diversified livelihoods and ecological balance.

Species: The semi-deciduous forest supports a rich diversity of tree species that farmers incorporate as shade and companion trees in cocoa and other perennial crop systems. Key commercial and ecological tree species include *Triplochiton scleroxylon* (Ofram), *Entandrophragma spp*. (Mahogany), and other indigenous hardwoods that provide timber, shade, and soil fertility benefits.

Socio-economic Dynamics

Demographic trends : According to the 2020 census, Goaso has a slightly higher male population (50.4%) and is largely youthful, with 41.9% aged 0–14 years. The active population (15–64) makes up 54.3%, and those 65+ account for 3.8%, giving a dependency ratio of 1:1. Goaso has 21,508 residents, making it the municipality's second-largest settlement.

Livelihood Sources : About 70% of Goaso's population engages in farming, primarily cocoa, which drives the local economy. Trading of foodstuffs and manufactured goods is also significant. Key exports include cocoa and timber, while imports are mainly processed and manufactured products.

Sources of Income : Income in Goaso comes from services, such as hairdressing, banking, transport, vehicle repairs, vending, and hospitality, and small-scale industrial activities. Manufacturing and processing are mostly agro- and forestry-based, including palm oil and cassava processing, sawmilling, woodwork, fabrication, blacksmithing, soap making, and dressmaking.

Socio-institutional Data

Key Stakeholders

- Cocoa farmers and producer cooperatives
- Ghana Cocoa Board (COCOBOD)
- Ministry of Food and Agriculture (MoFA)
- Local NGOs and CBOs focused on agroecology
- Research bodies such as the Council for Scientific and Industrial Research (CSIR)

Table 33: Key stakeholders and their functions in Goaso LL

Actor group	Key functions
Government/Public Institutions	Policy, extension, regulation, infrastructure, environmental management
Farmer -Based Organizations/Cooperatives	Collective marketing, input procurement, training, advocacy, adoption of innovations
Private Sector	Input supply, aggregation, processing, marketing, finance
NGOs/Civil Society	Capacity building, advocacy, project implementation, technical support
Traditional Institutions	Land tenure governance, dispute resolution, community mobilization
Transporters	Logistics and movement of goods

Key Projects : Several projects in Goaso support sustainable cocoa farming and forest conservation. The Ghana Agroforestry for Impact (2024–2026) targets 1,200 farmers to strengthen Fairtrade cooperatives and promote ecological cocoa systems. The Sankofa Project (2019–2025) has converted 862 plots (215 ha) to dynamic agroforestry and expanded diversified food systems to 1,000 ha. The IKI-funded initiative (2016–2021) rehabilitated degraded cocoa farms and established nurseries for native trees. The Cocoa Forest REDD+ Programme (2016–2035) aims to reduce emissions from deforestation by linking interventions to commodity supply chains. The Cocoa & Forests Initiative (2017–2025) seeks to end deforestation, restore forests, and improve farmers' yields and livelihoods through sustainable intensification and income diversification.

Table 34: Projects in the last 5 to 10 Years

Projects	Summary	Achievements	Reference
Ghana Agroforestry for Impact (GAIM) (2024 – 2026)	Launched to support agroecological transition of cocoa farms	Targets about 1,200 farmers across 20 communities Strengthen Fairtrade-certified cocoa cooperatives Promote ecological intensification of smallholder cocoa systems	https://thecocoapost.com/fairtrade-africa-launches-ghana-agroforestry-for-impact-gaim-project/
Sankofa Project (2019- 2025)	Improving incomes and building climate resilience through dynamic agroforestry (DaF)	To date, 862 plots covering 215 hectares have been converted to dynamic agroforestry with hundreds of thousands of new seedlings. An additional 1,000 hectares are now planted according to diversified food systems practices.	https://www.fairtrade.net/en/get-involved/news/sankofa--improving-incomes-and-building-climate-resilience-throu.html

IKI- Funded initiative (2016- 2021)	Focused on rehabilitation of degraded cocoa farms	Promoting shaded cocoa agroforestry systems Established community nurseries for native tree species	https://www.international-climate-initiative.com/en/project/partnership-for-deforestation-free-cocoa-supply-chains-img2023-iii-039-gha-partnership-for-deforestation-free-cocoa-supply-chain-in-ghana/
Cocoa Forest REDD+Programme (GCFRP) (2016 – 2035)	Significantly reduce emissions from deforestation and forest degradation over the next twenty years, addressing threats that undermine ecosystem services and environmental integrity in order to maximize co-benefits from forests.	The proposed measures and interventions targeted at addressing the drivers of deforestation and forest degradation are linked with the production and supply chains of major commodities and defined by clear ecological boundaries.	https://faolex.fao.org/docs/pdf/gha178876.pdf#:~:text=Ghana%20Strategic%20Investment%20Framework%20(GSIF)%20for%20Sustainable,a%2015%2Dyear%20programme%20to%20ensure%20sustainability%20of
Cocoa & Forests Initiative (CFI) (2017 – 2025)	End deforestation and restore forest areas, through no further conversion of any forest land for cocoa production.	Engagement and empowerment of cocoa-growing communities. Sustainable intensification and diversification of income in order to increase farmers' yields and livelihood	https://www.idhsustainabletrade.com/initiative/cocoa-and-forests/

Historical Data: Historically, Asunafo was dense forest with abundant wildlife. Human activities were minimal until cocoa farming began in 1902 and timber exports in the 1940s, leading to significant deforestation and habitat loss. Wildlife, including elephants and chimpanzees, largely disappeared due to habitat destruction and deliberate removal for cocoa expansion. Illegal logging and mining ("galamsey") continue to degrade the forest, with 16 tree species exploited between 2019–2021. Ofram, Emire, Onyina, and others were the most targeted, while Konkroma and Hyedua were the least exploited.

Institutional Data : The Asunafo North Municipal Assembly manages local governance through a General Assembly of 42 members, five Zonal Councils, one Urban Council, and 29 Unit Committees, supporting citizen engagement and decentralised decision-making. Goaso's institutional landscape includes local organisations, farmer groups, and traditional authorities aiding community development, agriculture, and resource management. Key state institutions for forest and agriculture management are the Ministry of Food and Agriculture, COCOBOD, and the Forestry Commission. The Ministry oversees agricultural services and soil fertility, COCOBOD manages cocoa quality, disease control, and seed production, while the Forestry Commission protects forests and wildlife, restores degraded areas, and provides technical advice for environmental conservation.

Innovations

In Goaso, agricultural innovations include cover cropping and green manure to enhance soil fertility, crop rotation and mixed cropping for resilience and soil health, and dynamic agroforestry with multilayered cocoa systems integrating diverse trees and crops. Farmers also use organic resources like composted cocoa pods and farmyard manure to maintain soil fertility, and organize into cooperatives to facilitate training, marketing, and the spread of innovations.

Table 35: Existing Innovations in Goaso

Innovation type	Description	Reference
Cover cropping/green manure	Use of legumes and fast-growing plants to improve soil fertility and structure	Programme of Accompanying Research for Agricultural Innovation (PARI) Science and Technology Policy Research Institute (CSIR) Forum for Agricultural Research in Africa (FARA) https://library.faraafrica.org/storage/2024/10/FRR-Vol-8-No-3-2024-Ghana-Agroecology_Clean1.pdf
Crop rotation/ mixed cropping	Alternating crops and growing multiple species together for resilience and soil health	Programme of Accompanying Research for Agricultural Innovation (PARI) Science and Technology Policy Research Institute (CSIR) Forum for Agricultural Research in Africa (FARA) https://library.faraafrica.org/storage/2024/10/FRR-Vol-8-No-3-2024-Ghana-Agroecology_Clean1.pdf
Dynamic agroforestry	Multilayered cocoa systems with diverse trees and crops	Solidaridad https://www.solidaridadnetwork.org/wp-content/uploads/2024/10/Cocoa-Life-Our-Impact-Stories-small.pdf
Soil fertility management using organic resources	Integration of organic resources such as composted cocoa pods and farmyard manure to main soil fertility	Research Institute of Organic Agriculture (FiBL) https://www.fibl.org/en/themes/projectdatabase/projectitem/project/2103
Cooperative organization	Formation of local farmer groups for training, marketing and innovation diffusion	Fairtrade Ghana https://fairtrade.net/us-en/why-fairtrade/impact/impact-stories/daniel.html

Challenges and Opportunities

Challenges : Cocoa agroforestry adoption in Goaso faces several challenges. Farmers often lackinformation and knowledge about its long-term benefits and perceive full-sun cocoa as more profitable, leading to low adoption rates. Financial constraints also limit uptake, as smallholders earn very little and face high upfront costs for seedlings, planting, and maintenance, with limited access to credit or incentives. Land and tree tenure insecurity further discourages agroforestry, since the state owns all naturally occurring trees, denying farmers economic benefits from timber. Environmental and institutional factors, including deforestation, soil degradation, weak enforcement of regulations, poor

stakeholder coordination, and the introduction of full-sun cocoa varieties, reduce landscape resilience and biodiversity, compounding the barriers to sustainable agroforestry practices.

Opportunities: Cocoa agroforestry in Goaso provides ecological, economic, and climate benefits. Ecologically, integrating trees conserves biodiversity, sequesters carbon, restores degraded lands, maintains soil fertility, regulates microclimates, and improves water retention. Economically, it diversifies farmer incomes through timber, fruits, and non-timber products, enhancing food security and livelihood resilience. Policy and market support from initiatives like the Cocoa & Forests Initiative and Ghana Agroforestry for Impact Project offer technical assistance, training, market access, and cooperative strengthening. Agroforestry also serves as a climate-smart strategy, protecting cocoa from heat and drought stress and increasing system resilience. Additionally, opportunities exist for carbon financing and eco-certification, providing extra income through sustainable land management. Local innovations, developed in collaboration with farmers and institutions, leverage indigenous knowledge and adaptive practices to enhance agroforestry outcomes.

Lessons learnt for Galileo upcoming activities

The Joabeso Goaso Living Lab plays a key role in demonstrating how cocoa-based agroforestry can combine ecological restoration, climate resilience, and improved farmer livelihoods in Ghana's forest agroecological zone.

4. Cross-Cutting Lessons Learned from the diagnosis made in the four countries

4.1 Farmers perceptions on agroforestry

In the eight LLs, we identified some key elements that work well in different contexts. Firstly, the majority of farmers in the various LLs have a positive perception of agroforestry. Even when it is challenging, they still view it positively. Farmers perceive agroforestry as an opportunity due to the potential benefits it can generate. For example, during the LL inception workshop in Aponoapono-Suhum (GH), the advantages of cocoa agroforestry were discussed, as they were in the focus group discussion in Kenya. Agroforestry is seen as a way to create jobs in the community, improve income levels and food security, encourage peer learning among farmers, reduce the use of environmentally unfriendly chemicals and explore ecotourism and the carbon market. In the Ntui-Bokito LL, farmers recognise the benefits of retaining certain species in cocoa plantations for improved soil fertility..

4.2 Role of Farmer-based organisations to create collective action and inclusion around agroforestry

In many LLs, farmer-based organisations (FBOs) are presented as drivers for collective action and inclusion in agroforestry. In the Embu LL, women farmers have organised themselves into 63 groups, which are registered under the Women Farmers Association of Kenya umbrella organisation. They are in the process of changing their name to Women in Agribusiness Network. In the two LLs in Ghana, KKFU plays a key role in mobilising farmers around dynamic agroforestry (DAF).

4.3 Degradated soils, erosion and climate challenge

Many common pitfalls have been identified in the diagnostic process. Degraded soils and erosion issues are observed in all LLs. The reasons for this phenomenon vary from one LL to another. For example, in the LLs in Ghana and Cameroon, this situation is explained by deforestation, the use of inorganic inputs, and monoculture practices. In the Loum-Tombel LL, the organic matter content is below 2%, primarily due to monoculture practices and the excessive use of agrochemicals, which have a negative impact on soil macrofauna such as earthworms, ants and termites, which play a key role in soil fertility (Tsufac et al., 2021). In the Embu LL, erosion is due to a fragile structure and limited ground cover.

Additionally, climate instability has been observed in the form of delayed rainy seasons, increased drought days, erratic rainfall patterns and variable rainfall durations. These modifications disrupt farming schedules, particularly for rain-fed agricultural systems. The agroforestry system is perceived as an opportunity to stabilise groundwater recharge, particularly in the Niakhar and Ouakhokh LLs.

4.4 Labor availability

In all LL, labour is identified as a major, cross-cutting challenge. It is a limited resource. In the Aponoapono-Suhum and New Edubiase LL areas, labour scarcity is due to competition with other

farming and non-farming activities. In the Aponoapono-Suhum LL area, young people are increasingly choosing to work in the "Okada" (motorcycle transport) industry for the opportunity to earn money quickly, rather than working in agriculture, which is perceived as hard work with delayed returns. This trend has become more prevalent over the past 3-4 years. The shift of young people to 'Okada' has led to a significant shortage of farm labourers and increased labour costs (e.g. GHS 300–500 per acre for maize planting/harvesting). In New Edubiase, young labourers are more interested in illegal mining (Galamsey), where they can earn more money more quickly.

4.5 Land and Tree ownership

Two main challenges for agroforestry have been identified: ownership of land and ownership of trees. Secure land tenure is a major issue in Cameroon, Ghana and the Makima ward of Embu sub-location in Kenya. Various informal sharecropping arrangements exist that do not incentivise farmers to invest in the farmland in the long term, such as planting trees. Many farmers in New Edubiase and Aponoapono-Suhum face uncertainties regarding land ownership and short-term leases, which discourages them from investing in the long-term maintenance of trees (Fig. 14).

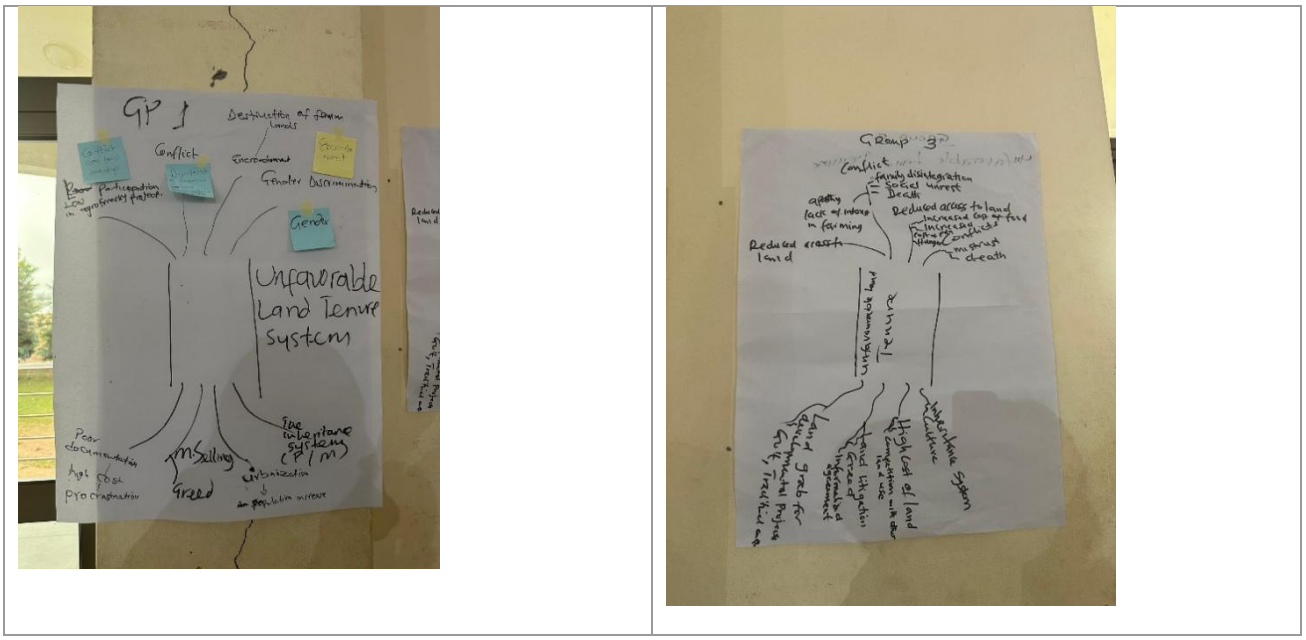

Figure 14: Examples of causes and effects of insecure land tenure in the Aponoapono-Suhum LL

Source : Aponoapono-Suhum LL inception workshop, 4-6 August 2025

In Embu County, land ownership is secured through title deeds (except in Makima Ward), with farmers possessing between 5 and 40 years of farming experience. There is no communal land, and land is acquired through inheritance or purchase. Renting land for cultivation is rare.

Tree ownership is also a major issue in Senegal, Ghana and Cameroon. In Senegal, the revised Forest Code (Law No. 2018-25 of 12 November 2018) introduces significant restrictions on the use of forest resources. It strictly prohibits the cutting, pruning and sale of protected species, including those from assisted natural regeneration (ANR), without authorisation from the Water and Forestry Department. In Ghana and Cameroon, based on forest protection laws, trees are not the property of the farm and authorisation is required to cut them..

4.6 Potential for cross-learning between the LL

In the LL, we identified some key good practices and mechanisms that can facilitate cross-learning. Cocoa farmers in Ghana and Cameroon are starting to incorporate beekeeping into their farming practices. In the Embu LL, farmers have more experience of this practice. In fact, beekeeping is widespread, with most farmers maintaining traditional log beehives, with between one and 50 hives per farm.

A key emerging incentive for tree planting in Embu LL is carbon credit programmes such as Acorn, which empower smallholder farmers by supporting them in transitioning to sustainable agroforestry practices, measuring the resulting biomass increase and issuing carbon credits accordingly. Acorn facilitates carbon credit payments to farmers through the sale of Carbon Removal Units (CRUs). These CRUs represent the amount of carbon stored in trees planted by farmers participating in the Acorn programme. Payments are made based on the amount of carbon sequestered, as measured by remote sensing technology (satellite imagery). This could be an incentive to explore in other LLs, particularly in Ghana and Cameroon..

4.7 Homogeneity vs contrasting soil and climate conditions in the LL area

Some of the proposed Living Labs (LLs) cover extensive territories with very contrasting soil and climate conditions. For instance, the Embu research team decided to divide the LL into two sub-living labs to better address distinct local dynamics: Nthawa/Mbeti South and Mavuria/Makima. This subdivision (regrouping about 20 villages) aligns with similar agro-ecological, socio-economic and institutional conditions, enabling targeted, context-specific interventions. The Nthawa/Mbeti South sub-region is characterised by relatively high rainfall, smaller farm sizes, mixed cropping systems and intensive external interventions. In contrast, Mavuria/Makima has drier conditions, larger farms, extensive livestock systems and unique socio-economic challenges. In Cameroon, despite the relief in Loum-Tombel ranging from mountains to hills and plateaus, the pedo-climate conditions are homogeneous. We observe the same homogeneity in the other LLs. In Ghana, the main issue is the distance between cities within the LL, particularly in the Assin-Fossu New Eduabiase LL and the Joabeso-Goaso LL.

4.8 Culture of participatory approaches

Some LLs are familiar with participatory approaches due to the existence of pre-existing LLs or innovation platforms. In Cameroon, for example, there are LLs on agroecology from the CANNALS project, and in Senegal there is an innovation platform from SustainSahel (conceived in 2020 and applied until 2025, primarily within the framework of LLs), as well as the SustaSahel project. In the LLs in Ghana and Kenya, no participatory research and innovation devices have been mentioned. In the eight LLs, the experience of participatory devices differs between researchers and other LL stakeholders. In the co-creation approach, the results clearly depend on the process. It is important to implement a high-quality, iterative, participatory process to achieve the best results from the LL approach. Two elements are key to a successful co-creation process: experience of participatory approaches by half of the LLs and the use of co-designed progress markers (PMs) to monitor the co-

creation process. The co-creation methodological guide will support the process, and researchers will also have access to training on co-creation and participatory approaches..

4.9 Gender consideration

In all LLs, the important roles played by women and young people in agricultural and livestock activities are highlighted. However, issues of legitimacy and recognition are also raised, such as access to land and cash crops. In the Embu LL, the existence of women's farming groups indicates a strong gender focus..

4.10 Role of livestock in agroforestry

In the living labs, we observe various considerations relating to livestock. We observe a gradient in the use of livestock, ranging from dominance to complementarity and integration with farming systems. Livestock can serve as an entry point into the system, as is the case in Ouarkhokh, where the agro-silvo-pastoral system is primarily based on transhumant livestock farming and the cultivation of rain-fed crops such as millet, cowpea and watermelon, as well as the utilisation of local woody species such as soump, acacia and sidème. In Niakhar, for example, livestock can be organised as complementary activities alongside crop farming and extensive livestock farming. They can also be integrated into farming systems, as in Niakhar and Ntui Bokito, to improve soil fertility and manage weeds and termite populations. In another situation, livestock can provide a supplementary income for specific events and unexpected expenses (weddings, education and healthcare), as observed in Embu and Loum-Tombe..

4.11 Diversity of innovations identified in the field

The diagnostic reveals various types of existing innovations : technical and organisational innovations. These innovations are endogeneous, initiated by local actors, others are driven/initiated by projects and have been uptaken by farmers.. Some innovations have been mentioned but experience of farmers shows that it didn't work well such as in Loum-Tombel : « *The distance and type of trees put cocoa trees in competition not only with each other, but also with other trees* » ; « *the use of timber trees: slow growth, late income, sometimes land disputes*", "*The selection of species was not ideal (this resulted in competition between cocoa and the other species for light and nutrients)*". Institutional and infrastructural challenges that prevent successful uptake and outreach of innovations have been identified such as bad roads, access to market, weak bargaining power of farmers. Also some macro-institutional threats have been identified as in Ghana the CocoBod's mounting debt which threatens Ghana's cocoa sector or reconversion of cocoa farmers in New Edubiase (threats with illegal mining). For the whole cocoa sector alignment with international regulation is key : the ARS (African Regional Standard) Traceability refers to the system for tracking cocoa beans from farms to the point of export, ensuring compliance with sustainability and ethical production standards. This system is crucial for meeting international requirements, particularly the EU Deforestation Regulation (EUDR), and demonstrating that cocoa is deforestation-free and ethically produced.

The diagnostic reveals various types of innovation: technical and organisational. Some of these innovations are endogenous, initiated by local actors; others are driven by projects and adopted by farmers. Some innovations have been mentioned, but the experience of farmers shows that they did not work well, as in Loum-Tombel: '*The distance and type of trees put cocoa trees in competition not only with each other, but also with other trees'*; *'The use of timber trees: slow growth, late income, sometimes land disputes*'; *'The selection of species was not ideal (this resulted in competition between cocoa and the other species for light and nutrients*)'. Institutional and infrastructural challenges that prevent the successful uptake and outreach of innovations have been identified, such as poor road access and weak bargaining power. Some macro-institutional threats have also been identified, such as the mounting debt of the Cocoa Board in Ghana, which threatens the country's cocoa sector, and the reconversion of cocoa farmers in New Edubiase due to illegal mining. Alignment with international regulations is crucial for the entire cocoa sector: the ARS (African Regional Standard) traceability system ensures that cocoa beans are tracked from farms to the point of export, guaranteeing compliance with sustainability and ethical production standards. This system is crucial for meeting international requirements, particularly the EU Deforestation Regulation (EUDR), and for demonstrating that cocoa is deforestation-free and ethically produced.

5. General implications and recommendations for the next steps of the projects

5.1 Choice of stakeholders for co-creation

The stakeholders can play various roles in the co-creation process. Ngome (2025) identified six key roles of stakeholders in the LL. The stakeholders :

- engage in the co-creation of combined agroecological practices and tools tailored made to the specific context of the LL;
- support in co-testing and monitoring, measuring and evaluation of agroecology strategies suitable for the LL;
- engage in the co-design of services, marketing tools, and business models relevant to the LL;
- support in capacity building, training activities and adoption of agroecological practices through knowledge exchange, and policy advocacy
- facilitate the dissemination and exploitation of project results using their own networks and forums in their respective countries and/or regions
- Propose innovations to be tested futher with the support of researchers, and then test them on- farm with the researchers' assistance

The main question is which stakeholders should be involved in the LL to fulfil that role. We must consider that co-creation is an iterative process, so some of the initial stakeholders may become irrelevant as the process progresses. The composition of the LL stakeholder group is not fixed from start to finish. It will be adapted according to the direction given to the co-creation process and the LL activities. In Galileo, we must strike a balance between maintaining a stable core of stakeholders to ensure continuity of the process and being flexible enough to include new, relevant stakeholders. The next question is: with whom should we start?
Thanks to the actor mapping in each LL, it is possible to identify representatives of the different categories of actors mapped. The inception workshop Terms of Reference (ToR) suggest the

following selection, which should be adapted for each LL based on the key actors identified in the area (Tab. 36).

Table 36. Composition of the participants in the inception workshop

Type of actors	Nb.
Farmers (Balance male/female/youth + innovative farmers/target farmers + crop/livestock)	6-8
FO representatives	2
Research	4
Development agency	2
NGO	2
Extension officers	2
Private sector (e.g. input dealer, buyer of commodity)	2
Other key actors according to the LL	2
Total	22-24

5.2 Adaptation of agroforestry definition in each context

Diagnosis of the LL reveals a variety of definitions of agroforestry. It is important to clarify what agroforestry is with the stakeholders at the level of each LL. Various dynamics around agroforestry have been identified across LLs. In LLs such as those in Ghana, the dynamics focus on reforestation in areas where cocoa production has led to deforestation, resulting in mainly secondary forest. In LLs such as Ntui-Bokito, the focus is on afforesting degraded savannah areas. The final dynamic is forestation in arid and semi-arid areas. Additionally, we observe an interest in striking a balance between having more trees and having trees that are better integrated with other crops.

A special session has been organised during the inception workshops in the Suhum and New Edubiase LLs to define what agroforestry is together. These discussions have generated interesting debates about the number and location of trees, planting models, shade management, and preferred tree species.

5.3 Managing diversity in LL

As mentioned above, some LLs exhibit significant heterogeneity in terms of topography, soils, and climatic conditions, particularly in the Embu and Loum-Tombel LLs. While this situation presents an interesting research context, it also poses a challenge in terms of designing appropriate experiments and conducting co-creation processes in parallel. Resources and protocols should be adapted at country level to address this issue.

5.4 Preferred vs adequate species and innovations

Based on field observations and literature, it is evident that farmers generally favour multipurpose trees. The diagnosis identified the preferred crop and tree species, as well as their function, in each LL by determining which trees had been planted by farmers. The co-creation process will allow the

selection of adequate species that strike a balance between being multipurpose and the effective and opportunity costs generated by using the species. The multicriteria indicators to be developed in Work Package 6 will inform the final selection..

5.5 Handle institutional and structural challenges

In Galileo, innovations are developed based on needs through the co-creation approach. The needs are huge, particularly with regard to the Galileo project's area of influence, particularly with regard to institutional and infrastructural issues. How can this aspect be better integrated into the project intervention? Institutional and infrastructural challenges have been identified in the LL. Innovations do not occur in isolation. The LL approach facilitates the development, uptake and outreach of innovation at different levels. This is where the connection between the LL and national and regional innovation platforms plays a key role in setting policy dialogue at various levels and enabling a favourable environment for upcoming innovations (T1.4).

5.6 Building on existing dynamics

One of the strengths of the Galileo project is its willingness to build on ongoing or past projects rather than starting from scratch. In Senegal, for example, interventions build on the EU-Horizon and SustainSahel projects; in Cameroon, on the EU Canalls project; in Ghana, on the Fairtrade Africa GAIMS project in New Eduabiase and Goaso; and in Kenya, on the Farm Africa Village-Based Advisors initiative. As a complementary approach, Galileo will further develop strong links with key stakeholders, such as state officials and programme and project staff, who are involved in interventions related to trees, crops and livestock in the area. This will help to create synergies and sustain the outcomes of Galileo. This partnership could occur at the national innovation platform level or within the LL. For the latter, Galileo will mobilise innovator farmers, i.e. farmers who have implemented endogenous or project-driven innovations..

5.7 Breakthrough vs frugal innovations

Using co-creation will help us adapt the innovations that we develop. The question is: what type of innovation are we looking for? Given the institutional and structural challenges, it is unlikely that breakthrough innovations will emerge from the co-creation process. As we are working with smallholder farmers in a highly constrained context, the project should prioritise frugal innovation. Frugal innovation involves the disciplined design of products, services or processes that deliver adequate performance at a significantly lower cost and use fewer resources. They are built for contexts with constraints such as low income, weak infrastructure and harsh environments. The core principles are: 1) Affordability first: start with a strict price/total cost target and work backwards; 2) Essentialism: focus on must-have features and remove nice-to-haves; 3) Resource thrift: use less energy, materials, data and capital, and repurpose existing technology; 4) Robustness: be simple, durable and easy to repair or maintain locally; 5) Accessibility: be inclusive by design, usable with low skills or connectivity and in multiple languages; 6) Scalability via simplicity: be modular, use open standards and have local supply chains. Frugal innovation is not just 'cheap' or low quality. Frugal innovation reframes the problem around constraints.

5.8 Information sharing within LL

In the co-creation process, constant knowledge and information sharing among stakeholders is essential. One of the first steps in LL activities is to produce the information and facilitate knowledge generation at an individual level from the contextual analysis available to all stakeholders. The LL inception workshop provides a space for sharing, discussing and completing the contextual analysis. Adequate documentation should be prepared and shared with LL stakeholders. In some LLs, we have noticed that some stakeholders are illiterate, reflecting the level of literacy in these communities. In the Suhum and New Edubiase LLs, the decision was made to include illiterate farmers in the co-creation process, as they are representative of the social reality in the cocoa sector.

6. Co-creation methodology

The methodology developed below is based on insightsinsights from the CIRAD e-learning on E-LP2 : All about using OI approaches in multiactor (R&I) partnerships and Mathé et al., 2025

6.1 What is cocreation?

"*Co-creation is a non-linear process that involves multiple actors and stakeholders in the ideation, implementation and evaluation of products, services, policies and systems with the aim of improving their efficiency and effectiveness, and the satisfaction of those involved in the process*" (Rizzo et Deserti, 2022). In the Galileo project, co-creation is a participatory approach involving multiple stakeholders in the joint identification of problems, generation of ideas and design of solutions. This approach ensures that innovations are contextually relevant, socially equitable and technically sound.

6.2 Why is co-creation important?

Co-creation aims to generate innovative solutions and establish sustainable implementation pathways to facilitate their adoption, whether the outcome is a new process, service or system. Throughout the co-creation process, dedicated stakeholders learn to take on collective responsibility and develop the practical expertise needed to address emerging challenges and iterate solutions as circumstances change..

The best context for co-creation :

1. When the context is complex and the community needs are difficult to extracts
2. Need for systemic change in a specific context
3. Need to build the capacity of stakeholders involved in the research/innovation process

6.3 How to implement co-creation?

The basis of co-creation revolves around the tryptic of context, a key common challenge for stakeholders, and a network of stakeholders. The co-creation process involves a series of activities, such as identifying the key challenge, developing scenarios, identifying options, experimentation and prototyping.

Co-creation is an iterative process. Addressing societal challenges requires more than a short series of participatory workshops. Co-creation only yields measurable results over extended periods, calling for persistence and patience. Through repeated practice and iterative refinement, stakeholders learn to co-create more effectively, enhance their solutions and focus their impact with greater precision.

6.4 Suggested methodology for the co-creation journey in Galileo project

To develop the co-creation methodology in Galileo, we have adapted the frame of the co-creation journey from the CIRAD e-learning: E-LP2 : All about using OI approaches in multiactor (R&I) partnerships

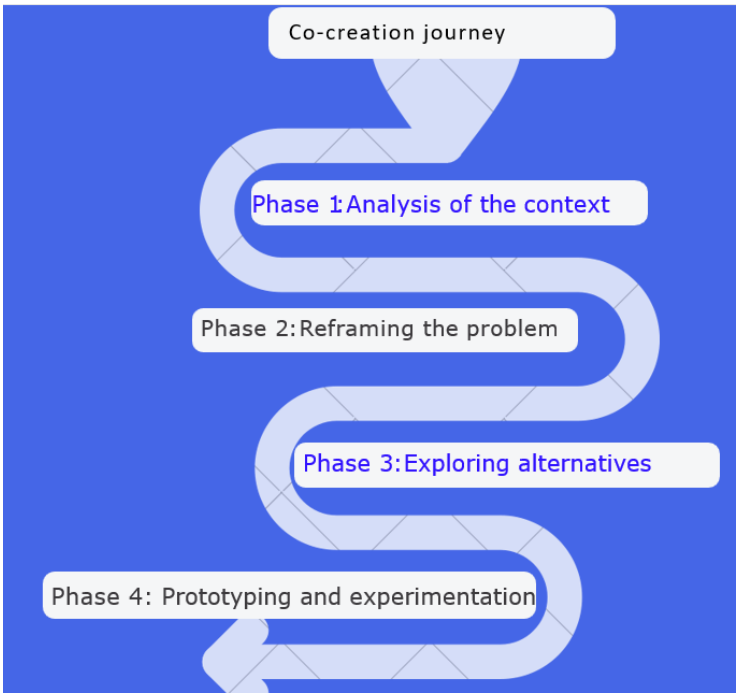

Figure 15 : Co-creation journey (Lecomte, 2025)

We suggest a cocreation journey in seven steps for Galileo project (Fig. 16):

1. Diagnosis: identification of the contextual characteristics (ecological, agricultural, social, economic and institutional) of the LL including the main challenges and opportunities. This step has been completed in Task 1.1 with the Diagnosis reports
2. Start engaging the LL stakeholders through the inception workshop : identify the LL stakeholders, agreement among all the stakeholders on the common goal and indicators to monitor the progress made in the co-creation process. The annexes 4, 5, 6 and 7 prodides details on the methodology for that step.
3. Implementation of scenario game to develop ex-ante scenarios (M10-M12)
4. Scenarios will be prioritized and key technical experimentations will be selected
5. Implementation of technical and social experimentations to develop prototypes that will be monitored and refined collectively
6. Collective mid-term evaluation of the experimentation and refining of the scenarios to develop mid-term scenarios (High interaction with WP6 to design tailored indicators) (M28-M30)
7. Final collective evaluation and refining of the mid-term scenario to develop ex-post scenarios (M46-M48)

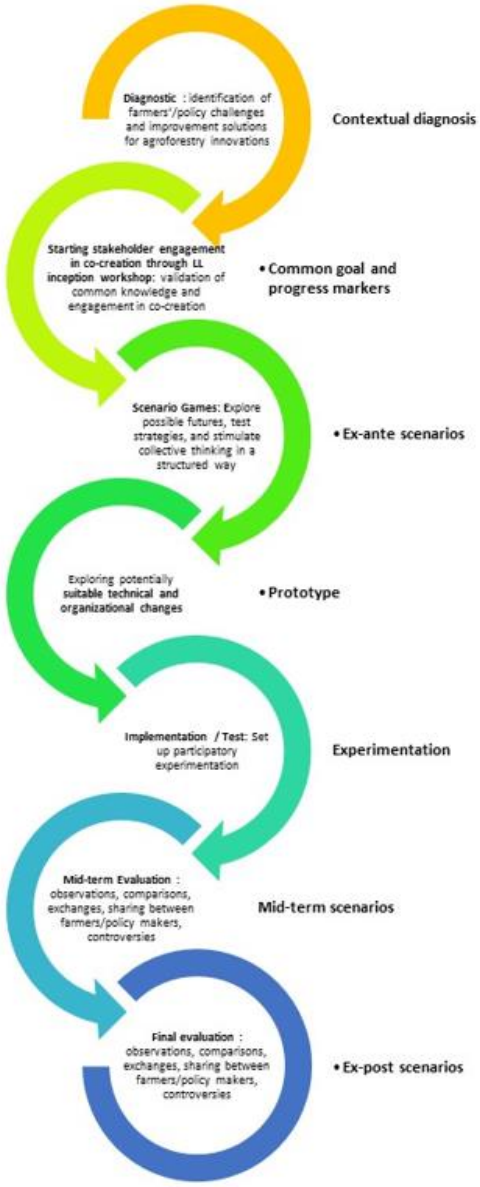

Figure 16 : Synthetic diagram of the steps for co-creation methodology along Galileo project

To support the co-creation process the research team will receive resources to be sensitized and trained on participatory approach and facilitation.

6.5 Suggested ToR for the Scenario Game (Step 3)

1. Main objectives

The main objective of the scenario game workshop is to :

- Identify main drivers of change
- Co-design ex-ante scenarios and associated experimentation
- Co-develop an action plan to implement the scenario

2. LogisticsLogistics

An **organisation Committee**[at which level, by whom], which budgetline?] should be set up. It should include all the project partners involved in that activity in the LL including the partners on the field to prepare the venue, mobilise the actors and organise the food/beverage.

The workshop includes **20 to 22 participants** based on those selected during the inception workshop, with adjustments to be done for any missing stakeholders.

The workshop will be organised during **2,5 days** to be able to have quality discussion without being stressed by the time pressure.

The **venue** should:

- Be booked in a room located in the living Lab area
- Be accessible easily by all the participants during the 2,5 days
- Be a place where all the participant feelfree and secure to discuss

The workshop should take place **by end November 2025**.

A **budget** should be established by the organising committee.

3. Methodology

The Galileo project will use and adapted approach based on scenario game.

Box 1 : Definition of Scenario Game

A scenario game is a participatory and interactive tool used to explore possible futures, test strategies, or stimulate collective thinking in a structured way. It combines scenario planning (developing alternative, plausible future situations) with game-based methods (rules, roles, and challenges) to make participants actively engage with complex issues. The Key Features of the scenario game are : 1) Scenario-based: The game is built around a set of predefined future situations or storylines ; 2) Role-playing: Participants may adopt specific roles (e.g., farmer, policymaker, investor) to see issues from different perspectives ; 3) Decision-making under uncertainty: Players make choices that have consequences within the game's scenario, helping them explore trade-offs and synergies ; 4) Facilitation and reflection: After the game, facilitators guide discussions to extract lessons learned and link them to real-world contexts. The scenario game can be used in various situations : 1) Testing policy options or project strategies in complex systems like climate adaptation, agriculture, or urban planning ; 2) Encouraging stakeholder dialogue and cooperation ; 3) Identifying unexpected challenges or opportunities before they occur in reality.

1. Starting from the common goal and horizon : this is the outcome of the LL inception workshop. Several activities during the workshop will support the development of the scenario. That's why the workshop should start with a reminder of the information and knowledge shared, the areas of agreement and disagreement identified, and the areas to be explored.

The Aponoapono Suhum LL inception workshop provided an example of the common goal to be achieved by the end of the project (Fig. 17). The boundary has already been defined by the LL's delimitation and local knowledge in the area has already been identified (through data collection and sharing with LL stakeholders during the LL inception workshop).

Figure 17 : Common goal set during the LL inception workshop in Aponoapono-Suhum

2. Identify the main drivers of change (social, economic, environmental/climate and policy) and score them according to their potential effect and manageability at LL level.
3. Select the drivers of change that are manageable and have a significant effect.
4. Develop 2x2 scenarios combining drivers.
5. Create storylines for each scenario.
6. Conduct a SWOT analysis and identify uncertainties around the scenarios.
7. Assess the scenarios and make a selection.
8. Identify the experiments to conduct based on the selected scenario.
9. Select key experiments according to available resources.
10. Develop a work plan for the key experiments.

Table 37. Draft of the agenda of the scenario game workshop

DAY 1	**Morning**	Presentation of participants (icebreaker exercice) Reminder from the inception workshop: information and knowledge shared, the points of agreement and disagreement, the areas to be explored that have been identified, common goal Identify the main drivers of change (group work with restitution)
	Afternoon	Select drivers of change that are manageable with huge effects Develop 2x2 scenarios with combination of drivers (group work with restitution)
DAY 2	**Morning**	Work on storylines for each scenario SWOT analysis and identify uncertainties around scenarios
	Afternoon	Assessment of the scenarios and selection Identify the experimentations to conduct based on the identified scenario Select key experimentation according to available resources
DAY 3	**Morning**	Develop a work plan for experimentations Finalisation of PM work

A **facilitator** should be identified. It should be an external person, if not someone neutral who can speak the local language and English or French. The role of facilitator will be to support the implementation of all the activities planned in the agenda and also to be sure that all the participants feel comfortable to contribute by paying attention to balance power relationships. Facilitation is not

manipulation !!!! No “Facipulation” ! For the workshop on scenario game, it is important to be well prepared. The development of a facilitation plan is key to organise each session an have a clear idea of who is doing what and the material needed for each working session.

Also it is important to identify **note takers** that are trained to identify the key points that should be considered for the next steps.

4. To explore the topic of co-creation further

- Resources and online video on co-creation : https://www.cocreate.training/resources/
- By end of September 2025, three e-learning courses will be available on the CIRAD e-learning platform on ‘’Mastering core capacities to manage R&I projects for sustainable impact in developing countries’’ : https://training.cirad.fr/?lang=en. One of the e-learning courses will be entitled ‘’ Innovating in partnership : Making collaboration work with open innovation approaches’’ and will bring key insights on the co-creation process.

7. Conclusion

D1.1 provides GALILEO with a robust, shared starting point for co-creation by coupling a comparable diagnosis of eight Living Labs (LLs) across Senegal, Kenya, Ghana and Cameroon with practical procedures. The synthesis translates heterogeneous starting conditions into harmonised overviews (biophysical, ecological, production systems, stakeholders) that teams can use as a common evidence base for action and cross-site learning.

Methodologically, D1.1 operationalises a five-step approach—desk review, key-informant interviews, analysis, write-up and cross-analysis—implemented under a common but flexible guide to ensure scientific rigour and stakeholder ownership. In total, 155 key-informant interviews were completed (vs. 200 in the GA), focus groups were concentrated where they added value (6 in Embu, 10 in Loum-Tombel), and co-selection of species/breeds/farm types is explicitly deferred to co-creation under T1.3. These adjustments were made to better serve the participatory pathway, without compromising data integrity, and resources were re-allocated to inception workshops. The strategic adaptations recorded (e.g., re-sequencing of activities, targeted use of workshops) reflect pragmatic responses to field realities that ultimately strengthen conditions for multi-actor co-creation.

The comparative lens points to differentiated priorities within a single co-creation framework: water and rangeland governance in Sahelian sites; tenure-sensitive shade/agroforestry packages in cocoa landscapes; and erosion control, input–service bundling and market access in Kenya. This justifies a portfolio approach that flexes common methods to local conditions while fostering exchange around “robust” practices that travel well. Anonymised source LL reports will be curated and shared via Zenodo to enable transparency and reuse across the consortium and beyond. These choices strengthen alignment with EU expectations on research integrity, data openness and stakeholder engagement.

D1.1 also suggests enabling design choices for the next phase: build deliberately on existing programmes and alliances (e.g., SustainSahel, CANALLS, GAIMS, Farm Africa VBA) and prefer frugal, context-fit innovations that are affordable, essential, resource-thrifty, robust and inclusive.

Concretely, the report lays out the co-creation journey for T1.3: Convene inception workshops to align on a common goal, prioritise challenges and co-develop “progress markers”; then run scenario-game workshops (M10–M12) to generate and select ex-ante scenarios that guide technical and social experiments, with mid-term and final collective reviews feeding adaptation and scaling. The inception workshop facilitation plan emphasizes inclusive participation (including illiterate farmers where relevant), careful time management and systematic capture of learning.

D1.1 is more than a compendium of context; it is the methodological spine and analytical map that moves GALILEO from diagnosis to design and early implementation. It aligns partners around a common baseline, translates diversity into actionable options, and equips teams with a staged pathway—tools, roles and indicators included—to co-create, test and learn their way toward scalable AFSP innovations with relevance for AU–EU policy dialogue and impact pathways.

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9. Annexes

9.1 Annex 1 : Outlines of the LL report in task 1.1.

1. Introduction

2. Summary of the ID of the LL (use also a Map if possible)

3. Methodology used in brief

4. Results

    1. Ecological data (Climate, soil type, vegetation type, ..)
    2. Agricultural system (Project in the last 5 to 10 years, Agricultural dynamics, Typology of agroforestry system, prefered trees, Farming system,)
    3. Socio-economic data (Population density, poverty level, market access, main source of income, ..)
    4. Historical data (important past events in the LL, highlights)
    5. Instititutional data (Farmer organisation, Infrastructure, important regulations that can affect our work)
    6. Challenges and opportunities
    7. Existing endogenous innovations (type of innovations)
    8. Mapping of actors (Diversity of actors, Functions of actors)
    9. Project intervention in the last 5 years (type of intervention)

5. Conclusion for Galileo intervention

6. References

9.2 Annex 2 : Key informant interview guide

A) Presentation of Galileo project and objective of the interview

B) Signature of concent form

C) BEGINNING of interview_____

1) Country and LL :
2) Name :
3) Organisation :
4) Functions in the organisation (since when) :
5) To what extend do you know *(cite the area of the Living Lab)* : Expert/ Knowledgeable/Fair/ Low
6) Concerning this area, what can you say about :

	Description/ Information	**Sources of information**	**Document available**	**Where ?**
1. Ecological data (Meteorological and Climatic data and past shocks and events for the last 10 years, soil type, vegetation type, Biodiversity hotspots and conservation activities)			Yes/No	
2. Agricultural system (Project in the last 5 to 10 years, Agricultural dynamics, Typology of agroforestry system, prefered trees, Farming system,)			Yes/No	
3. Socio-economic data (Population density, poverty level, market access, main source of income/ opportunity cost of non-agricultural activities, firms, villages..)			Yes/No	
4. Institutional data (Farmer organisation, Infrastructure, important regulations that can			Yes/No	

affect our work as Communal land planning, previous innovation platform)				

7) What have been the major historical events that have marked this area over the last 20 years (2 firsts colunms of the table) ? In your opinion, what consequences might these major events have on the development of agroforestry in the area (last column of the table) ?

Historical event	**When ?**	**Consequences on agroforestry development**

8) In you r opinion what are the main current of forcoming opportunities in this area ?

9) What have been the may intervention (project) in the area this last 5 years ?

Project Name	**Intervention**	**Organisations involved**	**When**

10) Who are the major players who operate or have operated in this area?

Name	**Organisation**	**Type of actors** *(Public organisation, Private organisation, Farmer based organisation,*	**Main functions/services in the area** *(access to ressources, sensitation and knowledge sharing, marketing, technical support, capacity building, Institutional support……)*	**Who are the beneficiaries** *(individual, formal PO, informal group, intermediary organisation)*	**Conditions to benefit from the service**	**If relevant link with other orgaisations in the area**

		NGO, *Informal actor)*				
	Yes/No					
	Yes/No					
	Yes/No					

11) Have you identified any (promising) innovations or innovative initiatives - related to AF- in the area? Yes/No
12) If so which one ?

Description of the innovation or innovative initiatives	**Innovation 1**	**Innovation 2**	**Innovation 3**
The novelty (newness) of the innovation: *What is the technical, organizational, social and methodological innovation with regards to what already exists? It is a question of the novelty of the solution, taking into account the context, time and unity of adoption. The chosen case will be considered as an innovation if it is perceived as new for its adoption unit.*			
Localisation *(or geolocalisation if possible)*			
Who initiate the innovation?			
Who is/are the actor(s) involved			
The central challenge to which the proposed innovation responds			
The scale of innovation (farm level, value chain, market, territorial level):			
The phase of the innovation process: Initiation/Emergence (*creative activities, designed by a very small group of actors, generally informal, around an idea of innovation***), Implementation/Development (***experimentation and/or adaptation activities, according to an action plan, by an organized group of actors (community, consortium, network, etc.)***, Dissemination/Diffusion: *use by actors who have not participated in the emergence or development, dissemination of innovation through intermediary organisations and/or political institutionalisation*			
Main/obstacles to successful innovation (optional item)**:** *What are the main obstacles to the emergence, development or scaling up of innovation today and which justify the need for support services to be provided?*			

Potential to affect sustainable agriculture and the agrifood system			
Alignment with national priorities? How is it linked to a political agenda?			
List any available documents and or references to the innovation			
Contact persons (name, organization, contacts)			

13) Do you have any additional documents that you would like to share with us?

14) Would you like to recommend someone we should meet to enrich our information base?

Name	**Organisation**	**Function**	**Contact**

15) Would you like to be informed about the activities of the Galileo project? Yes/No
16) If so, what are you most interested in?

17) Thank you for your time. Do you have any questions for us about the Galileo project or the interview we have just had?

END of the interview_____

9.3 Annex 3 : Guidelines for Focus Group to complete the Desk Review and secondary data collection in Kenya

Presentation of the Galileo Project and objective of the focus group:

GALILEO stands for StrengtheninG rurAL LIvelihoods and resiLiEnce to climate change in Africa: innovative agrOforestry integrating people, trees, crops and livestock. African food systems face a number of interconnected challenges, including food and nutritional security, climate change adaptation and mitigation, ecosystem degradation and biodiversity loss. Agroforestry practices can help to adapt to and mitigate climate change, while preserving and enhancing biodiversity. However, to fully generate these benefits, agroforestry innovations adapted to specific local contexts, in terms of biophysics, socioeconomics and institutions, are needed. It is in this context that IRAD, CIRAD, QPL, IRD, INRAe, UoB, WU, KU, FiBL, NTD, MHV, NCRC, ISRA, CSE, CNCR, UG, ICIPE, and UoEm are involved in the present project (GALILEO), which aims to co-design, test and evaluate, in close collaboration with local communities, agroforestry innovations that are resilient to climate change in the semi-arid zones of Sub-Saharan Africa. The objective of this focus group is to have a better understanding regarding the context of agriculture and agroforestry in the region, and the associated challenges. It will take the form of an open discussion between us addressing different aspects of agriculture and agroforestry.

FOCUS GROUP GUIDE

General information :
Name of the village/area/ward :
GPS location :
Number of persons assisting :
Functions of persons assisting (eg. farmers, VBA, head of village, representative of farmers organisations ….) :
Date - time of the focus group :

Description of the landscape and agroecological characteristics, wildlife and biodiversity
What is the total amount of rainfall per year?
Have you noticed changes in the climate over the past ten years?
What are the main soils in the region? How can the fertility of the soil be qualified?
What are the main form of vegetation found in the region (eg. natural forest, shrubland … etc)
Did you notice changes in the natural vegetation over the past 10 years? Degradation? Changes in the diversity of tree species?
Are there any sources of water in the region? (river, water pounds, dam …?)
At what level is the groundwater during the rainy seasons?
What are the main wild animals to be found in the region? Do there exist any regulations regarding wildlife?
Is there any wildlife conservancy close to the region?

Description of the agricultural and farming systems
What is the most common type of farm in the region (small, medium, large, commercial)?
What is, on average, the farm sizes?
How is commonly spatially organized a farm in the region (possibly sketch)?
How many people are working on a farm? Is there enough labour? Is it common to hire external labour?
What are the main crops cultivated as staple/food crops?
What are the main crops cultivated as cash crops?
What are the animals we can find on a farm in the region?

What are the main tree species we can find in a farm in the region? What are the main uses (listed them and the associated uses)?
What are the different forms of agroforestry we can found in the region (eg. hedgerows, scattered trees, alley cropping, orchards …)? What is the most common form of agroforestry?
Is beekeeping a common practice in the region?
Are farmers using inputs on their crops or trees? What type (chemical, organic)? Pesticides? Herbicides?
What are the main pest and disease issues in the region?
Can farmers easily access irrigation water in the region?
Do farmers own their lands? Is it coming from legacy or sale?
Is it common to rent land? For which reasons?

Description of the socio-economic systems
Do you have an idea of the population density? (low, medium, high?)
What is the general household composition?
Is the immigration a common fact in the region?
Is the migration of young people in more important cities a common fact?
What is the most important ethnic group in the region?
Are there marginalized groups or minor ethnic groups in the region?
What are the main sources of income?
What are the strategies to face shock/crisis (eg. livelihood diversification in space and time?)
Where is the closest market to sell/buy products?
How are the prices for the food products on the market (stables? fluctuating? increasing?)
Where is the closest market to buy inputs?
What is the main value chain in the region?

Description of the historic
Have there been any major political changes in the region in the past that have profoundly altered your life? When? and What type?
Have there been any major economical changes in the region in the past that have profoundly altered your life? When? and What type?
Have there been any major ethnic conflicts in the region in the past that have profoundly altered your life? When? and What type?
Have new regulations/ land reform been introduced in the past? When? and What type?
Have any major climate events happened in the past? When? and What type?
Have any major outbreaks happened in the past that have strongly impacted animals?\

Description of the institution and organisations impacting agriculture and agroforestry
Do you belong to any farmers organizations? List them
What are the most active farmers organizations?
What are the main governmental institutions related to agriculture and agroforestry in the region? List them
What are the main NGO related to agriculture and agroforestry in the region? List them
Do you have any extension offices/agents in the region? How many?
Do you have any VBAs in the regions? How many?
Are there any learning/training centers? Demonstration farms in the region?
What are the research institutes active in the region?
Are there any institutional frameworks impacting agroforestry in the region?

Challenges and opportunities for agroforestry
What are in general the challenges for agriculture in the region?
What are in general the challenges for agroforestry in the region?
What are in general the current or coming opportunities for agriculture in the region?
What are in general the current or coming opportunities for agroforestry in the region?
From your perception, what services to nature and population can agroforestry bring?

Endogenous innovations and practices
Are there any endogenous innovations and practices in the region allowing to overcome the challenges?

Agroforestry projects
Have there been any agroforestry-related projects in the last 5 years?
Have there been any projects related to tree planting in the last 5 years?
Have there been any projects related to nature-based-solution, agroecology, regenerative agriculture or organic agriculture in the last 5 years?

9.4 Annex 4 : Terms of Reference of an LL inception workshop

1. Main objectives

The main objective of the LL inception workshop is to :

- Receive feedback from the desk review and the key informant
- Validate the diagnosis as a common knowledge
- Start engage the actors in the LL
- Collect additional data
- Identify and prioritise challenges to overcome
- Agree on the willgness of all the actors to contribute to a co-creation process
- Co-develop indicators to monitor the process of co-creation

2. Logistics

An **organisation Committee** should be set up. It should include all the project partners involved in that activity in the LL including the partners on the field to prepare the venue, mobilise the actors and organise the food/beverage.

The workshop includes 20 to **22 participants** following the distribution in the table below.

Type of actors	Nb.
Farmers (male/female/youth)	6-8
FO representatives	2
Research	4
Development agency	2
NGO	2
Extension officers	2
Private sector (e.g. input dealer, buyers of commodity)	2
Other key actors according to the LL	2
Total	22-24

The workshop will be organised during **2,5 days** to be able to have quality discussion without being stressed by the time pressure. It could be reduced to 2 days if the logistics is too complex.

The **venue** should :

- Be booked in a room located in the living Lab area

- Be accessible easily by all the participants during the 2,5 days
- Be a place where all the participant fill free and secure to discuss

The workshop should take place in the **2nd half of 2025 (after submission of the first report on T1.1).**

A **budget** should be established by the organising committee to collect the necessary **funds** from each partner.

3. Methodology

The draft of the agenda includes collective activities.

DAY 1	**Morning**	Presentation of particpants (icebreaker exercice) Presentation of the project Data completion/Validation of diagnosis - Contextual data
	Afternoon	Data completion/Validation of diagnosis : - Key actors - Project - Existing innovations
DAY 2	**Morning**	Prioritazitation of Challenges and opportunities (group work) Problem tree with the most significant problem (related to agroforestry) *(See annex 4 : Problem tree tool)* Restitution
	Afternoon	Who to partner with in the LL to find solutions ? Exercise of delimitation of the LL action/field site (using a (iteractive) map) ***It is an optional exercise, it can be used for T1.2 (so the last session of day 3 can come afternoon of day 2)***
DAY 3	**Morning**	What do we want to acheive together Co-contruction of indicators (progress makers) Modalities of monitoring of the indicators *(See annex 5 : Co-construction of progress makers (process indicators)*

A **facilitator** should be identified. It should be an external person, if not someone neutral who can speak the local language and English or French. The role of facilitator will be to support the implementation of all the activities planned in the agenda and also be sure that all the participants feel comfortable to contribute by paying attention to balance power relationships. Facilitation is not

manipulation !!!! No “Facipulation” ! It could be good to develop a facilitation plan to have a clear idea of who is doing what and the material needed for each working session.

Also it is important to identified **note takers** that are trained to identify the key points that should be considered for the next steps particularly for the co-creation process.

The **material** needs for the workshop include :

- Project Roll-up
- Paper board
- Markers
- Large post-it
- Map of the area

The annexes 3 and 4 provide the methodology for the Problem tree exercise and the Co-construction of progress makers (process indicators).

NB. The process is as important as the result. All the exercises contribute to deliver products such as the problem tree. But the process of developing that product together plays a key role in the common understanding of challenges (sense making) and also in the building of trust. That’s why a smooth facilitation is key to produce quality products and processes.

9.5 Annex 5 : Problem tree tool

NB : This methodological sheet is an adapted version of the tool facsheet of CDAIS project on Capacity-focused Problem Tree : https://tapipedia.org/content/tool-factsheet-capacity-focused-problem-tree

1) Description of the tool/approach

The problem tree is a tool for discovering solutions by uncovering the anatomy of cause and effect around an issue. It is analogous to a mind map, but more structured. Participants have an opportunity to indicate their priorities.

2) Why using this tool/approach

This tool leads to a collective understanding of the chief problems; encourages the participants to think about multiple causes and effects; and support of prioritization of key entry point to solve the issues.

3) How to implement this tool/approach (when)

The approach includes 6 major steps that will be deployed during the LL inception workshop :
Step 1: Start by brainstorming about all major issues relatins to AFS. Within the group, decide on the core issues/problems relating to the enabling environment, organizations and individuals.
Step 2: Draw a “tree” and write the key problem on the trunk. If you think there is more than one key problem, you need to draw one tree per problem.
Step 3: Encourage the stakeholders to brainstorm on the causes of the key problem and write them on cards. Prioritize the causes.
Step 4: Discuss the factors that are possible contributory causes of the key problem. Focus on the factors that are potential drivers of change and write them on the roots of the tree.
Step 5: Look at the effects/impacts of the problem, and write down the primary effects on the branches of the tree.
Step 6: The diagram generated in this exercise provides a basis for discussion and can be converted into a objectives tree, turning the negative statements into positive ones.

When you use this tool don’t forget to give poeple enough time to explain their reasoning. Write down on a separate piece of paper related ideas and points that come up, and put them under headings such as: solutions, concerns and decisions.

Here are some questions to facilitate the discussion :

- Does this represent the reality of the situation? Have the economic, political and sociocultural dimensions of the problem been given due consideration?

- Which causes and effects are getting better, which are getting worse, and which are staying the same? What are the most serious effects? Which effects are most worrisome? What criteria are important to us as we think about a way forward?
- Which causes are easiest/most difficult to address? What possible solutions or options might there be? How might a policy change address a cause or effect, or deliver a solution?
- What decisions have we made, and what actions have we agreed upon?

4) How to store the data

The picture of the problem trees developed in each LL can be stored : https://drive.google.com/drive/folders/1DqzErU_gS3xkcY29SQ-itRlE0gUpNm5i?usp=drive_link

5) Related tools / additional resources

Problem Tree- MSP Guide : https://mspguide.org/2022/03/18/problem-tree/#:~:text=What%20is%20a%20Problem%20Tree,map%2C%20but%20with%20more%20structure.

How to use a problem tree analysis : https://youtu.be/q6qYZiW5BWU

9.6 Annex 6 : Co-construction of progress markers (process indicators)

1) Description of the tool/approach

Progress markers are part of a system of Monitoring, Evaluation and learning (MEL). Progress are successive milestones for measuring the progress made towards achieving the desired change. A Progress Marker is a smaller anticipated action that contributes to overarching outcomes. Tracking progress markers enables teams to show incremental changes in progress made in the short- term.

2) Why using this tool/approach

Progress markers are performative. It means that when you formulate it, it help to ease the realisation of the statement. That why it drives learning and capacity building that foster the upcoming cocreation process.

3) How to implement this tool/approach (when)

The PM will be co-constructed during the LL inception workshop.

PMs are graduated indicators of changes in the knowledge (K), attitudes (A) and practices (P) of stakeholders or stakeholder groups (KAP model). For the activity of cocreation, PMs corresponding to 3 different levels are formulated : (1) what is expected, (2) what is desired, (3) the ideal. The changes can be perceived at individual, collective, organisational or partnership level and are assessed collectively at the mid term and the final term of the co-creation process that mark out the capacity-building process.

Some questions that could be asked :

- What do you expect in terms of exchange or creation of knowledge furing the cocreation process ?
- What would you like to see as change of behaviors during the cocreation process ? Whom ?
- What change in practices would you expect to see ? Whom

The statement should be formulated as :

- A sentence with an action verb
- A subject (precise whom) is doing what
- Clear statments

Example of a table of progress markers deloped to follow partnership in a reasearch project

OBJECTIFS PRIORITAIRES	Expect to see	statut 0/1/2	EXPLICATIONS	Like to see	statut 0/1/2	EXPLICATIONS	Love to see	statut	EXPLICATIONS
P1: Bringing partners in the same space	CEDRES owns the project	NSP							
	IECD mobilise le staff compétant et disponible pour le projet	NSP		IECD met en œuvre les récommendations issuent du projet	NSP		Servinnov contributes to the improvement of the new extensionist through modules dedicated to	0	
	Les WP leaders confirment bien leur rôle	1	1 POUR ESSA POUR WP3	Coordination team manage to facilitate dynamic and exiting meetings	2	MADA	IECD crée un service interne dédié à l'innovation	NSP	
	MINRESI signe les documents pour mettre à disposition les financements pour l'Université de Dschang	1	EN COURS	IECD crée de nouveaux partenariats à l'échelle nationale et internationale	NSP		Manuel developed is adopted as reference document by innovation providers	0	
	All partners are clear of project goals and expectations	1	EN COURS ET LES ATTENTES SE CONSTRUISENT ENCORE	Partners have a commmon understanding of key concepts	1	IL RESTE DE DISCUSSIONS A ORGANISER SUR DES TYPOLOGIES, DES METHODES	Policy markers adopt our recommandations to improve ISS in the 3 countries	0	
	All partners are clear of the specific responsibilities linked with WPs	1	WP4 ET WP5 : à préciser				tous les partenaires construisent le cadre conceptuel et mérhodologique	1	GRACE AUX REUNION ET WORKSHOP
	Les partenaires de développement restent intéressés au	2	FIFATA				les différents parties prenantes harmonisent leur	1	
	Les chercheurs comprennent les problématiques sur le	2					Parters make use of the same terminology	0	
	Partners share common language on ISS	1	EN COURS						
	All SERVInnov partners communicate around delivrable		A CHANGER						
	Tous les partenaires sont tous impliqués dans le projet et se sentent responsables de sa réussite	1	WP3 N'A PAS DEMMARE						
	IECD et AGRO-PME aident les chercheurs à avoir une vision	NSP							
P2: Aligning actions around the same framework	Les partenaires se mettent d'accord sur les livrables précis attendus	1	Certains partenaires n'ont pas réagi à la rédaction des livrables						
	Partners join in designing a common framework	2	Le livrable sur le cadre conceptuel a été validé par les acteurs	Country fora invited within the project in the 3 countries	0,5	Les forums pays ont eu lieu seulement au Cameroun	les principaux bénéficiaires utilisateurs s'impliquent dans les espaces d'orientations	0,5	L'IECD et FIFATA se mobilisent dans les espaces d'orientation
	IECD met ses projets à disposition pour analyse/étude de cas	2	Mise à disposition par l'IECD de ces projets (APONH et TRANSFORM) au Cameroun pour la phase exploratoire et le WP2 et un cas à venir (APONH) pour le WP 3	Country fora involved in the mapping of innovation providers	0	Les groupes AFAAS n'ont pas été impliqués parce que les liens avec eux ne sont pas consolidés pour le moment	usefulness of framework is proven by field work	1	Le Burkina-Faso n'a pas mobilisé les cadres théoriques (typologie)
	Inventories and case studies are conceptually based on D11	1	Les caractérisations ont mobilisé le cadre conceptuel	AFAAS takes advantage of international events to reach policy makers at continental level	0,5	Le side event de Côte d'Ivoire a permis de communiquer au			
	Framework be accepted and ready for use by all	X	Il faut préciser le terme "framework"	WP2+3 make full use of guidelines provided (D12, D13)	X	Il faut préciser le terme			
P3: Ensuring relevance/outcomes for end users	Practionner partners understand need of research and vice vesa	1	FIFATA bien , IECD OK et GRET =0						
	All partners enabled to diagnosis and assess ISS and ISP	1	Tous les livrables non disponibles	LaF gets involved in SERVInnov BKF	0	N'est pas encore arrivé mais cela	l'agence de conseil en construction au Cameroun s'inspirent des resultats de SERVINNOV	0	L'agence n'a pas été mis en place
	AFAAS repackages contents using format that better matches each target audience	0	Pas suffisemment de communication	Researchers manage to build oriented-action frameworks	0	Pas pertinent. Il faut le supprimer car pas	Agro PME et l'IECD travaillent en réseau sur des projets dans la zone de Djombé	1	Agro-PME n'est pas encore suffisemment
	Country teams quickly identify motivated and interested end-users	0	Pas encore d'actions à ce sujet	(WP1) partners have tested auto-evaluation tool	0	Outil non constitué	WP4 team produces useful guides in a timely maner	0	Pas de guide disponible à jour
	Les partenaires partagent le même vocabulaire sur les services de support	1	Les concepts restent beaucoup en débat. Critique	D'autres praticiens veulent être impliqués dans le projet en proposant des cas qu'ils piloteraient et financeraient	0		les étudiants impliqués dans SERVINNOV sont recrutés par les agences de developpement sur les questions d'innovations	0	Pas de recrutement à ce jour
				Le guide de SERVInnov est insérédans le kit du	0	Pas arrivé			
P4: Financial tracking and ressource mobilization	AFAAS put in place all communication tools for the project	1		Les programmes nationaux de vulgarisation s'inspirent des résultats du SERVInnov	1	e.g Mada, the FIFATA extesion sytem is already getting inspired			
	Allocated budget is spent for purposes designed and no major deviations occur	1	Mada, unexpected expensis for consultants earlier lanned for Students, Cam, funding not recieved at all				le NEPAD souhaite financer la mise en œuvre de SERVINNOV dans d'autres pays	0	pas très réaliste
	All partners collaborate to the development of the common strategy	1	AFAAS's collaboration has been unstable e.g meeting attendance, continuing of Project actors, dely in Website Dev't				Allocated budget is sufficient and activities amerging in the course of the projet can be a realised	0	

4) How to store the data

Data can be stored (one sheet should be created to each LL): https://docs.google.com/spreadsheets/d/1qns4XVgD0pbVE9AtMH-pjFzU8m5BHJlOoUqgDKqBwkM/edit?usp=drive_link

9.7 Annex 7 : Facilitation Plan for GALILEO LL inception workshop in Suhum (August 4-6, 2025)

1. Main objectives

The main objective of the LL inception workshop is to :

- Receive feedback from the desk review and the key informant interview
- Validate the diagnosis as a common knowledge
- Start engage the actors in the LL including target farmers, innovator and control farmers
- Collect additional data
- Identify and prioritise challenges to overcome
- Agree on the wiliness of all the actors to contribute to a co-creation process
- Co-develop indicators to monitor the process of co-creation

2. Roles and responsibility

Organization committee (to be completed)

1. UG
2. KKFU
3. CIRAD
4. IITA

Note takers

Preferably note should be taken on computer to facilitate compilation as we have several note takers

1. UG

Time keeper

To be defined. Not the same for each day. Bring a bell for ending the session

Photographer

To be defined. Need clear picture of the post-it and flipchart and need pictures for reporting

3. List of participants

To be added to define the number of groups for the group work (2 or 3)

4. Facilitation plan for the 2,5 days according to the tentative programme

NB: Researchers are part of the discussion (as a stakeholder) and are invited to contribute based on a fairly distribution of speaking

Day 1_Setting the scene: building common knowledge

Timing	Duration (min)	Responsible	Content	Approach/Steps	Materials to be prepared or to make available
8.30-9.30	60		Registration + signing consent form Snack and coffee/tea available	Prepare labels for participants to write their names and organizations or roles on and stick on their clothes	Adequate labels and markers Print registration sheet and consent form Order snacks coffee and tea to welcome participants
9.00-9.05	5	KKFU	Open prayer		
9.05- 9.30	25	KKFU	Presentation of participants	Icebreak (Roll call?) / *to be defined*	
9.30-10.00	30	UG	Presentation of the project (take time to present and agree on the LL approach (including multi-actors approach, engagement of stakeholders, Activities planned as co-development of scenarios and co-creation of solution, experimentations, indicators co-construction and monitoring) and the interest of the participants for the LL approach) + take questions from participants	Oral presentation with the project roll-up Reporters take notes for questions	Prepare roll up and flyers Prepare a document that explain what is a LL activities *(ask leader of T1.2)*

10.00-10.15	15	UG	Presentation of the objectives and approach of the inception workshop, and the agenda for the 2,5 days + set the rules of the two days together	Oral presentation	Prepare a flipchart paper with the agenda to put on the wall Need a flipchart paper to set the rules (phone call, commitment for 2,5 days, engagement for the interactive sessions, organizer respect timing, use of a bell by the timekeeper, punctuality of participants ….)
10.15-10.45	30	CIRAD /UG	Presentation of the results of the contextual analysis	Oral presentation *Distribute speaking time fairly* Reporters take notes on discussion	Prepare PPT presentation per themes Video Projector Prepare a flipchart paper with the questions of the discussion
10.45-11.35	50	UG	Guided discussion	Start asking the question orally (around 12 min/ question) if not enough time give post-it *Distribute speaking time fairly* 1° What surprise you?	Prepare a booklet with some of the results to share with participants Prepare large post-it to collect contributions (one color per question)

				2° Which information do you disagree with? Why? 3° Which information seems consistent with your knowledge of the area? 4° Which information would you like to complete Reporters take notes on discussion	
11.35-11.45	5	Facilitator	Stretching exercise		
11.45-12.00	15	CIRAD	Presentation of the results of the actor mapping	Oral presentation (present classification, actors and their functions) Present the questions that will guide the discussion before the oral presentation	Prepare flipchart with the actor mapping
12.00-1.00	60	UG	Guided discussion	(around 12 min/ question) *Distribute speaking time fairly* Start with the first question orally and collect post-it if there is not enough time. On question 2 ask participants to suggest something if they disagree and put the suggestion on a flipchart. For question 3 ask the question orally. If there is not enough time go	Prepare large post-it to collect contributions (one color per question)

				to post-it. For the last question ask participants to fill the post-it and stick the post-it at the right place on the flipchart 1° What surprise you? 2° Does the classification of actors suit you ? Why ? 3° Do you agree with the functions of the actors presented? Why? 4° Who is missing? Which functions? Reporters take notes on discussion	
1.00-2.00			Lunch	Packed Lunch	Confirm the number of participants to order Packed Lunch
2.00-2.15	15	CIRAD	Presentation of the results of the project mapping	Oral presentation (present projects listed and interventions) Present the questions that will guide the discussion before the oral presentation	Prepare PPT with the projects
2.15-2.45	30	CIRAD/UG	Guided discussion	(Around 10 min/ question) *Distribute speaking time fairly* Start with the first question orally and collect post-it if there is not enough time. On question 2 collect opinion	Prepare large post-it to collect contributions (one color per question)

				orally. For question 3 collect post-it ask participant to stick them when finish ask them to comment their own post it. 1° What surprise you? 2° Do you agree with the projects and their interventions presented? Why? 3° Which project is missing? Which interventions? When? Reporters take notes on discussion	
2.45-3.00	15	CIRAD	Presentation of the results of the innovations related to cocoa agroforestry systems identified	Oral presentation (present innovations areas….) Present the questions that will guide the discussion before the oral presentation	Prepare PPT with the projects
3.00-3.40	40	CIRAD/UG	Guided discussion	(Around 10 min/ question) *Distribute speaking time fairly* 1° What surprise you? (oral) 2° Are you agree with the innovations that has been presented? Why? (oral) 3° Which innovations are missing? Which interventions? When? (post-it)	Prepare large post-it to collect contributions (one color per question)

				Reporters take notes on discussion	
3.40-4.00	20		Closing of day 1 Rappoters summary report	Ask participant what is the take-home message for Day 1? (oral answer) Brief outlines of the agenda for day 2 Ask participants: from experience of today, what could/should we improve for day 2? Reporters take notes on discussion	
4.00-5.30	90	Organizatio n committee	Debriefing of day 1 and preparation of day 2	Roundtable with two questions (one roundtable per question) 1. Agree on key information gather and the key points to keep in mind on day 1 2. Screening and Adjustment of day 2 agenda if necessary. Check the availability of all the material for Day 2 The note takers support the discussion	Have a room for the debriefing and the preparation of day 2

Day 2_Starting co-working: identify challenges and opportunities

Timing	**Duratio n**	**Responsibl e**	**Content**	**Approach/Steps**	**Materials to be prepared or to make available**

8.30-9.00	30		Registration for day 2 Snack and coffee/tea available		
9.00-9.15	15	UG	Recap of day 1 and presentation of the agenda for day two		Prepare the recap after Day 1 during the debrief and preparation session
9.15-9.45	30	IITA	Presentation of the results on the section on agroforestry models, challenges and opportunities collected in the desk review and the KII	Oral presentation + take 2 or 3 questions from participants *Distribute speaking time fairly* Reporters take notes for questions	Prepare PPT
9.45 – 9.50	5	IITA	Explanation on the assignment for the coming session	Oral presentation	Prepare printed document with the assignment (PPT)
9.50 - 10.20	30	IITA	Plenary discussion on two questions: 1. What does it mean to say, innovative agroforestry that integrate people, trees, crops and livestock in our LL? 2. Is it something that we want for the future of the	Post-it session for each question or oral answer *(to adapt based on the energy in the room)* Reporters take notes for questions	Prepare large post-it to collect contributions (one color per question)

			cocoa sector in the LL? Why?		
10.20-11.20	60	IITA	Group work (first session) Work on three questions 1. What are the opportunities in developing and implementing innovative agroforestry in the context of the LL?? 2. What are the challenges in the context of the LL? 3. Rank the challenge from the most important to the less important	Two or three groups One reporter and on facilitator per group Two questions to be discussed (20 minutes for question 1 and 2 and 10 minutes for question 3) Use flipchart to note the answer mention by the group Most important means the challenge to address in priority in the frame of the LL	
11.20-11.25	5	Facilitator	Stretching exercise		*Maybe we will need some snacks or nice chocolate to share*
11.25-11.40	15	Group reporters	Reporting and discussion in plenary	5 min per group if three groups Reporters put the most important challenges on flipchart	
11.40-12.00	20		Vote on the top priority	Give 2 stickers to the participants so that they can vote for two max Step 1 of the tree problem methodology	Prepare small round stickers (“gommettes”)

12.00-1.30	90	IITA	Group work (second session)	Follow the steps of the problem three methodology (see below Methodological sheet 8) Two or three groups One reporter and on facilitator per group	Adapt the methodology to the LL inception workshop if needed Prepare large craft paper, maker and cards or post it
1.30-2.30			Lunch	Packed lunch	Confirm the number of participants to order packed lunch
2.30-3.00	30		Restitution of the group work + discussion	5 min per group if three groups 15 minutes discussion on: 1° What surprise you? (oral) 2° What should we keep in mind as a LL group? Reporters take notes on discussion	
3.00-3.40	40		Plenary session Question to address: Based on the challenges identified, who is missing as a partner in that journey? Why?	Oral question Give participants 10 minutes to write on post-it Collect the post-it Invite participant to comment what they put on their post-it *Distribute speaking time fairly* Take a picture of the result at the end of the session	Prepare paper on the wall

3.40-4.00	20		Closing of day 2 Rapporters' summary report	Ask participant what is the take-home message for Day 2? (oral answer) Brief outlines of the agenda for day 3 Ask participants: from experience of 2 days, what could/should we improve for day 3? Reporters take notes on discussion	
4.00-5.30	90	Organizatio n committee	Debriefing of day 2 and preparation of day 3	Roundtable with two questions (one roundtable per question) 1. Agree on key information gather and the key points to keep in mind on day 2 2. Screening and Adjustment of day 3 agenda if necessary. Check the availability of all the material for Day 3 The note takers support the discussion	Have a room for the debriefing and the preparation of day 3

Day 3_Step in the co-creation mode

Timing	Duration	Responsible	Content	Approach/Steps	Materials to be prepared or to make available
8.30-9.00	30		Registration for day3 Snack and coffee/tea available		
9.00-9.10	10	IITA	Short recall on the activities planned in the LL		Prepare PPT ad use document on activities planned
9.10- 10.10	60	KKFU	Work on identification of areas for implementation of action and dissemination of findings (action area) and areas for dissemination only (Field site of the LL)	Use a printed map of the extended area	Prepare a map
10.10-10.20	10	CIRAD	Explanation on the coming session: co-construction of indicators (progress makers) to follow the progress made within the LL group and suggestions on modalities to monitor them Explanation on formulation of progress markers, categories (expect to see, like to see and love to see) and per type of PM (Knowledge, attitudes, practices)	Oral presentation	Prepare PPT Print a paper

10.20-11.30	60	CIRAD	Plenary session: co-construction of indicators (progress makers) to follow the progress made within the LL group General Questions: 1. What do we want to achieve together? Ask questions to formulate progress maker: • According to the activities planned, what do you expect in terms of exchange or creation of knowledge? • According to the activities planned, what would you like to see as change of behaviors during the? From whom? • According to the activities planned, what change in practices would you expect to see ? From whom ?	Follow the steps on Methodological sheet 9: Co-construction of progress makers (process indicators) Use post-it Collect post-it Invite participants to collect their post-it Invite participants to react *Distribute speaking time fairly*	Adapt the methodology if necessary Prepare flipchart to collect post-it for each question
11.30-12.40	10	CIRAD	Selection of PM and agree on regularity of monitoring	Give 9 stickers (3 color, 3 per color for expect to see, like to see and love to see) invite participant to selection one progress marker per category (expect to see, like to see and love to	Prepare small round stickers (“gommettes”)

				see) and per type (Knowledge, attitudes, practices)	
12.40-1.00	20		Closing of day 3	1.Presentation of the next steps 2.Ask participants for take home messages from the three days Reporters take notes on discussion	
1.00-2.00			Lunch	Packed lunch	Confirm the number of participants to order packed lunch
2.00-3.30	90	Organization committee	Debriefing of day 2 and preparation of day 3		Have a room for the debriefing
3.30			Back to Accra		

9.8 Annex 8: Overall description (title, size, coauthors) of the 4 countries (8 LLs) original documents

NB : the original files (anonymized) are shared in Zenodo (https://zenodo.org/communities/galileo_project/).

Country	Living Lab	File Name	File size (Mb)	File size (pages)	Coauthors	Institutions
Senegal	Niakhar	1_Senegal_Niakhar_T1.1 LL report.pdf	3.6	95	Chérif Syaka Assembène Mane Marame Ba Abdoulaye Fofana Fall Cathy Clermont-Dauphin Moussa N'dienor Finda Bayo Diakhate Adama Lo Diarra Sylla	ISRA ISRA ISRA IRD ISRA ISRA CSE CSE
	Ouarkhokh	2_Senegal_Ouarkhokh_T1.1 LL report.pdf	2.7	66	Pierre Sutter Dominique Masse Frédéric Do Ollo Sib Abdoul Aziz Diouf Moussa Sall Michael Diedhiou Olivier Roupsard	NTD IRD IRD CIRAD CSE ISRA CNCR CIRAD
Kenya	Embu	3_Kenya_Embu_T1.1 LL report.pdf	2.8	66	Madrine King'endo Samuel Maina Pierre-André Waite Gian Nicolay Louise Leroux Rebecca Yegon Jeremy Ireri	UoEm UoEm CIRAD FiBL CIRAD UoEm UoEm
Cameroon	Loum Toumbel	4_Cameroon_Loum_Tombel_T1.1 LL repor	5.2	42	Precillia Ijang Tata Ngome Fabrice Azebaze Doris Ehabe Lewis Dopgima Levai Benjamin Ngane Paul Bissang James Ndikum Gaelle Manguele Denis Folefack Verina Ingram Olivier Miantsia Ivan Cornut	IRAD IRAD IRAD IRAD IRAD IRAD IRAD IRAD IRAD WU GDA CIRAD
	Ntui Bokito	5_Cameroon_Ntui_Bokito_T1.1 LL report.p	5.9	58	Precillia Ijang Tata Ngome Gwendoline Egbe Doris Ehabe Jean Guy Mbile Apolline Reboud Verina Ingram Olivier Miantsia Ivan Cornut	IRAD IRAD IRAD IRAD NTD WU GDA CIRAD
Ghana	Aponoapono Suhum	6_Ghana_Aponoapono Suhum_T1.1 LL repo	0.8	27	Irene Susana Egyir Daniel Adu Ankrah Syndhia Mathe	UG UG CIRAD
	New Edubiase	7_Ghana_New Edubiase_T1.1 LL report.pdf	0.7	22		
	Joabeso Goaso	8_LL Ghana_Joabeso Goaso_T1.1 LL report	0.7	17		

Galileo

AGROFORESTRY FOR RESILIENT AFRICA FACING CLIMATE CHANGE

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FAIRTRADE MAX HAVELAAR

TERRE VERTE

ISRA 50 ans

CSE Centre de Suivi Ecologique

CNCR

JARDINS D'AFRIQUE

UNIVERSITY OF EMBU

icipe

FARM AFRICA

UNIVERSITY OF GHANA

IITA Transforming African Agriculture CGIAR

NCRC NATURE CONSERVATION RESEARCH CENTRE

KUAPA KOKOO PAPA PAA

IRAD

GDA Green Development Advocates For a Green Congo Basin

FiBL

Funded by the European Union