CANALLS
AGROECOLOGICAL PRACTICES FOR SUSTAINABLE TRANSITION

D2.3 CANALLS Decision Support Tools – Initial version

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Executive Summary

The Decision Support Tool (DST) in CANALLS supports farm advisors in facilitating tailored agroecological transitions. It was developed through a participatory and co-creative process involving the project's research and practice partners, and its completion meets the objectives of CANALLS Task 2.3. This report provides an overview of Task 2.3 methodology, realization, and outcomes. More specifically, it i) details the development process, ii) identifies initial needs, iii) reviews existing decision support tools, iv) outlines the requirements engineering process, v) presents the concept and initial prototype, and vi) shares feedback from test applications in one of the Living Labs (Ntui, Cameroon). The appendices include a table of reviewed tools, the prototype of the web-based tool, and the diagnostic questions used for the mobile tool.

The process of development of the first concept of the DST was conducted following a design-thinking approach in three stages: design, prototyping, and validation. Given the particular circumstances of the co-creation process in the Living Labs, we initiated the involvement of the Ntui Living Lab in Cameroon. A first identification of user needs was conducted between March and May 2024, carrying on interviews to potential users (country teams, farm advisors) to **identify needs**, expectations, and experiences. We also **reviewed** existing digital tools and explored possible avenues for its development through online meetings at different levels in CANALLS. At the same time, we reviewed how the agroecological framework could be applied to the DST. A **requirements engineering** process was conducted to clearly define the project functions and requirements. We created the **first concept and version of the prototype** by combining available tools with end-user and researcher requirements. The prototype was adapted several rounds, and the mobile tool was developed using an adjusted agroecological diagnostic. Finally, the web and mobile tools were integrated into a first version of the CANALLS DST. This first version **was assessed** with a group of extension agents from different organizations in Cameroon, and recommendations for improvement were collected including the opinions of different partners in CANALLS.

As a result of the process, we have a concept and a first version of the decision support tool shared and developed across different levels of the project. This concept is a solid foundation that proved to be accepted and realistic under the first test. As part of the process, the prototype will be further developed in the following iteration cycles until the development of the final version is achieved. Along the process, many lessons have been learned. Building a Decision Support Tool for a diverse group of advisors requires addressing several challenges: different objectives, different innovation support systems; different digital readiness levels of extension services and different understanding of agroecology and agroecological practices. In the following period, we are going to address these issues by converging in solutions that fit the needs of the area of influence and the priority areas observed.

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Table 1: Terms and Definitions

Abbreviation	Definition
AFAAS	African Forum for Agricultural Advisory Services
ALL	Agroecological Living Lab
APDIK	Association Paysanne Pour le Développement Intégré au Sud-Kivu
API	Application Programming Interface
CAMFAAS	Cameroon Forum for Agricultural Advisory Services
CANALLS	Driving agroecological transitions in the humid tropics of Central and Eastern Africa through traNsdisciplinary Agroecology Living LabS
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement
DST	Decision Support Tool
ETHz	Eidgenoessische Technische Hochschule Zuerich
IITA	International Institute of Tropical Agriculture
INERA	Institut National pour l'Etude et la Recherche Agronomiques
ISABU	Institut des Sciences Agronomiques du Burundi
IRAD	Institut de Recherche Agricole pour le Développement
MoSCoW	Method to categorize each requirement into one of three classifications: must-have, should-have, or may-have
Naturland	Naturland - Verband fuer Oekologischen Landbau e.v.
ODK	Open Data Kit
OLAM	Olam International is an agri-business company, operating in 60 countries and supplying food and industrial raw materials, one of the world's largest suppliers of cocoa beans, coffee, cotton and rice
RAB	Rwanda Agriculture and Animal Resources Development Board
RIKOLTO	Rikolto International
SICCACAO	Société Industrielle Camerounaise des Cacaos SA. Center of Barry Callebaut, Swiss Company
TAPE	Tool for Agroecology Performance Evaluation
UCB	Université Catholique de Bukavu

1. Introduction

CANALLS project aims to drive agroecological transitions in the humid tropics of Central and Eastern Africa via multi-actor transdisciplinary Agroecology Living Labs (ALLs). Eight ALLs will be set up in the Democratic Republic of the Congo, Burundi, Cameroon, and Rwanda, working alongside and enabling over 20,000 farmers and value chain actors to co-create and benefit from optimal combinations of agroecological practices focusing on crops that are vital for subsistence and economic development (cocoa, coffee, cassava, rice, maize).

The Decision Support Tool (DST) in CANALLS is a digital tool that enables farm advisors to facilitate tailored agroecological transitions in different farming systems. The DST is the application of frameworks developed in WP2 as easy-to-use DST with parameters tailored to different farming system challenges and particularities, facilitating their use and outreach for identifying optimal practices. The DST will be scaled up in the extension services of the countries where CANALLS is operated. Therefore, the DSTs will be used for capacity building for advisors (M30) and will be updated to a final version on M36.

A co-creation process is used to develop the DST (Task 2.3). An initial collection of needs, requirements, expectations, and experiences was done with the different users (country teams, farm advisory representatives), according to their current co-creation process. Once developed, usability tests will be run in the ALLs, leveraging the feedback to fine-tune the DST. Important features of assessment will be usability, cost-effectiveness, performance, relevance to users, and compatibility with current technologies used in the advisory work. The DSTs will be disseminated and scaled up in existing agricultural networks in Africa. Partners involved in the development, deployment and dissemination are CIRAD, ETHz, UCB, IRAD, IITA, ISABU, RAB, INERA, Naturland, RIKOLTO, and APDIK.

This report presents the approach, activities, key results, and outcomes of Task 2.3. It is structured into eight chapters. Chapter 2 describes the development process. Chapter 3 presents the initial needs assessment. Chapter 4 provides a summary of the review of existing decision support tools (DSTs). Chapter 5 details the requirements elicitation and prioritization process, based on the identified needs. Chapter 6 describes the concept and the prototype, which was designed and evaluated in one of the Living Labs (Ntui, Cameroon) and presented in Chapter 7. Finally, we present lessons learned and outlook in Chapter 8. The annexes include a table of reviewed tools, the mock-up of the web-based tool, and the diagnostic questions for the mobile tool.

2. Development process

Due to the high level of uncertainty surrounding the functions and processes of the DST, we initiated the conceptualization process in accordance with the design thinking procedure of co-creation, wherein the end user is at the center of the design. The user-centered design process entails the identification of user needs, followed by interactive and multiple interactions involving diverging and converging ideas.

Design thinking is a set of methods used to solve problems and create ideas that better meet consumers' needs and desires. According to Brown (2008), design thinking is a process that takes place in various stages (Figure 1). In these stages, an iterative and nonlinear process of inspiration, ideation, and the generation, development, and testing of ideas leads to the creation of new products, services, or strategies. (Brown 2008).

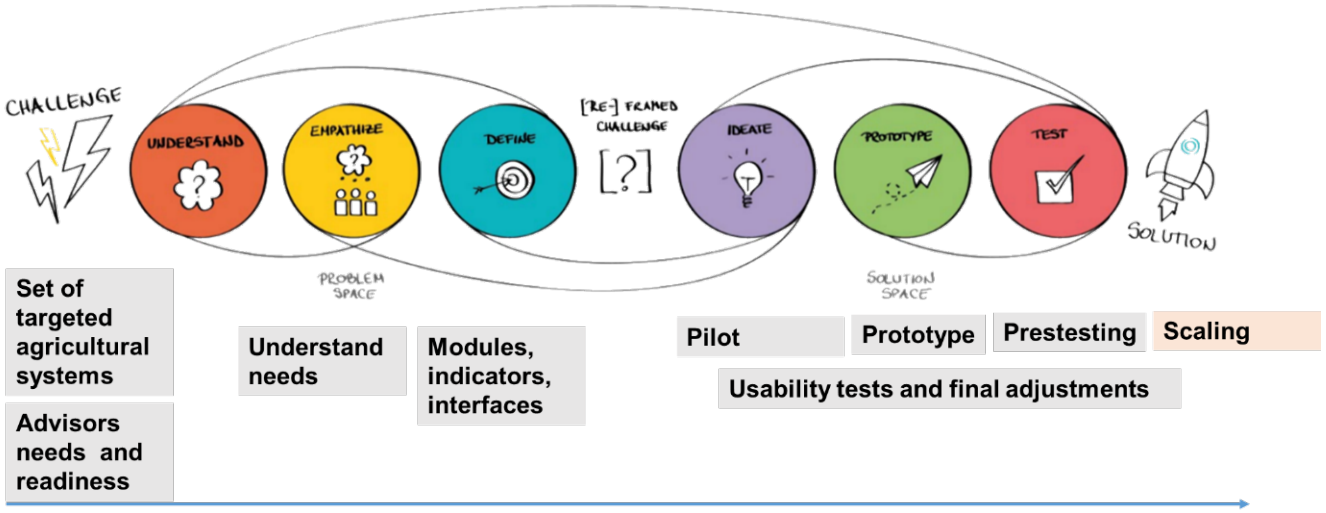

Figure 1: Spaces for design-thinking and expected steps

Around the world, there are currently numerous initiatives creating and testing digital and/or agroecological tools that could be applicable to the development of the DST within CANALLS. For that reason, we conducted two parallel processes of design and review. The first process considered design thinking principles, and the second one reviewed the knowledge of existing tools (Figure 2).

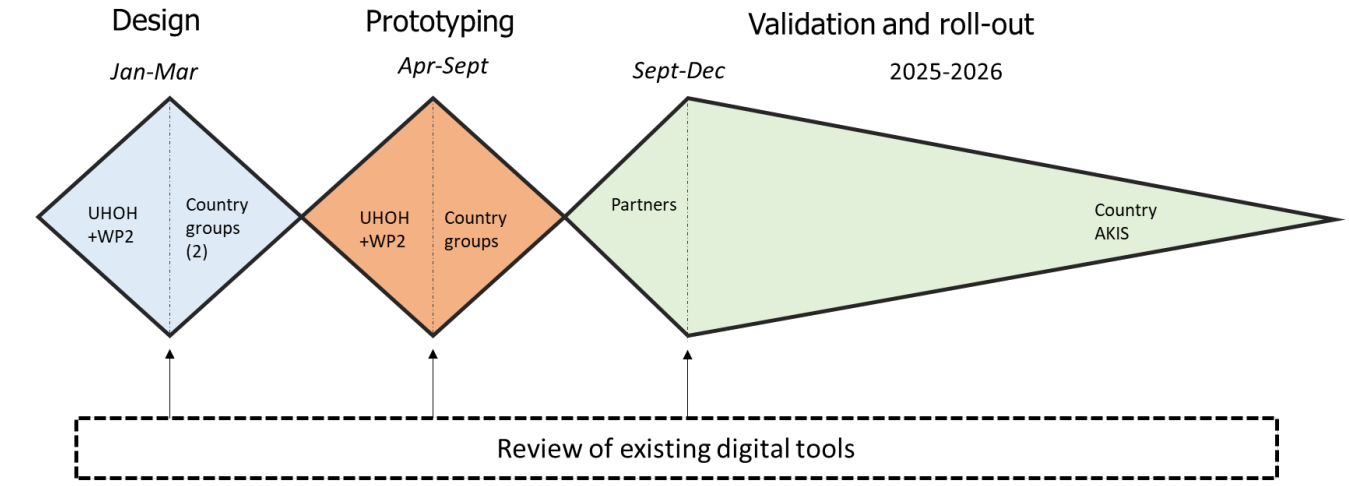

Figure 2: Roadmap for the development of the DSTs (the diamonds represent process of divergence and convergence in each step)

The project was divided into three distinct phases: design, prototyping and validation. Concurrently with the initiation of the design phase, the co-creation process of agroecological practices was underway in several Living Labs. The advancement observed at the end of the first year was taken into consideration to involve the Ntui Living Lab in Cameroon as a piloting experience of the DST.

During the **design phase,** the main users' needs were identified (Chapter 3). Between M11 and M18 an initial collection of needs, requirements, expectations, and experiences was done involving different users (country teams, farm advisory representatives). We conducted 11 interviews with researchers and project managers, 6 with extension agents, and 2 with IT-developers. Additionally, a review of existing digital tools was done from M12 to M17 (Chapter 4).

Following the identification of needs and the exploration of available solutions, we explored potential alternatives for developing the tool through online meetings with WP2 partners, WP leaders, and the CANALLS Advisory Board. At the same time, we met with developers, reviewed the application of the agroecological framework in the Decision Support Tools (DSTs), and discussed capacity-building necessities for extension agents. A requirements elicitation procedure was conducted to better define the functions and requisites that the project must or should have (Chapter 5).

The **concept and prototype** (Chapters 7 and Annexes 3 and 4) were defined with the available tools, the requirements of end users (agricultural advisors) and other relevant parties (researchers and partners). The initial prototype of the web-bas. The mobile tool was then implemented, utilizing an adapted version of different agroecological frameworks. The third step was the establishment of the first linkage between the web-based tool and the mobile tool. The first prototype was assessed in M24 and will be updated with the information and feedback from other ALLs. The final stage will be to validate and roll out the system in the four countries' AKIS systems during 2025.

3. Identification of end users' needs

The purpose of identifying users' needs is to empathizing with their problems, daily challenges and motivations to use new tools. To this end, semi-structured interviews were conducted in order to gain insights into how and why different groups of interest are involved in the implementation of a DST for extension services. The objectives of the interviews were to identify the main activities, the purpose and the digital tools that are currently used in the area, and with this information define the potential functions and features of the DST. Two main groups of interest were identified:1) researchers, project managers and 2) extension agents or advisors.

Researchers and project managers were interviewed to find out about their experience, their relationship with the extension service and their knowledge of tools for providing extension services, including digital tools. In total, 11 researchers or project managers from CIRAD, IITA, CAMFAAS, AFAAS and IRAD were interviewed. All the interviews were conducted online.

Table 2: Content of the interview used with researchers and the core team project managers

	Key questions	***Probe questions***
1	Can you tell us about your experiences related to agricultural extension services	What did you do?
2	Does your organization provide extension services?	What type? What are the main activities of the extension agents? How do they interact with farmers? In the planning? In the production? In the marketing? What type of data do extension agents collect from the farmers? What type of reports do extension agents make and to whom? What type of monitoring and evaluation activities do extension agents do?
3	What tools do extension agents use to facilitate advice/knowledge for farmers?	How do they use them? How useful are they for the extension agents? Are there specific tools targeting agroecology?
4	Do you know digital tools used for help farmers in the crop production cycle?	Who use them? What is your experience with them?
5	What are their advantages and disadvantages of those digital tools?	How easy to use they are? How useful they are for advisors? What are the most common difficulties? Can you provide me with some links?

Extension agents interviewed were contacted by IITA. Most of the interviews were conducted via WhatsApp with the support of one translator. In total we interviewed 6 extension agents, 2 from enterprises, 2 from cooperatives, 1 freelancer and 1 public extension agent.

Table 3: Content on the interview used for interviewing advisors and extension agents

	Key questions	Probe questions
	Introduction	
1	Can you tell us about your experiences related to agricultural extension services?	What do you normally do?
2	What type of advice do you provide to the farmer in the different stages of crop production?	In planning? Sowing? Planting? Weeding? Harvest? Post-harvesting? Marketing or selling?
3	Which methods do you use for advising the farmers?	What activities do you do? How frequently? What didactic materials do you use? What other methods? What is the one that farmers like the most? What is the reason for that? What is the most difficult one to implement? What is the reason for that? Any digital tool? How frequently? Is it easy to use? Have you heard about any other digital tools?
4	What type of information do you provide to the farmer?	What type of information do you provide the farmer? How frequently? How do you provide it? What type of information do you ask the farmer? How frequently? How do you collect it? To whom do you give reports? How frequently?

The answers were analyzed using qualitative software MAXQDA searching for objectives, activities and tools. Graphical representations of those were done according to the type of actor involved. We identified 10 types of actors and represented the tools, activities, objectives and expected impacts from their activities (Figure 3).

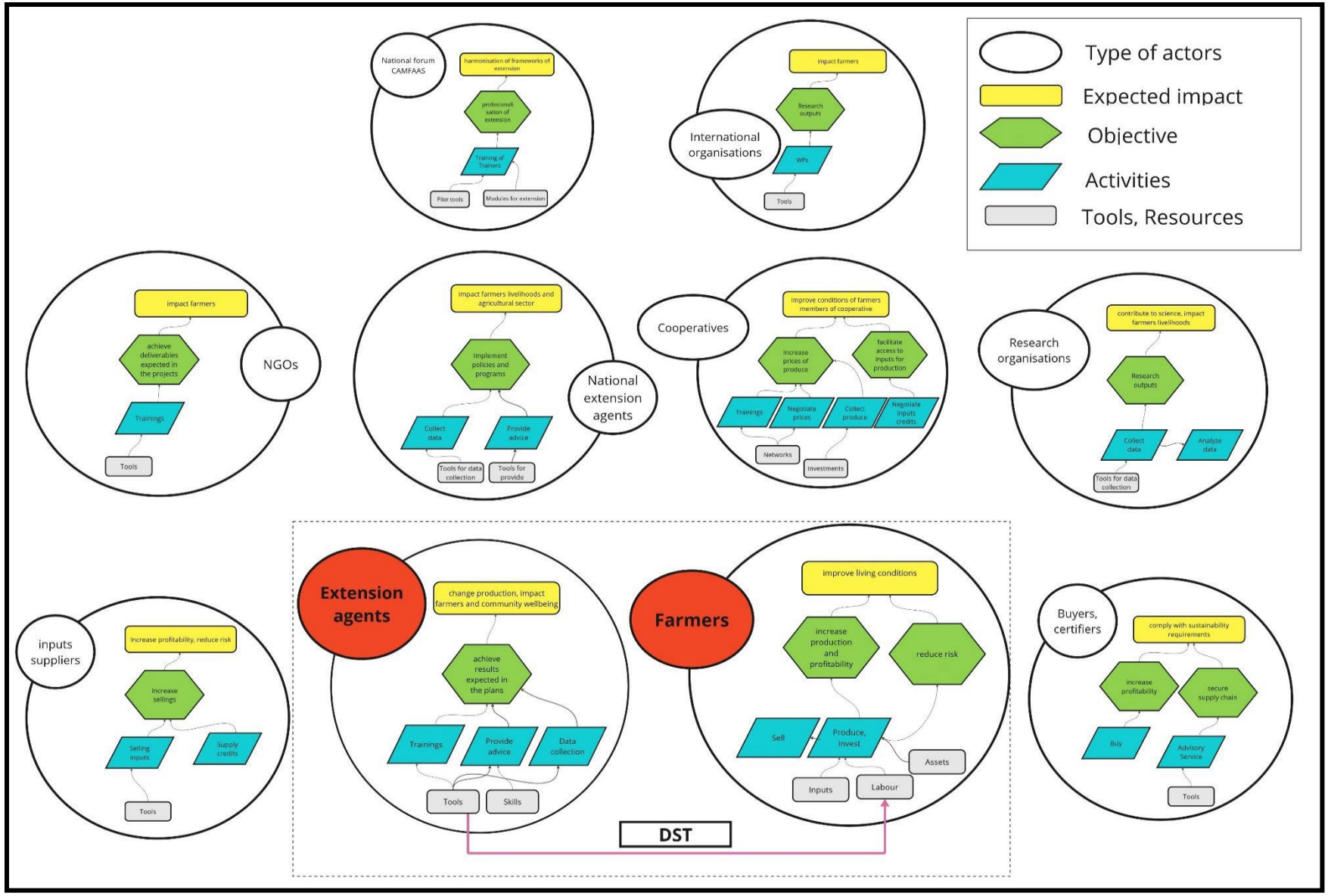

Figure 3: Type of actors identified with tools used, activities, objectives and expected impacts

Looking closely to the relation extension agent- farmer, we identified 5 different types of extension service systems, with different tools, skills, activities, objectives and expected impacts (Figure 4).

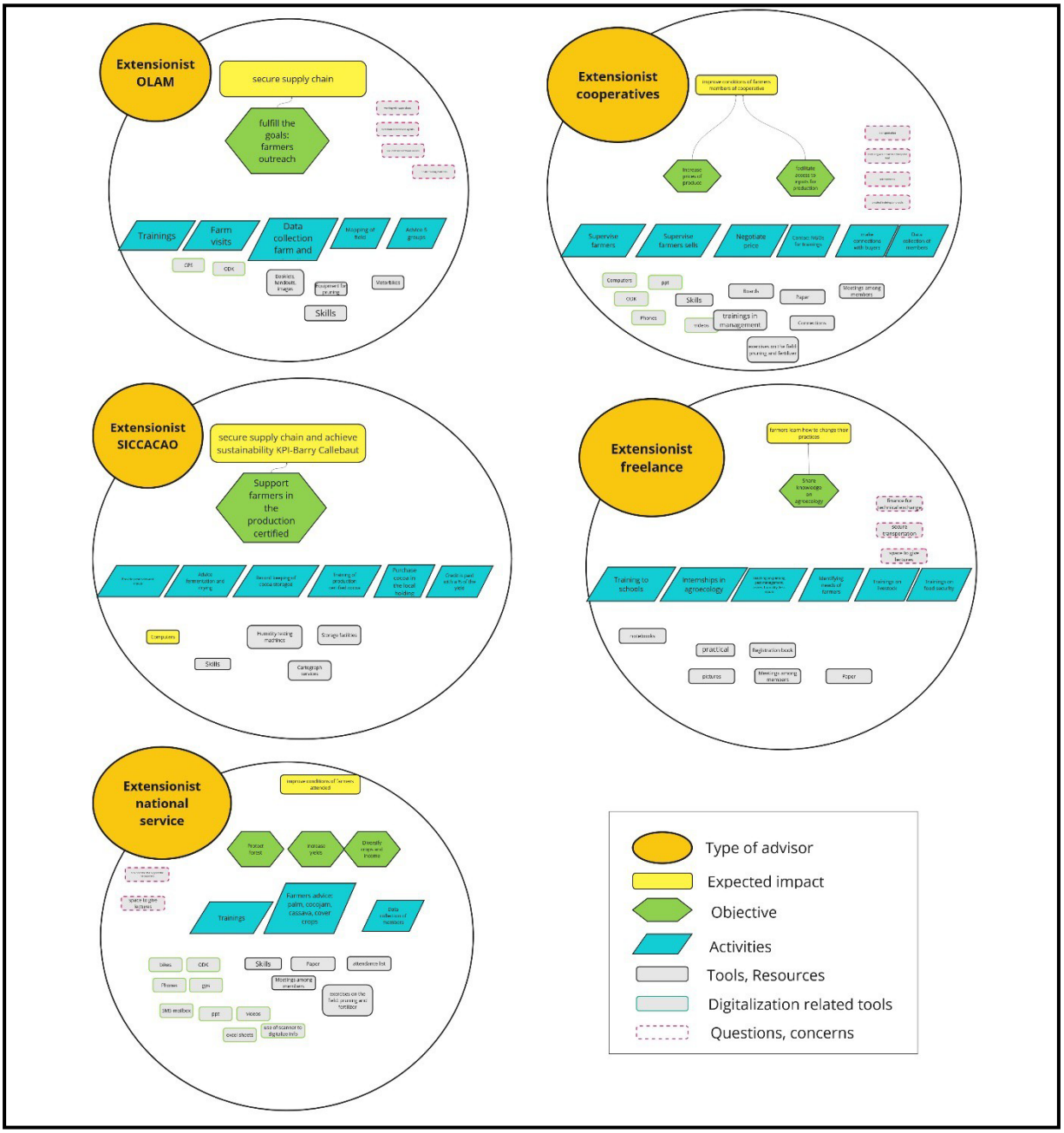

Figure 4: Different types of extension agents with activities, objectives, tools, and expected impacts.

In summary, the analysis revealed that extension services operate in varied extension services landscapes with numerous actors having diverse objectives and interests. Additionally, interviewees emphasized the need to account for limitations in infrastructure, electricity, and internet access, as well as the specific challenges faced by extension services in promoting agroecology in the ALLs. This step highlighted the interests, challenges, and primary issues to address, which led to the identification of key design characteristics.

4. Literature review on Decision Support Tools

Decision support tools exist in a variety of different forms. As Rose et al. (2016) posit, these tools can be either dynamic and interactive, offering recommendations based on a variety of inputs, or they can function more as a source of information. Despite the variety of forms that DSTs may take, there are several key components that are essential for their success. When developing a DST, it is advisable to examine the existing state of the art, not only to gain insights from existing tools but also to identify areas where the CANALLS DST can make a significant contribution in supporting advisors in their daily activities and in advancing the agroecological transition. A substantial corpus of work has been produced on the topic of decision support tools, which can be utilized as a foundation for further development and as a source of inspiration for our design process. Conversely, it is possible to identify the areas where other tools are already in use, where current DSTs are applicable, and where an innovative approach could be introduced.

4.1 Methodology

To get a comprehensive understanding of the wide variety of existing DSTs, a review of existing tools was conducted. Hereby, the focus was not on systematically reviewing literature but rather on gaining a comprehensive overview of the tools that have been previously utilized in a comparable context to CANALLS. The goal of creating the inventory was to identify tools for similar conditions and examine their objectives and functionality. The inventory is a living document that is continually updated in accordance with advancements made during the design process, providing ongoing support for the development of the DST.

DSTs are widely used around the world with many different objectives and users. To define the framework for the DST, we fall back on the definition of the CANALLS DST given in the Grant Agreement: The user group of the DST is extension services, the DST should contribute to the promotion of agroecology, and it should be available in digital and printed form in French and English. Google was used as the main search engine. The following keywords were used to narrow down the results and specifically relate them to the case of the CANALLS DST: "decision support tool", "advisory services", "Africa", and "agroecology". The results were then filtered according to the context of CANALLS. Specific criteria identified as suitable DST were the location in Africa, the link to agroecological approaches, and the specific use of the DST for extension services rather than for farmers themselves. In the second step and to get more relevant results, the search was narrowed down to DSTs that were developed by the project partners in CANALLS. Therefore, the keywords “IITA”, “AFAAS”, “CIRAD”, “ETH”, “AATF” and “CAMFAAS” were added. Subsequently, the results were classified according to specific criteria: Study/Origin, Name, Location, Rationale and Medium. The results and the current state of the inventory are presented in Annex 1.

In order to derive recommendations from the DST inventory for the design of the CANALLS DST, it was necessary to conduct a comprehensive analysis of the most promising cases found. In this process, a schema was applied which contains specific categories, facilitating the analysis and

enabling the comparison of results. With this method, 23 DSTs were analyzed. The criteria for categorizing the most promising DSTs were as follows:

1. A brief description of the functionality of the specific DST
2. A list of functions, which the specific DST contains
3. The specific parts of the DST, if it consists of, for example, an app and telephone service

4.2 Findings

A closer look at the analysis of the inventory shows that there is a rapidly growing number of different DSTs. The DSTs differ not only in their functionality but also in their tools and applications. However, it was possible to define three broad areas in which most DSTs fall:

1) Digital advice tools (mobile Apps or Websites)
2) Platforms (mobile Apps or Websites)
3) Service points (phones, SMS, social media or messengers, chatbots)

The findings of the analysis of the inventory will focus on these three categories.

4.2.1 Digital Advice Tools

The term "digital advice tools" encompasses a vast array of diverse tools with varying functions, including applications for mobile devices, web-based platforms, and other digital resources. The number of digital tools in this category is notably higher (number) than in other areas of DST that we have analyzed. It is essential to differentiate between the various categories of digital advice tools, including those that utilize sophisticated methodologies such as modeling, artificial intelligence, or remote sensing (e.g. yield modeling) and those that offer more straightforward information and calculation solutions (e.g. fertilizer optimization). The former is more intricate and encompasses a broader scope, while the latter provides uncomplicated and accessible recommendations for end-users. Both are employed to provide specific counsel.

The latter option, which provides straightforward calculations, is frequently employed in the context of particular practical use cases. One illustrative example of this category of digital advice tools is the IITA Herbicides Calculator". The application is employed for the calibration of pesticide applications utilizing knapsack sprayers. A further example is the Shade Tree Advice Smartphone Tool, which provides pre-loaded, locally specific guidance on the utilisation of shade trees in coffee farming via a mobile application. It is anticipated that this application will be utilised by farmers or agricultural advisors. An additional example, employing a comparable rationale but exhibiting distinctive functionality, is the Stepwise Smartphone Application, developed by IITA for utilisation in Uganda. The app offers recommendations for optimal practices for farmers by categorizing the numerous techniques into distinct phases that the farmer can implement. The data collected by the application is restricted to a series of binary questions. Once more, the app offers a solution to a particular issue with a minimal amount of data and no requirement for communication with a back-office or external source for data processing. An illustrative example of a digital advice tool with a greater degree of complexity is the Crop Disease Surveillance system developed by IITA. This tool comprises a smartphone application and differs from the more basic digital advice tools in that it collects, transfers, and analyses complex data, rather than providing advice. This is done at a data management center. In this case, photographers and information on crop diseases are reported for pest occurrence and

diagnosis and can be followed up by subsequent inspections, laboratory confirmation testing, and the implementation of solutions to prevent and control crop pests. Another example is the "PixFruit" digital solution, which is composed of a webpage and an app. This tool provides a solution for the acquisition, management, and sharing of yield data, thereby facilitating the structuring of fruit value chains in Africa. Here, mango yields can be detected through pictures, which are then processed on remote servers via yield models. These two applications demonstrate the specifics of complex digital advice tools, which provide tailored advice through the use of sophisticated tools, methods, and models.

4.2.2 Platforms

The second area identified in the analysis of the DST inventory is that of platforms. A platform may be defined as a digital tool that consolidates a variety of digital and non-digital resources, including didactic materials, on a single webpage, thereby providing advisors or end-users with convenient access to these resources. This is typically undertaken with a specific topic in mind, such as rice crop management. Conversely, the platform can function as a central web-based point of contact for stakeholders across the value chain, including buyers and sellers.

An example of the former is AKILIMO, developed by IITA for Nigeria and Tanzania. It is an advisory service for cassava developed for smallholder farmers. The AKILIMO platform offers analytical tools that provide site-specific recommendations. The user portal provides access to a variety of tools, including the AKILIMO advisory tools, promotional materials, training resources, and analytics. An additional exemplar of this category of DST platforms is the Rice Crop Management Advisory Service, which was developed for the Philippines. This platform, designed for the provision of advisory services, consolidates the Rice Crop Manager and a range of complementary decision-making tools and services into a single integrated advisory and information service for rice-based farming. It is based on a web portal, an app, and lecture material. The platform allows advisers to manage data, generate recommendations for specific farmers, and disseminate these recommendations via didactic materials (printed via PDFs) or via SMS.

The second type of platform to emerge from the analysis of the DST inventory is the multi-stakeholder focal point. This type of DST acts as a nexus between different types of actors along the value chain, creating links and exchanges. Jangolo, developed for Cameroon, is one such platform that acts as a central hub connecting farmers, agro-industries, restaurants, and consumers, promoting a seamless and efficient agricultural value chain. Jangolo targets farmers, traders, consumers, and agro-industries, as well as investors and organizations. The main purpose is to provide a B2B buying and selling platform. Other target-group-specific tools are also offered. These can be market prices, business contacts, etc.

4.2.3 Service Points

Another category identified by the analysis is service points. Service points offer personalized advice to end users via SMS, telephone, social media, or instant messaging applications. Other recent development is the use of AI for big data, messengers, or chatbots. The type of advice provided ranges from weather forecasts to highly personalized recommendations. Service points act as a nexus, facilitating communication between farmers and advisors. Service points are often used in combination with platforms or even digital tools. An example of this specific type of DST is the Ushauri service point developed by CIRAD for Tanzania. Here, farmers use regular telephone calls to select

and listen to agricultural audio content. In these 3 to 5-minute messages, an extension worker and an experienced farmer explain a specific agronomic topic. Farmers can also leave further questions on the hotline, which are answered by push calls from advisers. This farmer-to-consultant voice message communication can increase the efficiency of extension services.

An AI-based example is the Arifu chatbot in collaboration with AKILIMO. Here, users can receive customized fertilizer advice from the Arifu chatbot through various channels such as SMS, WhatsApp, and Telegram. Precision Agriculture for Development provides digital agricultural extension services to smallholder farmers by delivering personalized agricultural advice through their mobile phones. SMS is used in two ways, combined with AI and machine learning to deliver personalized advice to farmers and digitally connect advisors with farmers.

4.3 Conclusion

The categorization of DSTs into categories was undertaken to identify patterns and potential pathways for the CANALLS design process to build upon. One significant finding is that a multitude of DSTs, encompassing a diverse range of functions and purposes, are already in use. Nevertheless, the subject of agroecology is not yet represented in the DSTs identified in this study, even when the review focuses on tools in the area of agroecology. This process has enabled the identification of a gap in the current landscape of DSTs that CANALLS DST is well-positioned to address by focusing on the concept of agroecology. Secondly, the majority of the DSTs that have been reviewed are designed to address a specific issue within the agricultural production cycle. These issues include e.g.: the use of fertilizers, the control of pests, the estimation of yields, and the irrigation process. Some DSTs are designed for use by advisory services, yet they continue to concentrate on offering recommendations rather than on aiding the workflow of advisers. It is anticipated that the CANALLS DST will provide support to advisers in the process of fostering the agroecological transition. This is a rather broad approach that differs from the specific uses of most of the DSTs, as it focuses more on the advisor and supports them in their daily work. Based on these two conclusions, it can be argued that the CANALLS DST should seek to combine the two types of DSTs identified in this review, the Digital Advice Tools and the Platform, and focus on the agroecological concept and the support of advisers in their daily advice routine.

It should be noted that the analysis is not without limitations. In some cases, it was challenging to categorize different tools within specific types of DSTs, as they may be utilized in diverse contexts and use multiple different functions. For instance, service points and platforms frequently employ comparable approaches, such as SMS or websites, which can make it difficult, if not impossible, to categorize them with precision. Consequently, the analysis is primarily aimed at identifying underlying concepts within the vast array of DSTs and translating the inventory into a schematic format to inform the design process. Another limitation was narrowing the search of DSTs to Africa and for agroecology (rather than agronomy or other wider term) which could have excluded some useful DST. This narrowing down was made for practical reason but bring some limitations in the extensive landscape of digital tools.

5. Requirements engineering

To design a digital systems or tools, one common role in systems engineering is the concept of *Requirements engineering*. Requirements engineering is the process of defining, documenting, and maintaining requirements in the engineering design process before a prototype or pilot of the system is deployed. The list of requirements is a guide for the development and implementation of the tool being designed. Common methods to conduct the requirements elicitation and evaluation are surveys, interviews, anthropological studies and participatory methods. For CANALLS DST we conducted a process following six steps: 1) defining personas, 2) defining user stories, 3) identifying core requirements, 4) prioritizing requirements, 5) detailing core requirements and 6) assessing core requirements. We followed those steps using the interviews (described in Chapter 3), punctual interactions with different project teams and two online workshops with the development team (UHOH). The following sections describe the concepts of requirements engineering (what is and why is important) and describe the results for CANALLS DST.

5.1 Personas

The goal of using personas in requirements engineering is to enhance the user experience by ensuring that the end product not only meets functional requirements but also resonates with its intended audience on a deeper level. This user-centric approach significantly increases the likelihood of product adoption and satisfaction. *Personas* are fictional characters created to represent different user types within a targeted demographic that might use a product, service, or system. This technique helps stakeholders to better understand user needs, behaviors, and goals by personifying them, making it easier to empathize with users during the design and development process. Personas are crafted based on diverse research measures, including user interviews, workshops, and usability studies, which inform their characteristics, motivations, and challenges.

By employing personas, teams can prioritize requirements that address the specific needs of distinct user groups, ensuring that the final product is user-centered. For example, a persona might represent a busy professional who values efficiency and quick access to information, while another persona could depict a novice user who requires more guidance and support. This distinction allows developers and designers to make informed decisions about features, functionality, and user interfaces. They can also guide decision-making throughout the project lifecycle by providing a reference point against which design choices can be evaluated. However, it's important to remember that personas are not static; they should evolve based on continuous user feedback and changing market trends.

For the initial version of the DST we based our persona on a male advisor from agri-business, local government or cooperative (Table 4). We selected those demographics which are predominant in the

sector according to the interviews. Further version of the DST will evolve to different type of personas (female and young advisors).

Table 4: Characteristics of the persona selected for the design of the DST

Characteristic	Description
NAME	John

ROLE	- Agricultural advisor
	  o Advisor from agri-business (OLAM)
	  o Advisor from local government
	  o Advisor from cooperative
	- Main tasks:
	  o Advise farmers on food quality
	  o Support farmers with food security
	  o Train farmers to increase productivity

DEMOGRAPHICS	- Male - Between 20 and 40 years old - Living in the same country but not necessarily in the same place as farmers - At the beginning of their career - Well-equipped and trained

GOALS	- Farmer focus
	  o Make specific recommendations based on individual situation of farmers
	  o Efficient communication and collaboration with farmers
	  o Increase quality of recommendations for farmers
	  o Want to have positive impact on region
	- Advisor focus
	  o High quality reporting on advisory activity to supervisors
	  o Meet targets/goals set by supervisors
	  o Acquire skills for better job opportunities (career springboard)
	- Employer focus
	  o Reach annual goals
	  o Make employer (company) grow
	  o Provide high quality and quantity of food for community
	  o Support local communities
	  o Meet required number of farmers

CHALLENGES	- Technical challenges
	  o Limited IT knowledge of older advisors
	- Resources
	  o Lack of economic resources
	- Work setting
	  o Hard working conditions
	  o Low salaries
	- Clients (farmers)
	  o Diverse types of farmers as clients
	  o High number of clients within limited amount of time
	  o Distrust from farmers on advisory services
	- Infrastructure
	  o Bad means of transportation
	  o Long distance to farmers

BEHAVIORS	- Interactions with farmers
	  o One on one as well as group advisory settings
	  o Advisory as well as “friends” role depending on needs and situation of the farmers
	  o Want to have a positive impact on farmers and their work
	  o Enjoy seeing the progress of their farmers
	  o Provide farmers with background knowledge (prices, markets, etc.) to support them
	  o Meet with farmers in their fields to collect relevant data
	- Interactions with supervisors
	  o Show that they can meet the annual targets
	  o Provide proof that advisory activity supported farmers
	  o Provide proof that advisory activity increased quantity and quality of farmers´ products

NEEDS FROM THE SYSTEM	- The system needs to be easy to use - The system needs to save time during daily work - The system needs to combine the efficient digitalization of work with the offline necessity on the farmers´ fields - The system needs to improve the quality and efficiency of advisory activities - The system needs to provide proof for the success of advisory activities - The system needs to analyze activities, status quo, improvements, etc. of farmers - The system needs to standardize and structure data - The system needs to provide data for better research in agroecology - The system needs to improve reporting activities to supervisors - The system needs to serve as an exchange platform between advisors

5.2 User Stories

User stories are concise, informal descriptions of features or functionalities from the perspective of the end user. Similar to personas, user stories aim to capture user needs and expectations, but they do so in a more actionable format that emphasizes specific goals and outcomes. A typical user story follows a simple structure: "As a [user type], I want [goal] so that [reason]." This format helps teams clarify the intent behind each requirement, making it easier to prioritize and implement features that add real value to users.

By focusing on user outcomes, teams can ensure that they are building features that genuinely meet user needs rather than merely fulfilling technical specifications. For instance, a user story might describe a scenario where a busy professional needs to quickly access their schedule to manage time effectively, while another story could reflect a novice user who requires step-by-step guidance to complete a task.

Additionally, user stories encourage collaboration among cross-functional teams, including developers, designers, and stakeholders. They serve as a common language that promotes discussions around requirements, fostering a shared understanding of user objectives. However, it's crucial to keep user stories flexible and open to revision based on user feedback and changing

requirements. This adaptability ensures that the final product is not only functional but also resonates with its users on a meaningful level.

In CANALLS DST, the user stories were built according to three main perspectives: farmer focus, advisor focus and supervisor focus. Those user stories are the basis for the identification of users' needs.

Farmer focus user stories are mostly based on improve advisory work and relation with farmers (Table 5).

Table 5: Farmer focus user stories

User objective	User story
Improve advisors´ collaboration with farmers	○ *As an advisor, I want to reduce the distance to the farmers, so that I can support more farmers.* ○ *As an advisor, I want to save time, so that I can work with more farmers.*
Improve advisory activities for farmers	○ *As an advisor, I want to know which agroecological practices I can recommend, so that the farmers can improve their food production.* ○ *As an advisor, I want to have information about advisory activities, so that I can compare which practices are most effective in which situations.* ○ *As an advisor, I want to get support in giving advice, so that I can improve my advisory activities and give the correct recommendations.* ○ *As an advisor, I want to have a tool that helps me to make decisions based on collected data, so that I can support farmers specifically regarding their individual needs.* ○ *As an advisor, I want to get supportive material for giving advice, so that I can improve my recommendations and advisory activities.* ○ *As an advisor, I want to learn about new innovations, so that I can support farmers and their communities as good as possible.*
Improve farmers´ knowledge and work	○ *As an advisor, I want to facilitate learning amongst farmers, so that they know better what they are doing and how they can improve.* ○ *As an advisor, I want to offer practical training, so that farmers have the possibility to learn and improve.* ○ *As an advisor, I want to show the farmer, which changes he has implemented and their effectiveness compared to other farmers, so that they can understand, compare, and adapt accordingly.* ○ *As an advisor, I want to improve the transition of agroecology in my working region, so that the quality of life becomes better.* ○ *As an advisor, I want to increase the adoption of agroecology, so that people have more and better food to eat and sell.* ○ *As an advisor, I want to train farmers, so that they know how to produce good quality cocoa that can be sold.* ○ *As an advisor, I want to train local communities, so that they produce high quality food and increase the diversity of their diets.*

Advisor focus user stories are aligned with an increase in the efficiency of the advisory activities and with the development of capabilities of advisors to provide advisory (Table 6).

Table 6: Advisor focus user stories

User objective	User story
Show success of advisory activities	○ *As an advisor, I want to document success stories for other farmers, so that they try to emulate these stories.* ○ *As an advisor, I want to track the progress of the farmers, so that I can see how the advisory activities supported and improved the farmers.*
Facilitate and digitalize advisory activities	○ *As an advisor, I want to digitalize my work, so that I do not have to write everything down on paper.* ○ *As an advisor, I want to automatically use collected data and analyze it, so that it is easier to understand and draw conclusions.*
Improve skills/knowledge of advisors	○ *As an advisor, I want to get specific training, so that I can advance in my career.* ○ *As an advisor, I want to learn new practices and concepts, so that I can increase my knowledge and improve my qualifications.* ○ *As an advisor, I want to learn about digital tools and technologies, so that I can increase my chances to advance in my career.*
Improve collaboration with other advisors	○ *As an advisor, I want to have a network of colleagues, so that we can support each other in case of questions or problems.* ○ *As an advisor, I want to get connected with my colleagues, so that we might exchange farmers to save time and distance.*

Employer focus user stories show the broader interest of facilitate monitoring and evaluation of advisory activities and the collection of good quality data that can be used for research (Table 7).

Table 7: Employer focus user stories

User objective	User story
Improve research data and findings	○ *As an advisor, I want to generate data that is usable for research, so that there is a solid base for identifying problems or patterns.* ○ *As an advisor, I want to improve research findings, so that novel concepts or practices can be developed.* ○ *As an advisor, I want to get structured data from the farms and analyze it, so that I can investigate agroecological practices and their effectiveness.*
Generate relevant reporting for supervisors	○ *As an advisor, I want to generate reports that show the changes in the farms, so that I can see and prove the impact of my work.* ○ *As an advisor, I want to analyze the data collected, so that I can demonstrate the activities I do to my supervisors* ○ *As an advisor, I want to get support in creating relevant reports, so that I can improve my reporting to my supervisors.* ○ *As an advisor, I want to get support in creating relevant reports, so that I have more time available for more important activities.*

5.3 Core requirements

The core requirements of a system are derived from user stories, serving as foundational elements that define the essential functionalities and features needed to satisfy user needs from a system-perspective. As user stories articulate specific user goals and the rationale behind them, they guide the identification of these core requirements, ensuring that the development process remains user-focused. By analyzing user stories, teams can distill key functionalities that the system must provide to deliver value to its users. Maintaining a close alignment between user stories and core requirements is essential for a successful development cycle. It ensures that the evolving needs of users are consistently reflected throughout the project lifecycle. As the system is developed and tested, feedback from users can lead to further refinements of both user stories and core requirements, fostering an adaptive approach that enhances user satisfaction and ultimately drives the success of the product.

For CANALLS DST development, based on the user stories, we identified eight core requirements.

Core Requirements

1. **Data-driven recommendations (Prio 1)**
   The system provides personalized recommendations based on data collected by advisors from farmers. This data will encompass various aspects of the farm and household, allowing for tailored advice that aligns with agroecological principles. The recommendations are ranked by relevance and effectiveness, suggesting the best solutions based on diagnostics specific to each farm. A modular structure with clear instructions and questions guides the advisors during their discussions with farmers, accommodating both digital and paper-based interactions, which in the end allows them to make specific recommendations based on farmers´ characteristics. This feature aims to empower advisors to make informed, context-specific recommendations, ultimately improving farmers' productivity and food quality.

2. **Training materials and resources**
   To empower advisors in their roles, the system offers a rich repository of training materials, including videos, literature, and other educational resources. These materials cover a range of agroecological practices and innovations, enabling advisors to enhance their knowledge and skills continuously. By ensuring that advisors have easy access to relevant training content, the system will facilitate improved advisory activities and high-quality recommendations for farmers. This focus on professional development will not only boost advisors' confidence and their careers but also promote effective support for farmers in adopting sustainable agricultural practices.

3. **Success stories repository**
   The inclusion of a success stories repository is vital for showcasing the positive outcomes of agroecological practices and the underlying advisory work. This feature should serve as a placeholder for documented success stories and may also link relevant content from the internet. By highlighting real-life examples of successful transitions, this repository will inspire both advisors and farmers. Advisors can utilize these success stories to motivate farmers to adopt new practices, while farmers can learn from their peers' experiences, fostering a culture of continuous improvement and shared learning within the agricultural community.

4. **Reporting and data transformation (Prio 2)**
   The system is equipped to collect, analyze, and generate reports that meet the specific needs of various stakeholders. By transforming collected data into multiple agroecological frameworks, such as Biovision, TAPE, and others such as NATURLAND, the system will enable advisors to demonstrate the impact of their activities effectively. Streamlined reporting will enhance accountability and provide proof of improved farming practices and productivity. This feature is essential for empowering advisors to validate their contributions and ensure that they can present credible evidence of their work's effectiveness to supervisors and other stakeholders.

5. **Appointment management**
   To enhance the efficiency of advisory services, the system facilitates appointment management between advisors and farmers. This feature will allow farmers to easily request or book appointments for farm visits, specifically addressing their unique challenges. By linking appointment scheduling to particular issues, the system will ensure that advisors can provide timely and relevant support. This functionality will improve resource allocation and enable advisors to reach more farmers in need of assistance, ultimately enhancing the overall effectiveness of advisory interventions.

6. **Route optimization**
   A route optimization tool is necessary for improving the efficiency of farm visits. This feature helps advisors plan the most effective routes to visit farmers, using collected data such as locations and addresses. The system can also provide real-time navigation assistance. Additionally, the tool could analyze the locations of farmers within an advisor's portfolio and suggest potential swaps with other advisors to maximize efficiency. This feature aims to minimize travel time, allowing advisors to focus on delivering impactful support to farmers.

7. **Networking and collaboration platform**
   The system includes a networking feature to connect advisors, fostering collaboration and knowledge exchange. This could take the form of a chat function, forum, or other interactive platforms. Such a community will empower advisors to support one another, share challenges, and discuss solutions, creating a more robust advisory network. Including a chatbot could further enhance communication, providing quick responses to common queries. This collaborative environment will strengthen the advisors' capabilities and enhance the overall quality of advisory services provided to farmers.

8. **Real-time data correction and management**
   The system features an automatic backend system that allows for real-time correction of information entered by advisors. This functionality will ensure that data is accurate and up-to-date, facilitating better communication and correct data. By allowing for seamless updates and corrections, the system will improve the overall efficiency of data management processes. This feature is crucial for maintaining the integrity of the information used in decision-making and enhancing the effectiveness of advisory services.

   Table 8 describes the relation between the eight core requirements (Section 5.3) and the user needs listed according to the user stories (Section 5.2).

Table 8: Linkages of core requirements with user needs

	Core Requirements							
	Data-driven recommendations	Training materials and resources	Success stories repository	**Reporting and data transformation**	Appointment management	Route optimization	Networking and collaboration platform	Real-time data correction and management
Users' needs								
Improve advisors´ collaboration with farmers		●			●	●		
Improve advisory activities for farmers	●	●						
Improve farmers´ knowledge and work	●	●	●					
Show success of advisory activities			●	●				
Facilitate and digitalize advisory activities	●			●				●
Improve skills/knowledge of advisors		●	●				●	
Improve collaboration with other advisors						●	●	
Improve research data and findings				●				●
Generate relevant reports for supervisors				●				●

5.4 Requirements Prioritization

The prioritization of identified core requirements built from user stories is a critical step that ensures resources are allocated effectively to deliver maximum value. This process begins with assessing the relative importance of each requirement based on factors such as user impact, business value, and alignment with strategic goals. User stories serve as a foundation for this prioritization, as they encapsulate the needs and motivations of various user personas. By understanding which user stories represent the most pressing needs, teams can identify the core requirements that should take precedence. Incorporating stakeholder input during the prioritization process is essential, as it provides a broader perspective on business objectives and market trends. Furthermore, prioritization should be revisited regularly throughout the development lifecycle, allowing teams to remain agile and responsive to changing user needs or feedback.

The team for development of the DST (UHOH team) prioritized the core requirements according to votes. The order of prioritization of core requirements shows that the focus of the development will be based on comply with *Data-driven recommendations* and *Reporting and data transformation.* In a second place, the *training material and resources* and the *development of interfaces for networking and collaboration* are going to be included.

Table 9: Prioritization of core requirements.

Core requirements	Dot voting	Resulting order
Data-driven recommendations	13	1
Training materials and resources	3	3
Success stories repository	1	5
Reporting and data transformation	8	2
Appointment management	1	5
Route optimization	0	6
Networking and collaboration platform	2	4
Real-time data correction and management	2	4

5.5 Requirements Detailing

Once core requirements have been prioritized based on user stories and stakeholder input, it becomes essential to elaborate on these requirements to ensure clarity and comprehensiveness. This detailing involves breaking down each core requirement into specific, measurable, and testable components, often referred to as sub-requirements or acceptance criteria.

For instance, if a core requirement involves a streamlined calendar interface for busy professionals, the detailing process might specify functionalities such as drag-and-drop capabilities for scheduling, color-coded categories for different types of appointments, and integration with existing email systems. Each of these components should be described in detail, outlining how they function, the expected user interactions, and the performance standards they must meet. This level of specificity not only aids developers in understanding what needs to be built but also serves as a reference point for testing and validation.

Furthermore, detailing should consider non-functional requirements, such as usability, security, and performance metrics. For example, defining usability criteria may include benchmarks for load times and ease of navigation, ensuring that the system meets user expectations for efficiency. Engaging stakeholders during this process is vital, as their insights can help refine requirements further and ensure that all critical aspects are covered. Regular reviews and updates to the detailed requirements are also necessary, as user feedback and evolving market conditions may necessitate adjustments.

5.5.1 Core Requirement 1. Data-driven recommendations

Table 10: Requirements specification - Data driven recommendations

Components	Details
Inputs	Structured questions aligned to different components of agroecology
	Use of ODK/link to ODK and the stored data within Potential list of practices as recommendations
Outputs	Quantitative results in the form of graphs and/or tables
	Linkage between diagnostic questions and potential recommendations
	Varying recommendations depending on crop type, country, …
	Recommendations tailored to the level of adoption and behavioural change desired
	Results are provided in Excel or PDF
Process	Data analysis within the system
	Automatic creation of recommendations based on ODK data
Non-functional requirements	Low latency of recommendation creation
	Training of users on the use and creation of recommendations
	Recommendation function is available 24/7
	Only advisors should be able to generate recommendations
Data management	Results and recommendations are stored in downloadable format
	Data access is limited depending on user (data for recommendations, data for research, …)
	Some users are able to edit while others can only view
	Data output is available in French and English

5.5.2 Core Requirement 2. Reporting and data transformation

Table 11: Requirements specification - Reporting and data transformation

Components	Details
Inputs	Data derived from farm (size, location, …)
	Data derived from farm practices (crop type, water, pest and disease, animals,
	Data derived from farmer/farmer household (members, workers, markets …)
	Data derived from community level (number of citizens, number of farmers, …)
Outputs	FAO 10 elements of agroecology
	Wenzel 13 principles of agroecology
	Biovision farm report
	Report about individual advice
	Report about group advice
	Report about agroecological diagnostics
	Report about changes in agroecological diagnostics
	Reports are comparable across multiple aspects such as time or location
User interaction	User can select which type of report to be generated automatically
Process	Define and select the criteria for the generation of the reports
	Automatically generate the reports with one click
Non-functional requirements	Advisors can only access own data collected
	System is able to create reports for multiple users in 6 different locations
	System tracks who uses the function and how it is used
	Reports are in simple language either in French or English
Data management	System handles non-fitting characteristics accordingly

5.5.3 Core Requirement 3. Training materials and resources

Table 12: Requirements specification -Training materials and resources

Components	Details
Inputs	Videos from CANALLS project
	Results from CANALLS project (if available)
	Additional existing material for extension agents (e.g., FAQ agroecology knowledge hub)
Outputs	Display of videos e.g., from Youtube
	Training material such as handouts, manuals
	Training material is downloadable and printable
User interaction	Users visit training section to access material
	User can access different modules and corresponding steps
	User can take materials to the filed with him to support their work
Process	Material is uploaded/linked in system
	Users can access material over specific section in system
	Users can download material or work with it online
Non-functional requirements	Material and training are accessible 24/7
	No user limit is set for accessing material
	Material and training is structured to motivate users (e.g., over gamification with certificate)
	Copyright restrictions must be addressed
Data management	Data is linked to external resources
	Data is available online or downloadable to use with farmers
	Data is available 24/7
	Data is linked to the internal “Train the Trainer” modules
	Data is linked to replication guidelines and printed version of DST
	Data is automatically kept up-to-date
	Data is available in different languages

5.5.4 Core Requirement 4. Networking and collaboration platform

Table 13: Requirements specification - Networking and collaboration platform

Components	Details
Inputs	Relevant information about other advisors in CANALLS (location, experience, etc.)
	Classification of advisors to expert groups
	Questions/problems from advisors
Outputs	Groups/lists to which questions can be asked
	Relevant literature/videos/links that can help solve the problem
User interaction	User asks questions in forum (text or pictures)
	Other users can see and answer questions
Process	User writes question with problems he wants to solve
	Colleagues get notification that new question is up
	Colleagues can answer the question
	Further material provided by chatbot can help find the solution
	User can close question or ask for further details
Non-functional requirements	Questions are available for at least one week
	Forum is available 24/7
	User identity is protected
	Forum moderator can help lead the conversation
	Translation to English and French is necessary
Data management	Questions and answers are stored
	Offensive questions or bad answers are filtered
	Identity of users is only visible for oneself

5.5.5 Core Requirement 5. Real-time data correction and management

Table 14: Requirements specification - Real-time data correction and management

Components	Details
Inputs	Structured diagnostic questions and corresponding answers stored in ODK
	Data/data ranges to crosscheck the inserted data by “back-office manager”
	Automated technical “back-office manager” crosschecking data
Outputs	Corrections necessary in ODK
	Automatic correction of ODK data
User interaction	User can do automatic data check to show anomalies and correct them automatically
Process	Data is sent from ODK for validation to “back-office manager”
	“Backoffice manager” checks data for anomalies
	“Backoffice manager” send suggestions for corrections back to user
	User initiates corrections proposed by “back-office manager”
Non-functional requirements	Updates uploaded immediately
	Scalability of “back-office manager” depending on number of current users
	24/7 accessibility
	Prior training of users to correctly execute the process
Data management	Users can only access own data
	Validation only possible after data has been uploaded in ODK
	Corrections can only be done in case of internet connection

5.6 Requirements Evaluation

The process of determining whether specific requirements must, should, or may be integrated into a system is a vital step in aligning the development efforts with personas priorities and resource constraints. Once a set of requirements has been identified, the evaluation process ensures that decisions are made based on collective insights and organizational goals. This evaluation involves categorizing each requirement into one of three classifications: must-have, should-have, or may-have, often referred to as MoSCoW prioritization.

For instance, if a requirement addresses a critical security feature, it may be classified as a must-have due to regulatory compliance. In contrast, a requirement for additional reporting functionalities might be categorized as a should-have, essential for enhancing user experience but not critical for initial deployment. Meanwhile, a request for a customizable dashboard could be considered a may-have, offering added value but not essential for the first release. This classification helps streamline decision-making and resource allocation, ensuring that the most critical features are prioritized.

Documentation of the evaluation outcomes is also necessary, as it establishes a clear rationale for why certain requirements were prioritized over others. This transparency not only aids in communicating decisions to the broader team but also serves as a reference point for future evaluations or changes in project scope. By methodically evaluating the necessity and priority of each requirement, teams lay a strong foundation for the development process, enhancing the chances of delivering a system that aligns with both users' needs and strategic business objectives.

This evaluation was conducted for the prioritized Core Requirements. In table 15, 16, 17, 18, and 19 the detailed assessment of the key features to be included are detailed.

Core Requirement 1. Data-driven recommendations

Table 15: Evaluation of specific requirements Data-driven recommendations, that may, should, or must be implemented in the CANALLS DST

Category	Detail	Evaluation
Inputs	Structured questions aligned to different components of agroecology	Must
	Use of ODK/link to ODK and the stored data within	Must
Outputs	Quantitative results in form of graphs and/or tables	Must
	Linkage between diagnostic questions and potential recommendations	Shall
	Varying recommendations depending on crop type, country, …	Shall
	Recommendations tailored to the level of adoption and behavioral change desired	May
	Results are provided in Excel or PDF	Must
Process	Data analysis within the system	Must
	Automatic creation of recommendations based on ODK data	Shall
Non-functional requirements	Low latency of recommendation creation	May
	Training of users on the use and creation of recommendations	Must

	Recommendation function is available 24/7	Shall
	Only advisors should be able to generate recommendations	Shall
Data management	Results and recommendations are stored in downloadable format	Must
	Data access is limited depending on user (data for recommendations, data for research, …)	Must
	Some users are able to edit while others can only view	Must
	Data output is available in French and English	Must

Core Requirement 2. Reporting and data transformation

Table 16: Evaluation of specific requirements-Reporting and data transformation, that may, should, or must be implemented in the CANALLS DST

Category	Detail	Evaluation
Inputs	Data derived from farm (size, location, …)	Must
	Data derived from farm practices (crop type, water, pest and disease, animals,	Must
	Data derived from farmer/farmer household (members, workers, markets …)	Must
	Data derived from community level (number of citizens, number of farmers, …)	Must
Outputs	FAO 10 elements of agroecology	Shall
	Wezel 13 principles of agroecology	Shall
	Biovision farm report	Shall
	Report about individual advice	Must
	Report about group advice	Must
	Report about agroecological diagnostics	Must
	Report about changes in agroecological diagnostics	Shall
	Reports are comparable across multiple aspects such as time or location	Shall
User interaction	User can select which type of report to be generated automatically	Must
Process	Define and select the criteria for the generation of the reports	Must
	Automatically generate the reports with one click	Shall
Non-functional requirements	Advisors can only access own data collected	Must
	System is able to create reports for multiple users in 6 different locations	Shall
	System tracks who uses the function and how it is used	Shall
	Reports are in simple language either in French or English	Must
Data management	System handles non-fitting characteristics accordingly	Shall

Core Requirement 3. Training materials and resources

Table 17: Evaluation of specific requirements-Training materials and resources and data transformation, that may, should, or must be implemented in the CANALLS DST

Category	Detail	Evaluation
Inputs	Videos from CANALLS project	Must
	Results from CANALLS project	Shall
	Additional existing material (e.g., FAQ agroecology knowledge hub)	Shall
Outputs	Display of videos e.g., from Youtube	Shall
	Training material such as handouts, manuals	Shall
	Training material is downloadable and printable	Shall
User interaction	Users visit training section to access material	Must
	User can access different modules and corresponding steps	Must
	User can take materials to the field with him to support their work	Shall
Process	Material is uploaded/linked in system	Shall
	Users can access material over specific section in system	Shall
	Users can download material or work with it online	Shall
Non-functional requirements	Material and training are accessible 24/7	May
	No user limit is set for accessing material	Shall
	Material and training are structured to motivate users (e.g., over gamification with certificate)	Shall
	Copyright restrictions must be addressed	Must
Data management	Data is linked to external resources	Shall
	Data is available online or downloadable to use with farmers	Must
	Data is linked to the internal “Train the Trainer” modules	Shall
	Data is linked to replication guidelines and printed version of DST	Shall
	Data is automatically kept up-to-date	May
	Data is available in different languages	Shall

Core Requirement 4. Networking and collaboration platform

Table 18: Evaluation of specific requirements- Networking and collaboration platform, that may, should, or must be implemented in the CANALLS DST

Category	Detail	Evaluation
Inputs	Relevant information about other advisors in CANALLS (location, experience, etc.)	Shall
	Classification of advisors to expert groups	Shall
	Questions/problems from advisors	Must
Outputs	Groups/lists to which questions can be asked	Shall
	Relevant literature/videos/links that can help solve the problem	Shall
	User answer to question	Must
User interaction	User asks questions in forum (text or pictures)	Shall
	Other users can see and answer questions	Shall
Process	User writes question with problems he wants to solve	Shall
	Colleagues get notification that new question is up	Shall
	Colleagues can answer the question	Shall
	Further material provided by chatbot can help find the solution	Shall
	User can close question or ask for further details	Shall
Non-functional requirements	Questions are available for at least one week	Shall
	Forum is available 24/7	Shall
	User identity is protected	Must
	Forum moderator can help lead the conversation	Shall
	Translation to English and French is necessary	Shall
Data management	Questions and answers are stored	Shall
	Offensive questions or bad answers are filtered	Shall
	Identity of users is only visible for oneself	Must

The general assessment with MoSCoW prioritization coincides with the previous prioritization: the DST should focus on the *Data-driven recommendations* and *Reporting and data transformation* (Table 19).

Table 19: General Evaluation of core requirements that may, should, or must be implemented in the CANALLS DST

Core requirements	Evaluation
Data-driven recommendations	Must
Training materials and resources	Shall
Success stories repository	May
Reporting and data transformation	Must
Appointment management	May
Route optimization	May
Networking and collaboration platform	Shall
Real-time data correction and management	May

In summary, in this chapter we presented the process of requirements elicitation and prioritization. Those requirements are the guidelines for the development of the concept, prototype, development and assessment of the final version and the deployment of the DST.

6. Concept

Following the identification of needs, review of existing DST and definition of requirements, a conceptual framework for DST was developed. The CANALLS DST could be classified in the platform tools classification described in Chapter 4.

CANALLS DST comprises three components: a web-based tool, a mobile tool, and a printed tool (Figure 5).

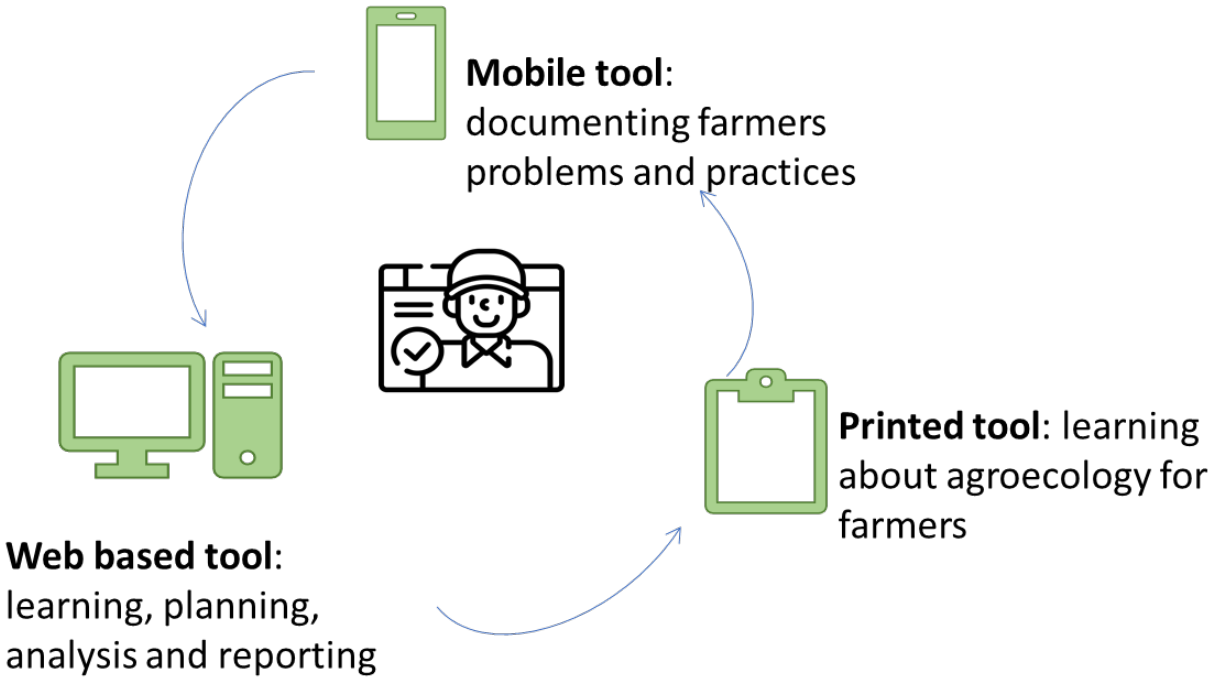

Figure 5: Basic concept of the DSTs

The tool has been designed to facilitate the dialogue and advisory work with farmers, offering support through a combination of digital and printed educational materials. This makes learning accessible to a wide range of users. Importantly, the system is able to operate without an internet connection during field visits, making it highly adaptable in regions with limited or challenging communication infrastructure.

In addition, it offers essential support with data management, helping advisors make informed decisions about their practices. Using the tool can enhance the advisory skills of agricultural professionals in agroecology, contributing to the growth of their careers. Additionally, whether for cash crop production or crops intended for consumption, the DST is adaptable to diverse farming needs, aiming to improve both productivity and sustainability in the farm as a whole.

The **mobile tool** (Annex 3) works with an application extensively tested and used by local partners (ODK). This tool has the advantage of being used in remote rural areas, being adaptable according to the needs of the partners, and collecting different types of variables, including images, georeferenced points and voices. The data collected with the mobile tool is based on two main aspects. The first one is the activities of the advisor (individual visits and group events). The second one is an agroecological diagnostic which collect information from 10 main components of the farm: water, soil and nutrient management, pests and disease, trees, energy, crops, animals, workers, households and community. The questionnaire was designed considering the 10 elements of agroecology of FAO (2016) and the 13 principles of agroecology from the Deliverable 2.1 (Mulumuna et al 2024); Wezel, 2020, and the questionnaire developed by Biovision- FACT tool (2019). Table 20 shows an overview of the data to be collected in the mobile tool.

Table 20: Overview of the data collected with the mobile tool

	Number	Topic	Information collected											
I Advisory work activities														
	1.1	Farmer ID	Registration of the farmer											
	1.2	Individual visits	Activities conducted, results, recommendations											
	1.3	Group events	Activities, participants, results recommendations											
II Agroecological Diagnostic														
			Agroecology principles											
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
	Section 1. The farm														
	1.1	Soil	x	x	x		x	x							
	1.2	Water	x	x	x	x	x	x							
	1.3	Crops	x	x	x	x	x	x	x						
	1.4	Livestock	x	x	x	x	x	x	x						
	1.5	Trees	x	x	x	x	x	x	x						
	1.6	Pest and disease	x	x	x	x	x	x	x						
	1.7	Energy	x	x											
	1.8	Household							x	x	x	x		x	
	1.9	Workers										x			
	Section 2. The food system														
	2.1	Community							x	x	x	x	x	x	x
	2.2	Value chain							x				x		
	2.3	Policy												x	x

The **web-based tool** (Annex 2) has as a purpose to process and generate the reports derived from the inputs from the mobile-tool. The web-based tools allow the different user to manage their data, generating reports and graphs that could be used in their daily work. The web-based tool will have four main components: 1) Reports about advice activities; 2) Reports about agroecological diagnostic; 3) Courses and resources and 4) Collaboration and support (Figure 6).

Figure 6: Components of the web-based tool-First version of the prototype

The first component **Advice activities** creates reports about the activities and farmers involved. It will generate reports of activities of advice in the individual farms or in event groups. This feature will reduce the burden of reports about activities in the field, and improve monitoring and evaluation processes in the advisory organizations. The **Agroecological Diagnostic** section allows to generate report on a given situation in a farm in different points in time, according to the components described in Table 20. The agroecological diagnostic is the basis to compare individual diagnostics and create benchmarks with farms with similar characteristics. The agroecological diagnostic should be coupled with specific options for recommendations provided according to the results. The segment **Courses and Resources** will have resources**,** either derived from lessons learned from CANALLS or recommended from previous experiences and knowledge in the consortium or Living Labs. Finally, the S**uppor**t section will be tested according to the technological possibilities in order to provide a tutor to receive and answer acute questions from the users of the website.

The **printed tool** will be provided by the advisors to the farmers. This part would be essential to use in remote areas and under management of the farmer. During the first version of the DST this part was not yet developed, but main ideas were collected from local teams and extensionists.

In summary, the DST works as a system where the main actors involved interact and have access to data and information and share knowledge (Figure 7).

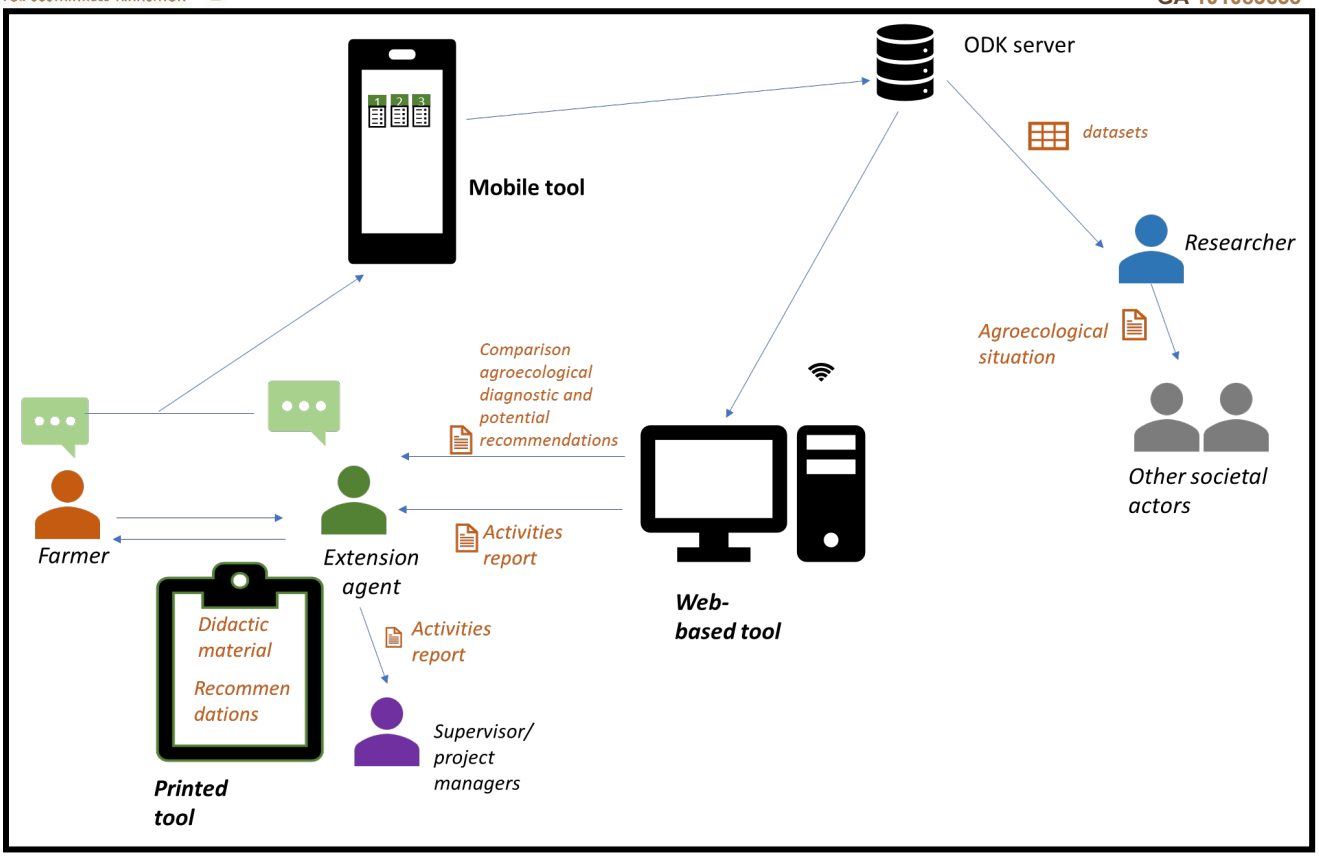

Figure 7: Scheme on how the DST is handled by different actors

Each component of the prototype was developed and tested separately. A first version of the API linking ODK cloud with web based-tool was also developed which will be further refined according to the opinion of the main users.

Additionally, to the criteria to assess the DST such as performance, ease of use, peer recommendation, trust, cost, habit, relevance to the user, and compatibility (Rose, 2018), we consider the principles for the inclusion of smallholders. Those are from particular relevance in the case of CANALLS to avoid the creation of irrelevant or even risky tools that endanger privacy or does not consider local needs (Ditmmer et al 2022). Those set of principles for digital tool use and co-creation of best practices with farmers are also applicable to the development of tools with advisors. Six principles are mentioned, as part of several global agreements: i) engage with different types of farmers; 2) enhance access, 3) co-create digitally enabled farming practices with farmers, 4) use technology appropriately, 5) use farmer data responsibly, and 6) develop tools responsibly.

7. Field testing

The first assessment with end-users was made with the purpose to proof the concept and the features of the prototype. To conducting the assessment a field work was done in Ntu Living Lab from the 2nd to the 4th of December 2024. Ten extension agents from different organizations participated in the workshop invited by IITA, IRAD and SCOOPMAN.

The workshop followed a programme of three steps. Firstly, the participants got to know each other. Next, they described their daily activities, according to the type of advice they provide. Finally, they tested and provided feedback on the three components of the DST (Figure 7).

After explaining the objectives, the first step was to know the advisory work realized by the participants. Participants introduced themselves and explain the main activities of the organization. Four participants are advisors from private enterprises, three from cooperatives and three work as consultants or freelancers (Figure 8)

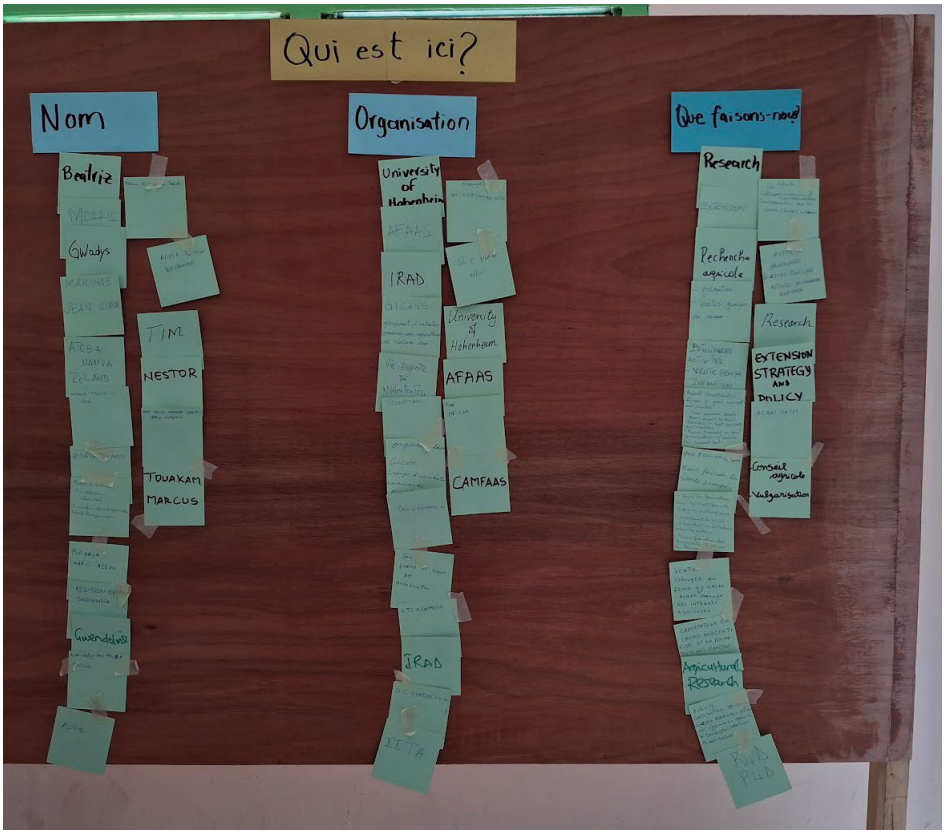

Figure 8: Identification of advisors and organizations

During the second step, the three groups were separated and they described their daily activities in chronological order. The objective of the exercise was to identify the activities and the points in the process where the DST could support them. As a result, three different processes were identified: one for advisors of private companies, for advisors of cooperatives that buy or sell products and for advisor that provide trainings and capacity building (Figure 9).

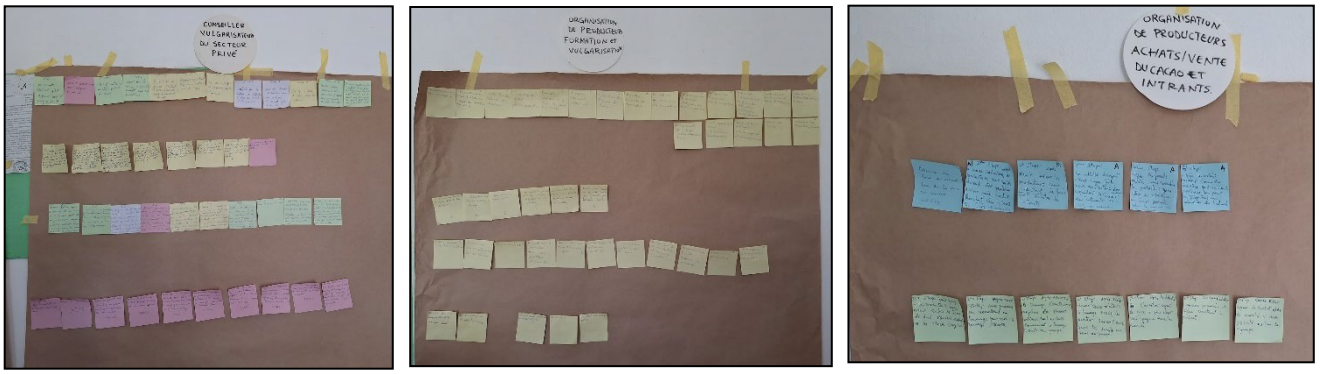

Figure 9: Identification of working flows according to the type of advisors. Left: advisors from private organizations. Middle: advisors from farmers organizations providing trainings; Right: advisors from farmers organizations buying or selling cocoa.

The third step was to test and provide their feedback about the different components of the decision support tool. Participants were separated into three groups of three or four participants. In each group, a facilitator was explaining how the decision support tool works. One group observed and commented on the Mobile Tool; another group commented on the Web-based tool and another group commented on the printed didactic materials that can support the interactions between farmers and extension agents. The three groups rotated in the different tables and provided their comments and feedback (Figure 10). The facilitator team summarized the result of the testing and also provided some ideas for further development.

Figure 10: Groups of advisors providing feedback about the different components of the DST

To summarize the results of the exercise, the project team reflected on the comments and observations that could be improved. The results of the testing are outlined in Table 21.

Table 21: Synthesis of the feedback from the components of the DST

	Web-based tool	Mobile Tool	Printed tool
What they like	• Generation of reports • Virtual tutor • Availability of material about agroecology	• Practical • Easy to use • Can support learning from agroecology • Can prove that a farm is agroecological	• Works offline and supports the farmer • Given as supplementary material
What they don't like	• Dependent on the internet and computers • Some persons don't have computers • Some persons don't have skills to navigate internet or manage MSExcel	• The questions are complicated • The language is too elevated • Some persons don't have access to smartphone • Only works with Android	• High costs
Recommendations	• Training on the use • Develop a version that can work offline	• Simplify the language • Train the users	• Handbook for trainers • Calendar of activities, normal calendar • Guide • Paper, notebooks
Ideas for further development (by the project team)	• Elaboration of reports that are the outputs of the web-based tool • Ideation of graphs and tables • Ideation of the dashboard	• Compare the indicators included in the mobile version with local indicators developed by the team	• Ideas on what type of printed material could be developed to support

In addition to the assessment by extension agents, the project team conducted a brainstorming session on the type of didactic materials to be used. The team also reflected on the indicators that the extension agent should know in order to provide good agroecological advice. For each component of the farm, questions and indicators were identified, and the desired reports to be produced by the web-based tool were designed. Those inputs are going to be taken into consideration in the following steps of the process.

8. Lessons learned and outlook

In the last 12 months, we conducted a process to co-create a DST that could be usable by extension agents to support the farmers in the transition to agroecology. Along the process, many challenges, and lessons learned were generated.

Extension systems and innovation support services are highly diverse, depending on geographical, cultural, and economic contexts. Developing a single tool or platform that can meet the needs of a broad range of these systems is difficult because each system may have different requirements, challenges, and objectives. Additionally, the sector itself is complex, involving diverse stakeholders, varying technologies, policies, and knowledge structures. Designing a tool that addresses all these complexities and remains adaptable across different settings is a major challenge.

By starting small and iterating, the development process becomes more flexible. This flexibility allows the tool to be continuously adapted based on feedback and evolving requirements. Co-creation is a process where stakeholders (including users, experts, and developers) collaborate in designing and developing tools. This way of work increases the chances that the tools meet real-world needs and are grounded in practice. Also, starting small ensures that the tool stays relevant, respects good practices, and aligns with the principles for inclusivity in the development of digital tools for smallholder farmers.

For direct application in advisory work, many of the frameworks used in agroecology are very complex. The challenge is adapting these frameworks, originally designed for research, so they are useful and practical for extension work, where real-world guidance and actionable insights are needed. To make this transition smoother, it's essential to concretize (make abstract concepts more tangible) and simplify the language used, ensuring that complex theories are communicated in a clear, practical way that practitioners can easily understand and apply. This helps make the advice more accessible and implementable in real-world scenarios.

As an outlook for further work, we plan to incorporate the feedback and comments gathered during the testing phase. This will involve refining the current version and replicating the testing process across other ALLs. Based on the additional feedback, we will make adjustments and improvements. to finalize a version, which can then be disseminated across the different Agricultural Knowledge and Innovation Systems (AKIS) involved in CANALLS.

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10. Annexes

10.1 List of decision support tools

Table 22: DST Inventory

Study/Origin	Tool	Location	Medium
Sida et al., 2023	Fertilizer Optimization Tool (FOT)	Burkina Faso, Ethiopia, Ghana, Kenya, Mali, Mozambique, Niger, Nigeria, Rwanda, Tanzania, Uganda, Zambia	PC, Paper, App
	Nutrient Expert®	Ethiopia	POC, Web, App
	The Soil Plant Analysis Development	Mozambique	Digital Gadget
Alvar-Beltrán et al., 2023	AquaCrop	Burkina Faso	Digital
Abayechaw, 2021	Decision Support System for Agrotechnology Transfer (DSSAT) model	Worldwide	Digital
Farnworth et al., 2023	Gender Action Learning System	Tanzania	Digital
Schwilch et al., 2012	DESIRE-DSS	Cape Verde Botswana Morocco	Digital & Paper

Struif Bontkes & Wopereis	Nutrient monitoring approach (NUTMON) □ Now called MonQI	Kenya, Uganda	Digital
	Quantitative Evaluation of the Fertility of Tropical Soils (QUEFTS)	Togo, Zimbabwe, Tanzania,	Digital
	The Agricultural Production Systems sIMulator (APSIM)	Zimbabwe, Ghana, Kenya, South Africa,	Digital
	RIDEV	Sahel	Digital
	SARRA-H	Not specified, but focused on CILLS countries	Digital
	Rothamsted Carbon (RothC) Model		Digitla
Alliance Bioversity International - CIAT, 2023a	Climate Risk Planning & Managing Tool for Development Programms in Agri-Food Systems (CRISP)	Newly released	Digital
Alliance Bioversity International - CIAT, 2023b	NextGen Agroadvisory	Ethiopia	Digital
Ramaraj et al., 2023	“Intelligent agricultural Systems Advisory Tool – iSAT”	Co-developed by the East African Hub	Digital
Ortiz-Crespo et al., 2021	Ushauri	Tanzania	Digital/Telephone
Zinyengere et al., 2015	CropGro (DSSAT v 4.0)	Malawi	Digital
CIRAD	PixFruit®		Digital
Constantin et al., 2023	MERCI	-	Digital
Biard et al., 2021	OptiReUse	-	Digital
RAB	Land-use Decision Support System (LUDSS)	Developed for Western Australia, applied also in Rwanda	Digital
USAID	Sustainable Agriculture Decision Support Tool	Senegal	Digital
FAO	CROPSYST	SSA	Digital

Hunt et al., 2006	Yield Prophet	Mainly Australia, but also used in SSA	Digital
Estes et al., 2013	GAM Model	South Africa	
AKILIMO	AKILIMO	General Africa, with a lot of work in Tanzania and Uganda	Paper & Digital
CGIAR-CSI (2017)	Impact Based Spatial Targeting Index	Focused on Tanzania till now	Digital
IITA	Shade Tree Advice Smartphone Application	Uganda	Digital
	Stepwise Smartphone Application		Digital
	PlantVillage	Africa	Digital
	Herbicides Calculator	Nigeria	Digital
	Crop Disease Surveillance	General	Digital
Ahmed et al., 2020	Ethiopian Digital AgroClimate Advisory Platform (EDACaP)	Ethiopia	Digital
FAO	Tool for Agroecology Performance Evaluation (TAPE)	General	Digital
Whitney et al. (2023)	Methodology establishment for DSS for agroecology	General	Publication
Biovision	F-ACT: Farm-level agroecology criteria tool	General	Digital
Trabelsi et al. 2019	ESSIMAGE: a tool for the assessment of the agroecological performance of agricultural production systems	General	Publication
Duff et al. (2022)	Development of ways to develop a DSS with precision agroecology	General	Publication
UMR INNOVATION	BoosT-AE: Collaborative Platform for Agroecological Transition: (Rather a platform)	"Countries in the South"	Digital
FAO (2021)	The Transformative Partnership Platform (TPP) on Agroecology	"Tropical areas"	Digital
Precision Development	Precision Agriculture for Development	Africa, Asia	Digital
Department of Agriculture OSEC	Rice Crop Manager Advisory Service	Philippines	Digital
Jangolo	Jangolo Agribusiness 360°	Cameroon	Digital

10.2 Mock-up images (web based platform)

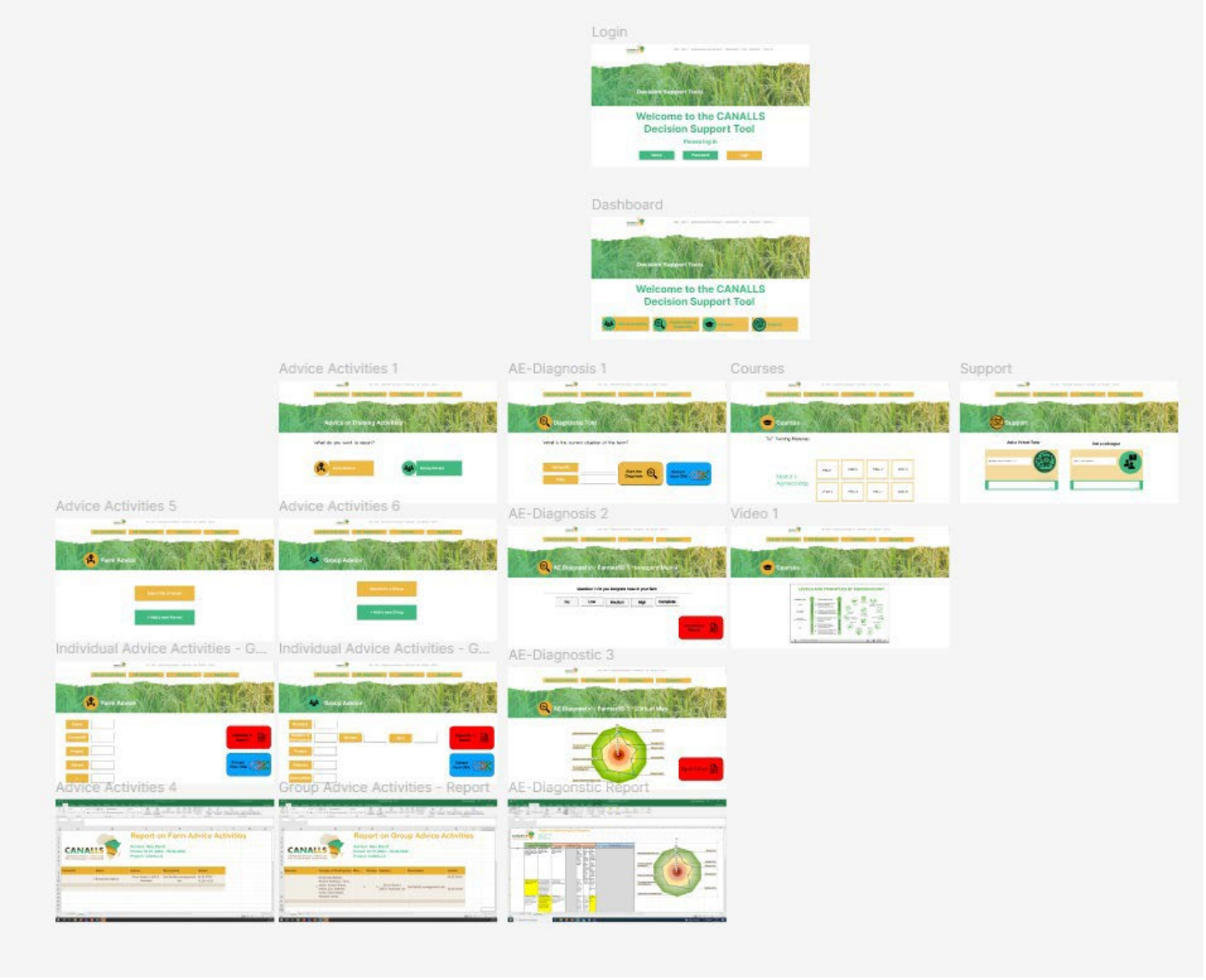

Figure 11: Overview of the mock-up of the web-based tool prototype

10.3 Adapted agroecological diagnostic (mobile version)

Screenshots of the data collection tool developed for the decision support tool

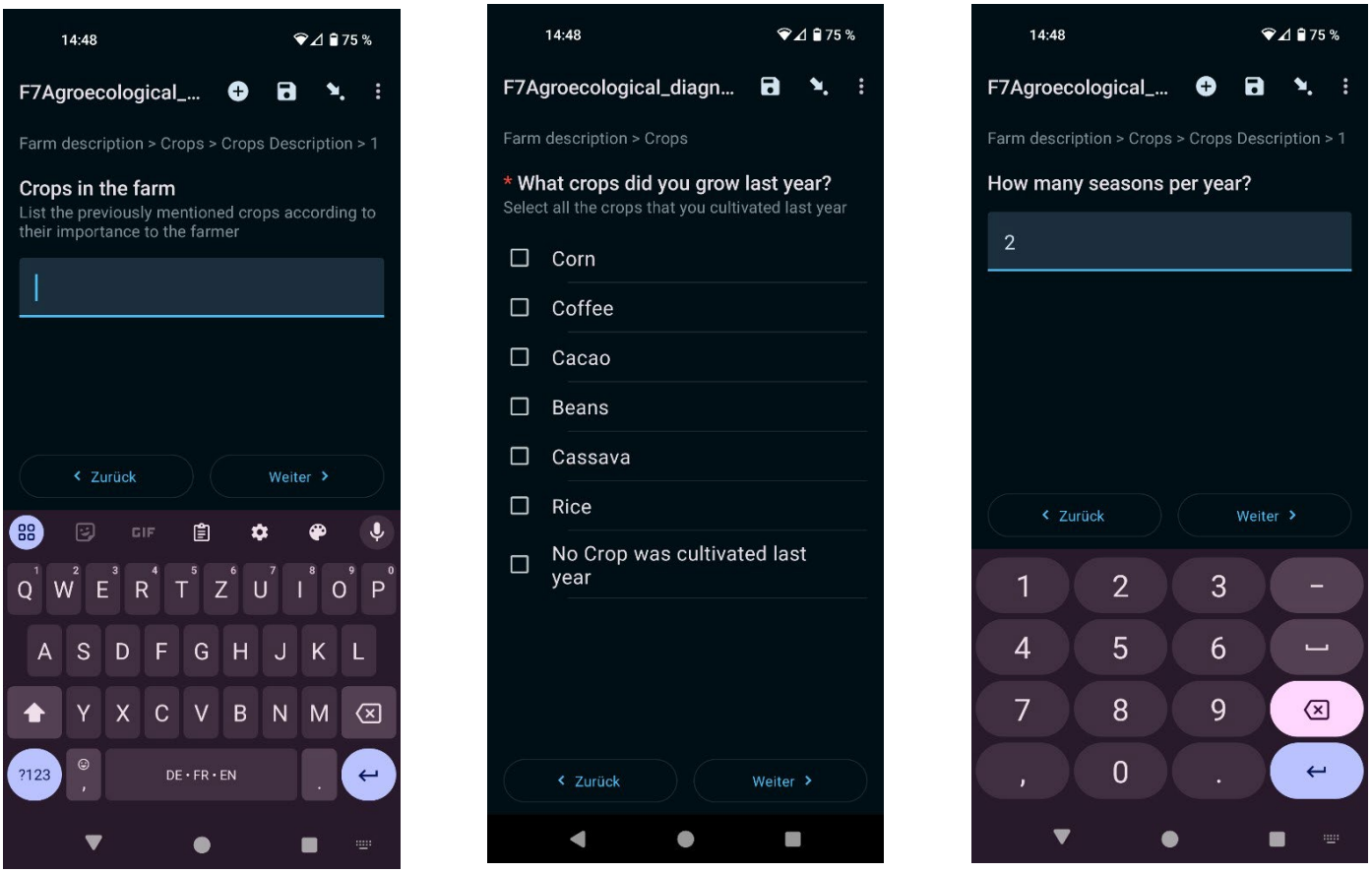

Figure 12: Interface of the ODK mobile data collection tool

Instruments for mobile data collection by extension agents in DST CANALLS.

Compatible with CANALLS Agroecological Framework

Version 2

November 2024

Beatriz Herrera, Roman Spiegelsberger, Diego Cerrudo, Hycenth Tim Ndah

Content

Content

A. Introduction

The objective of this document is to present the instruments for data collection through the mobile application used in CANALLS DST. Those instruments have two main purposes: i) support the extension agent in the documentation of his/her daily work and ii) simplify and provide a tool to make a general agroecology diagnostic feasible to implement by extension agents, usable for providing advice, report project managers and inform on the agroecological situation.

These instruments are only **a data collection tool.** That means that in this document the analysis will not be described. The analysis of the data will be made according to the different interests and roles of the users on the system (farmers, extension agents, project managers and researchers).

An overview on how those data collection tools interacts within the DST component is presented in the Figure 1.

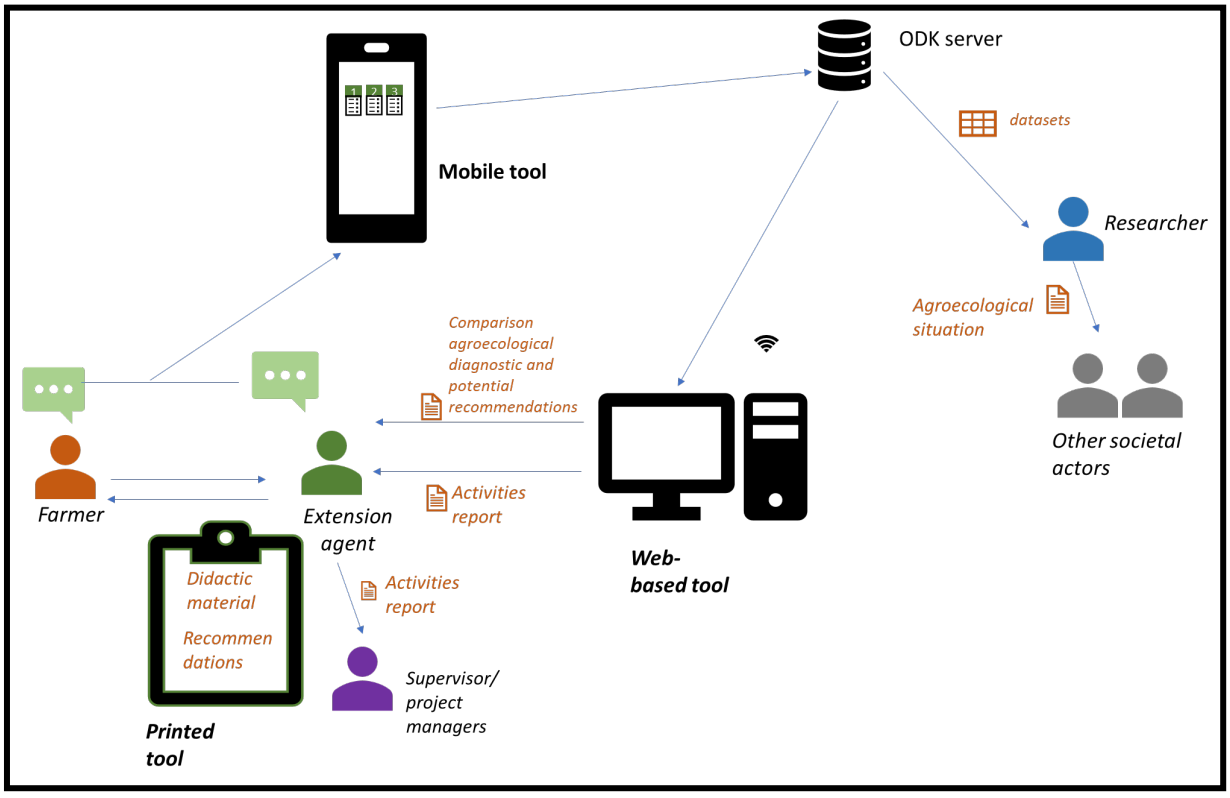

Figure 1. Data and information flows CANALLS DST

The data collection tools presented in this document are visualized I the Figure 2 and described in the Table 1.

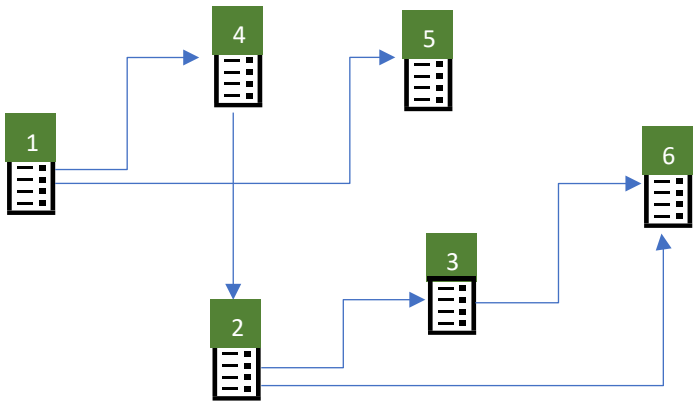

Figure 2. Connections between data collection instruments of CANALLS DST

The data collection instruments are interconnected and have a purpose to facilitate the further storage and analysis:

Number	Name	Purpose
1	Advisor/user registration	Create user ID
2	Farmer registration	Create a farmer ID
3	Farm description	Create a farm ID with basic description
4	Visit (individual event) formular	Document main characteristics of each advice visit
5	Group event formular	Document group events activities
6	Agroecological diagnostic tool	Collect data which will be analyzed to derive an agroecological diagnostic

For the diagnostic we used the framework of F-ACT Biovision (Figure 3) for several reasons:

- We can collect data based on intuitive manageable resources
- Could be easily collected by extension agents using ODK and/or Kobo
- Uses the 13 principles and 10 elements of agroecology framework which facilitates the further analysis within TAPE or F-ACT framework

Figure 3. General framework agroecology diagnostic linking section of the diagnostic with 13 principles. Source: Biovision- FACT tool

B. Tools

1 Advisor/user registration

2 Farmer registration

3 Farm description

4 Visit (individual event) formular

5 Group event formular

6. Agroecological diagnostic tool

1. Advisor, user registration

100. Consent agreement for registration	_<yes/no>_
101. Name of the user	_<name>_
	<family name>
102. Advisory organization	<name>__
103. Email	_<email>_
104. Code of the enumerator	_<automatic>_

2. Farmer registration

200. Consent agreement for registration	_<yes/no>_
201. Farmer name	<string>_____
203. Sex of the farmer	<1: male; 0 female>
204. Birth year of the farmer	mm/yyyy
206 Village	____<mas>_____
206 County	____<mas>_____
207 Phone number	____<mas>_____
207 Country	<list>_____
202. Code of the farmer (if already in the database)	<automatic>_____

3. Farm description

300 Consent form on register the farm

301 Location of the farm (georefere ce points from GPS)

___coordinates x_____

_coordinates y_____

302. Total owned land <ha>

303. Total cultivated area each season <ha>

304 What crops do you produce?

<from list>_	[ha]	type [main intercrop/main monocrop]]
<from list>_	[ha]	type [main intercrop/main monocrop]]
<from list>_	[ha]	type [main intercrop/main monocrop]]
<from list>_	[ha]	type [main intercrop/main monocrop]]
<from list>_	[ha]	type [main intercrop/main monocrop]]

305 From the crops do you produce?

	How much do you harvest?	How much do you consume in the household? %	How much do you sell? %	How much do you lose after harvest? %
Crop1	Unit -quantity	%	%	%
Crop2	Unit -quantity	%	%	%
Crop3	Unit -quantity	%	%	%
Crop4	Unit -quantity	%	%	%
Crop5	Unit -quantity	%	%	%

306 What type of livestock do you have? (including vermicompost, bees, fish)

<from list> ___	[number of animals]
<from list> ___	[number of animals]
<from list> ___	[number of animals]
<from list> ___	[number of animals]

306 What other gainful activities related to your farm do you have? (milk, honey, eggs, cheese, food processing, compost sales, energy, firewood, tourism,)

<from list>_
<from list>_
<from list>_
<from list>_

307 What percentage of your household annual incomes come from?

Crops	%
Animals	%
Trees or forest products	%
Other gainful activities related to the farm (processing, tourism)	%
Off-farm work	%

308 Do you participate in a certification scheme?

No	<yes>
Only for one part of the produce	<yes>
The whole produce	<yes>

309 Which one (s)? **organic, agroecological, biodynamic, permaculture, rainforest, natural land**

<from list> _
<from list>
<from list>_

311 In your farm, are there any bodies of water or water storage facilities?

None	<yes>
streams, springs, natural lakes, natural ponds	<yes>
water reservoirs, water storage facilities,	<yes>
Community or farmers association water storage or irrigation facilities	<yes>

310 Did you irrigate last season?

<yes, no>_

308 How severe is soil erosion in your plots?

<not a problem>
<very low>__
<low>
<medium>

__<high>

202. Code of the farm <automatic>_____

4. Visit (individual event) formular

401. Date <ha>

402. Code of the advisor (automatic) <number>_____

402. Code of the farmer (if already in the database) <number>_____

403 Location of the visit (georefere ce points) automatic
___coordinates x_____

_coordinates y_____

404 Duration of the visit
___start_____

_end_____

405. Purpose of the visit _____<text>_____

406. Main results _____<text>_____

407. Comments about the visit _____<text>_____

408. Actions to take _____<text>_____

409. Number of participants _____<men>_____ _____<woment>_

5. Group event formular

501. Date <ha>

402. Code of the advisor () <number>

502. Name of the group <text>

503. Type of the event <list>

504 Location of the event (georeferenced points)

_coordinates x

_coordinates y

505 Duration of the event

_start

_end

506. Purpose of the event <text>

507. Main results <text>

508. Comments about the event <text>

509. Actions to take/Lessons learned <text>

510. Number of participants <men> <women>

511. Number of young participants <30 <men> <women>

6. Agroecological diagnostic

Overview of the diagnostic

		Agroecology principles														
	Topic	1	2	3	4	5	6	7	8	9	10	11	12	13	Number of questions	Number of questions
Section 1. The farm																
1.1	Soil	x	x	x		x	x								5	10
1.2	Water	x	x	x	x	x	x								6	6
1.3	Crops	x	x	x	x	x	x	x							7	9
1.4	Livestock	x	x	x	x	x	x	x							7	10
1.5	Trees	x	x	x	x	x	x	x							7	8
1.6	Pest and disease	x	x	x	x	x	x	x							7	8
1.7	Energy	x	x												2	2
1.8	Household							x	x	x	x		x		5	9
1.9	Workers										x				1	4
Section 2. The food system																
2.1	Community							x	x	x	x	x	x	x	**7**	**13**
2.2	Value chain							x				x			**2**	**3**
2.3	Policy												x	x	**2**	**3**

6.1 Diagnostic identification

101. Date dd/mm/yyyy

107. Code of the farmer (if already in the database) <number>_____

110. Location of the diagnostic (georeferenced points)

_coordinates x_____

_coordinates y_____

6.2 Soil

201. What fertilizers do you use?
□ Chemical fertilizers
□ Organic fertilizers
□ No fertilizers, no alternative fertilization practice

202.[if]How much chemical fertilizer did you apply last main season in the main three crops?

Crop	Area of application	Unit of chemical fertilizer	Quantity applied last main season
Crop1			
Crop2			
Crop 3			

203. [if]How much organic fertilizer did you apply last main season in the main three crops?

Crop	Area of application	Unit of organic fertilizer	Quantity applied last main season
Crop1			
Crop2			
Crop 3			

204.Which of the following practices for fertilitazion did you use during last season?

Nutrient management practice	
Soil testing	
Application of micronutrients	
Production of compost	
Selling of organic fertilizer outside the farm	
Cover crops	
Increase and validate the list!	

205. What do you do with crop residues of your farm?

- ϒ All are burned or disposed of.
- ϒ Majority is burnt but some are used for compost, mulch or livestock feed.
- ϒ Majority is used for compost, livestock or mulch but some are burnt occasionally.
- ϒ All are used for compost, livestock feed or mulch. No organic material is burnt, with the exception of diseased plant.

206. What type of tillage practices do you use on your farm?

- ϒ Common tillage frequently
- ϒ Common tillage, not frequently
- ϒ Reduced tillage in most of the farm
- ϒ No tillage

207. Do you grow cover crops (beans, other leguminous)?

- ϒ No green manures are grown in the farm
- ϒ One type of cover crop between growing seasons
- ϒ One type of cover crop between and during growing seasons
- ϒ Two or more types of cover crops are used **between** and **during** growing seasons

208. [if] If you have animals, how do you use the animal manure?

- ϒ Manure is not applied and is left to decompose
- ϒ Some animal manure is applied untreated to the soil surface but not incorporated
- ϒ All animal manure is applied composted to the soil surface but not incorporated. No manure is wasted.

209 [if] How do you use the animal by-products (e.g. bones, feather, skin *vermicompost)*?

- ϒ No animal by-products are used
- ϒ Some animal by-products are used and some are wasted.
- ϒ All animal by-products are used. No by-products are wasted.

210. Do you sell outside your farm compost or other soil related activities (selling compost, organic fertilizers, crop residues, earthworms)?

- ϒ No selling activities related to that
- ϒ One selling activity
- ϒ Two selling activities
- ϒ Three selling activities

6.3 Water

301 [if] How many land did you irrigate last season? <ha>_

302. Do you use any of the following methods to save or recycle water?

	None	One	Two or more
Water saving technology (e.g. timed or drip irrigation)			
Water saving practices (e.g. **mulch, zai pits**)			
Rain water harvesting			
Used water recycling (e.g. rain tanks, zai pits, swales, reed beds)			

303.Which of the following practices did you use during last season to avoid soil erosion?

Soil erosion avoiding practices	
Contour planting	
Terraces	
Earthworks	
Living fences	
Wind breaks	
Use of trees	
Increase and validate the list!	

304. [if] If you have any bodies of water (e.g. ponds) how do you protect them?

- ϒ No bodies of water
- ϒ No practices for water protection
- ϒ One body of water (e.g. ponds) AND practices for water protection.
- ϒ Multiple bodies of water (e.g. ponds) AND/OR practices for water protection.

305. [if] If you have livestock, do your livestock and other farm animals, have consistent access to clean drinking water throughout the year?

- ϒ Animals have no water provided to them
- ϒ Animals have inconsistent access to water and water that is provided is not clean
- ϒ Animals have consistent access to water but it is not cleaned regularly OR animals have inconsistent access to clean water
- ϒ Animals have consistent access to clean water

306. [if] [if] If your farm contains bodies of water how are they integrated into crop and animal systems (e.g. water hyacinth production for compost biomass, fish farming, aquaponics, or hydroponics)?

- ϒ no water bodies on farm
- ϒ No practices that integrate water bodies on the farm with crop or livestock production
- ϒ One practice that integrates water bodies on the farm with crop OR livestock production.
- ϒ One practice that integrates water bodies on the farm with crop AND livestock production.
- ϒ Multiple practices that integrates water bodies on the farm with crop AND/OR livestock production.

6.4 Crops

401. Are crops planted in monocultures or are forms of intercropping used on your farm?

- Monoculture of one crop, or, no crops grown in system.
- Two or three crops grown separately, each being grown on at least 20% of land.
- Two or three crops grown, with at least one example of intercropping.
- More than 3 crops grown, with at least one example of intercropping.

402. Do you plant cover crops on your farm or is soil left bare between growing seasons?

- Soil is left bare between growing seasons.
- One cover crop is grown between growing seasons on some but not all land. Some land is left bare.
- One cover crop is grown between growing seasons on all land. No land is left bare.
- A diverse mixture of cover crops are used on all land, or, land is continually cultivated with regenerative soil building practices (e.g. Biointensive farming) No land is left bare.

403. How do you obtain crop seeds and plant material? (e.g. from the market, on-farm seed saving, or local exchanges).

- All seeds and plant material are purchased from the market. No seed saving or local exchanges occur.
- Majority but not all seeds and plant material are purchased from the market. Minority are self-produced (saved) or locally exchanged.
- About half of all seeds and plant material are self-produced (saved) or locally exchanged, the other half is purchased from the market
- The majority or all seeds and plant material are self-produced (saved) or exchanged. Some specific seeds are purchased from the market.

404. Do you grow any non-crop plants for ecological benefits? (e.g. pollination, pest regulation, water purification or nutrient cycling) [Not including trees.]

- No non-crop plants grown for ecological benefits
- One non-crop plant grown for one ecological benefit (e.g. pollination, pest regulation, water purification or nutrient cycling). Does not include trees.
- Two non-crop plants grown for one or more ecological benefits. Does not include trees.
- Three or more non-crop plants grown for multiple ecological benefits. Does not include trees

405. Do you plant any perennial alternatives to annual crops? (e.g. perennial kale or ratoon cropped sorghum).

- n/a - no perennial alternatives to annual crops on farm.
- No perennial alternatives to annual crops are grown.
- One perennial crop is grown
- Multiple perennial crops are grown

6.5 Livestock & Other Farm Animals **[if]**

(Inc. Large And Small Mammals, Poultry, Fish, Honey-Bees, And Vermiculture Worms)

501 How do you use the products derived from your livestock and other farm animals?

	Consumption in the farm	**Selling outside the farm**
Livestock units		
Pigs		
Chickens		
Goats		
Fish		
Meat		
Milk		
Eggs		
Honey		
Fish meat		
Worms		
Cheese, other dairy products		
Increase the list		

502. Do animals have consistent access to diverse and nutritious feed throughout the year?

- ϒ farm has no animals
- ϒ Animals spend three or more months of the years without access to adequate amounts of feed.
- ϒ Animals spend one or two months of the years without access to adequate amounts of feed.
- ϒ Animals have consistent access to feed, but lack consistent access to certain nutrients.
- ϒ Animals have consistent access to nutritious and diverse feed.

503. Where do you obtain your feed for farm animals? (e.g. grown on the farm, from the market, or locally exchanged)

- ϒ n/a - farm has no livestock
- ϒ Farm sources all feed from the market
- ϒ The majority of feed is purchased from the market. A small amount of one type of animal feed is produced onsite or by neighboring farms (e.g. pasture, fodder, hay, silage).
- ϒ Farm produces two types of fodder AND/OR permanent or temporary single-species pasture is available for animals to graze. A small amount of animals feed or supplements are purchased from the market.
- ϒ Farm produces three or more types of fodder AND/OR permanent or temporary multi-species pasture is available for animals to graze. A small amount of livestock feed or supplements are purchased from the market.

504. What type of grazing do you use, if any, on your farm?

- ϒ n/a - farm has no livestock
- ϒ Animals are confined in zero-grazing systems all year.
- ϒ Animals graze on pasture for less than six months of the year. No rotational or regenerative grazing is practiced.
- ϒ Animals graze on pasture for six to nine months of the year. Rotational or regenerative grazing is practice (e.g. mob-grazing)

Animals graze on pasture ten to twelve months of the year. Rotational or regenerative grazing is practiced.

505. Do animals receive adequate medical attention?

- n/a - farm has no livestock
- □ Livestock receive little to no medical attention
- □ Livestock receive routine and adequate medical attention

506. Are animals kept in in housing that allows them to express natural behavior?

- n/a - farm has no livestock
- Livestock cannot express normal behavior
- Livestock can express normal behavior

507. Which efforts made to reduce stress before slaughter of animals?

- n/a - farm has no livestock
- Do not slaughter
- No efforts are made to reduce stress at the time of slaughter.
- Efforts are made to reduce stress at the time of slaughter.

508. Do you practice any integrated crop-animal or mixed livestock management practices (e.g. multispecies grazing, rice-duck-fish farming, pig-fish farming, poultry viticulture etc.)

- n/a - farm has no livestock
- No crop-livestock or mixed livestock management practiced.
- Crops & livestock integration is limited to the use of livestock manure as a soil amendment and/or crops and weeds used for livestock feed.
- One integrated crop-livestock OR mixed livestock system practiced.
- Two or more integrated crop-livestock OR mixed livestock systems practiced.

6.6 Trees & Other Woody Perennials

601 How are trees integrated into your crop and animal systems? (e.g. do you use practices such as silvopasture or alley cropping etc?)

- ϒ Trees are not integrated into crop or livestock systems. Or farm has no trees.
- ϒ One agroforestry practice is used to integrate trees into crop OR livestock systems (e.g. alley cropping, silvopasture, shade coffee etc.)
- ϒ Two agroforestry practices are used to integrate trees into crop AND/OR livestock systems.
- ϒ Three or more agroforestry practices are used to integrate trees into crop AND/OR livestock systems.

602 How is the landscape in the surround areas of your farm?

- ϒ Landscape is mainly agricultural.
- ϒ Farm borders one non-agricultural area (e.g. woodland or forest).
- ϒ Farm borders two or more non-agricultural areas (e.g. woodland or forest).

603 Which species of tree are planted on your farm?

604 Do you produce and use any tree products on your farm? (e.g. green fertilizer, timber, neem extract)

Product	On farm use	Selling outside farm
Green fertilizer		
Timber		
Neem extract		
Leaf litter		
Fence posts		
Firewood		
Charcoal		
Ramial woodchip		
Food harvest		
Increase and validate the list!		

605 Do you produce and use any tree fodder sources on your farm?

- ϒ n/a - farm has no livestock
- ϒ No fodder is harvested from trees on farm OR there are not trees.
- ϒ One type of tree fodder is available for part of the year.
- ϒ Two types of tree fodder are available for part of the year
- ϒ More than two types of tree fodder are available for the whole year.

6.7 Pests & Disease

701 How do you manage weeds on your farm?

Chemical herbicide

□always
□used only for specific crop
□as last resort
□ never

Mechanical weed management (physical method used for weed control, tine harrow cultivation, rotary hoe cultivation, inter-row and intra-row cultivation, thermal weeding)

□always
□majority of the farm
□some
□never

Cultural practices (resistant varieties, tillage, mulching, hand weeding and hoeing, pruning, trapping and hand picking of insects and weeds, and the use of physical barriers such as row covers and sticky bands).

□always
□majority of the farm
□some
□never

702 How do you use residues from weed management?

- residues are not used
- residues are incorporated to the soil
- residues are used as livestock feed

703 How do you manage pests and diseases that affect crops on your farm?

Chemical pesticides

□frequently
□used only for specific crop
□as last resort
□ never

Integrated pest management (e.g. scouting, physical removal, biological control agents, biopesticides etc).

□always
□majority of the farm
□some
□never

Prevention measures

□always
□some
□never

704 How do you manage pests and diseases that affect the animals?

n/a - farm has no livestock

Synthetic veterinary medicine

- □frequently
- □used only for specific animal
- □ used for specific animals as last resort
- □ never

Biological veterinary medicine

- □all, including prevention measures
- □most of the cases, except on specific cases
- □some, infrequently
- □never

705 Which practices have you made to control pests and disease

Practices	Zero	One	More than one
Intercropping or companion planting that pairs two crops together (e.g. onions and brassica crops) for pest/diseases/weed reduction			
Complex system that uses three or more crops (e.g. push-pull farming or chaos gardening)			
Simple two crop rotation			
Three or more crops are rotated			
Fallow periods or grazing periods are integrated into the rotation.			
Presence of non-agricultural features (barriers, fences) on farm which support natural enemies			
Biological pest control			
Basic storage facilities to store some of their crops after harvest			
Hermetic seals to prevent damage during storage			
Increase and validate the list!			

6.8 Energy

801. Do you produce and use any renewable energy on your farm?

- ϒ No renewable energy is used or produced on the farm.
- ϒ The majority of energy is purchased, but a small amount of renewable energy is produced (e.g. wood, charcoal, solar, animal traction, wind, turbine, hydraulic, biogas, etc.)
- ϒ Half of the energy used is renewable and produce at the farm, the other half is purchased.
- ϒ Almost all of the energy required is met by renewable energy produced on the farm. There is a negligible use of fossil fuels (e.g. for cars).

802 Do you have any energy savings practices on your farm?

Practices	Zero	One	More than one
Controlled traffic			
Light timers			
Building isolation			
Cookstoves			
Solar dryers			
Solar pumps			
Off-grid electricity			
Solar panels			
Increase and validate the list			

6.9 Household

901 Does your farm activity provide you with sufficient income to meet your goals and invest in further development?

- Farm income does not cover farm costs
- Farm activity does not provide sufficient income to meet basic household costs.
- Farm income covers farm costs, and profits can be used to invest in small development projects.
- Farm income covers farm costs, and profit is used for small to medium development projects on the farm.

902 Do you engage in on off-farm work?

- Farm does not engage in off-farm work
- At least one household member engages in part-time work for additional income.
- Two or more household members engage in part-time work for additional income.

903 Do you have access to financial support (e.g. credit, loans or insurance)?

- Farm has no access to financial support or very limited (informal lender)
- Farm has access to financial support to cover costs and basic needs
- Farm has access to financial support to larger investments

904 Do you keep farm records?

- Farmers keeps no records.
- Limited or inconsistent records are kept related to yield OR records are only kept for one farm product.
- Consistent records are kept for all farm products regarding yield and income but no further detail is recorded.
- Records are kept regarding yield, income, and other notes such as pests, weather, or results of new practices etc.

905 Do you have secure ownership documents for the land you farm OR do you have secured rights that enable you to make long term decisions on the land you farm? (e.g. secured access, right to occupy, long-term lease agreements)

- Farmers have no official documentation to show they or their family are the legal owners of their land OR they have no secured rights to farm the land.
- Farmers have documented secured rights to make short-term decisions on the land they farm BUT they do not have documentation declaring their legal ownership of the land.
- Farmers have documented secured rights to make long term decisions on their land OR documentation declaring their legal ownership of the land BUT do not have the right to bequeath the land to future generations.
- Farmers have documentation of their secured right to make decisions over the land they farm OR possess documentation declaring their legal ownership of the land AND have the right to bequeath the land to future generations.

906 Does your household have consistent access to adequate food (from the farm or market) to meet its needs all year?

- The household is not able to access a consistently adequate quantity of food from the farm or market to meet the household's nutritional needs for most of the year

- The household is able to access a consistently adequate of quantity of food from the farm or market but it is not diverse enough to meet the household's nutritional needs
- The household is able to access a consistently adequate quantity and diversity of healthy food from the farm or market to meet their nutritional needs for the majority of the year.

- The household is able to access a consistently adequate availability of quantity and diversity of culturally appropriate and healthy food from the farm or market to meet their nutritional needs at all times

906 How would you rate the following statements?

	Highly disagree	Disagree	No opinion	Agree	Highly agree
Men and women have the knowledge and skills to provide their families with nutritious diets.					
Women and men are equal decision makers					
Women and men have equal ownership of or access to shared assets and finances					

907 Which of the following nutrition practices are implemented at your home?

Practice	**never**	**frequently**
Kitchen gardens		
Use of green leaves		
Use of medicinal planta		
Use of wild plants for nutrition		
Assessment of nutrition		
Share with neighbors		
Meals in schools		
Ask the LL!		

6.10 Workers

10-01 How many persons work in the farm in the last year?

Regular unpaid persons_____(farmer, spouse, children, relatives)

Occasional unpaid persons_____(farmer, spouse, children, relatives who help in occasionally in some seasons)

Regular paid persons_____(workers who receive payment)

Occasional paid persons_____(seasonal workers who receive payment)

10-02 What is the average payment per day for farm paid workers?

_____

10-02 What is the level of health risk of the workers of the farm?
n/a - farm has no workers.
- □ Low
- □ Medium
- □ High
- □ Very high

10-02 Which practices do you implement to reduce the level of health risk of the workers of the farm?

Practice	Never	Regularly	Sometimes
Equipment for chemicals application			
Limited number of hours during harvest			
Payment every 2 weeks			
Trainings			
Involvement of young <30 persons			
Ask the LL!			

6.11 Community

11-01 Do you or someone from your household participate in one of the following communities' activities?

	Member	Directive	No
Farmers organization or association			
Cooperative			
Group (savings, kitchen gardens, advice, trainings, field schools)			
Other networks or groups			
Local markets (for selling produce)			
Local government (authority)			

11-02 In your community, are there resources managed collectively?

	Yes	NO	Don't know
Water bodies			
Community forest			
Common grazing and pastures			
Water reservoir			
Natural park			
Maintenance of hedgerows			
Communal land ownership			
Wildlife corridor			
Watershed management			
Cultural activities (fairs, feasts)			
Technology development			
Experimental fields			

11-03 How do you participate in it?

Activities	YEs	NO	Don't know
Voluntary Work			
Pay a fee			
Rotate in the use			
Sharing of tools			
Following regulations			
Ask the LL!			

11-04 What rules are used in those organizations or communal activities?

- ϒ None
- ϒ There are regulations and a board that are followed
- ϒ The regulations are there, but not always followed
- ϒ Don't have an idea

11-05 How would you rate the following statements?

	Strongly disagree	Disagree	No opinion	Agree	Disagree
All community members have equal power or access to the organizations					
Farmers in this community engage in activities to promote or preserve local or traditional values and culture.					
Men and women have equal power or access to the organizations and decisions					
The farmers are active organizers who decide the agenda of the platform, agenda or group					
There is a high level of trust in the collective management of natural resources					

6.12 Value chain

12-01 – Who are the buyers of the farm produce that you sell (in percentage)?

Crop 1:

- Directly to local markets or final consumers:
- Sell to cooperatives:
- Sell to intermediaries or brokers:

Crop 2:

- Directly to local markets or final consumers:
- Sell to cooperatives:
- Sell to intermediaries or brokers:

Crop 3:

- Directly to local markets or final consumers:
- Sell to cooperatives:
- Sell to intermediaries or brokers:

12-03 -[if] If you produce organic, agroecological, biodynamic, permaculture or similar produce, how frequently have you experienced

	Never	**Sometimes**	**Frequently**	**Always**
Premium price				
High costs of certification				
Increase in production				
Increase in quality of production				
Increase in living standards				

6.13 Policy

13-03 - How much, if at all, do you participate in policy making processes related to agriculture?

- Farmer do not participate and is not aware of policies
- Farmer has been informed about some policies
- Farmer has been consulted for some policies
- Farmer has been actively engaged in decision making processes
- Farmer is able to influence decision making process