INITIATIVE ON Agroecology

HOLPA Country Report: Tunisia

Véronique Alary (CIRAD, ICARDA), Waël Toukabri (INRGREF), Zahra Shiri (ICARDA), Layal Atassi (ICARDA), Abeyou Worqlul (ICARDA), Haithem Bahri (INRGREF), Meriem Barbouchi (INRGREF), Zied Idoudi (ICARDA), Bao Le Quang (ICARDA), Hatem Cheikh M'Hamed (INRAT), Maryline Darmaun (CIFOR) & Aymen Frija (ICARDA)

Date: 10th December, 2024

Contents

Table of contents

INTRODUCTION

Background to the Programme

The Agroecology Initiative (OneCGIAR) launched in 2022 aimed to transform Food, Land, and Water Systems (FLWS) to promote more significant equity, sustainability, and resilience of local food systems. The targeted transformation focused on diversified agroecosystems and diets, reducing land and water degradation, curbing biodiversity loss, and improving the equity and profitability of farmers and communities.

The Initiative used an agroecological approach to food production systems in several countries and contexts to leverage nature's resources while minimizing environmental impacts. The Initiative proposed mobilizing different tools and methods, such as strengthening connections between farmers and consumers, fostering knowledge co-creation, and building inclusive relationships among food system actors.

The Initiative has followed a holistic and adaptive process composed of five WPs, i.e.:

(WP1) Establishes a network of user-centred, multi-actor environments (living labs) to co-develop context-specific agroecological innovations, including technologies, policies, institutional arrangements, and services.

(WP2) Assesses the benefits and trade-offs of agroecological innovations, compared to conventional practices, across diverse contexts based on available evidence.

(WP3) Develop innovative business partnerships and sustainable financial strategies to pilot inclusive business models for scaling in targeted territorial food systems.

(WP4) Facilitates multi-stakeholder dialogues to identify policy instruments and approaches that enable cross-sectoral and cross-scale integration to mainstream agroecological principles in FLWS.

(WP5) Investigates behavioural barriers that hinder the adoption of agroecological practices, helping to address bottlenecks and accelerate equitable transitions.

So, the Initiative proposed to focus on scalable, user-centred agroecological innovations supported by scientific and local knowledge. The Initiative has worked with farmers, business partners, and policymakers to drive agroecological transformation across FLWS in seven Global South countries to achieve that.

Within the WP2, participatory monitoring and modelling research was conducted to generate usable evidence, drawing on scientific and local knowledge. This research focused on the conditions (Context assessment) and potential changes (with agroecology adherence and holistic performance assessment tool) in FLWS related to ecosystem health, biodiversity, resilience, social equity, profitability, water productivity, and nutritional diversity.

The evidence enabled comparisons of the benefits and trade-offs between 'business-as-usual' practices and agroecological alternatives co-designed and implemented across all Agroecological Living Labs (ALLs) (in WP1) along the delineated and expected impact pathways in each and across contexts (WP1). The pieces of evidence will guide stakeholders toward sustainable agroecological options. It will also inform on private sector out-scaling pathways (WP3) and vertical and horizontal policy integration (WP4). Key assumptions include stakeholder interest in using the framework and continued use beyond the Initiative's lifespan to facilitate the change of behaviour at a multi-scale level (WP5) (See Figure 1).

Figure 1 presents the WP2 pathway (Agroecology Initiative proposal submitted in Sept. 2021).

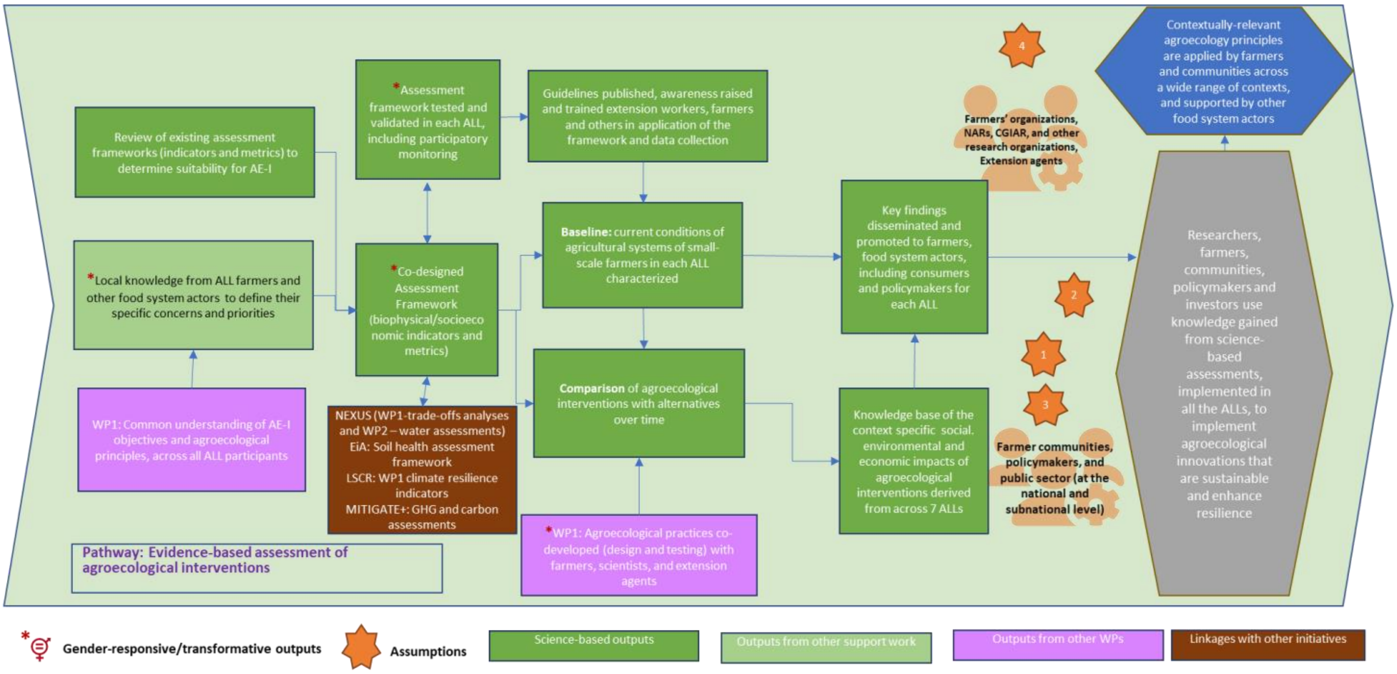


Figure 1. Presentation of the Work Package 2 and links with other Work packages in the Initiative Agroecology (Agroecology Initiative proposal submitted in Sept. 2021).

Context

a) Description of the agroecology living landscape(s) in Tunisia

The Tunisian Agroecological Living Landscape (ALL) is located in the semi-arid region covering the Kef-Siliana transect of northwestern Tunisia, a priority area identified by national partners (Figure 2). The main physical assets of farmers are land and livestock in the two governorates, kef and Siliana. In 2004, 98% and 70% of the family farms in the two governorates depended on only on-farm activities for their subsistence. Around three-quarters of the total agricultural holdings are small-scale family farming systems, using only 43% of the total agricultural area of the zone (Marzin et al., 2016; Alary et al., 2023). A total of 66.8% of the small family farms had an area of less than 5 ha, and 86.7% had an area of less than 10 ha in 2014. The kef-Siliana area features mixed cereal, tree, and small-ruminant farming systems. The Initiative focuses on three AE transition pathways: integrating crop-livestock systems, valorizing olive products, and promoting local products like honey and carob, often combined at the farm or landscape level.

Initially, four farmers' organizations (FOs) were selected to participate, representing varying levels of partnerships and agroecological (AE) practices linked to past and present research and development projects in the region. The entry by the farm organizations should allow to involve the maximum of small and medium farms often isolated and also build on some collective actions that need the support of local entities. Over time, two additional FOs joined, expanding the ALL to six FOs by 2023 (Figure 3). These organizations, with legal forms like SMSA (*Sociétés Mutuelles de Services Agricoles*) and GDA (*Groupements de développement Agricole*), were involved in various projects, including conservation agriculture, soil rehabilitation, and product market development that constituted stepping stones for building agroecological transitions. Moreover, their activities can benefit to FOs' adherents and all farmers who are interesting in the activities without exclusion. Key activities proposed at the starting point included crop diversification, recycling agricultural by-products, and enhancing animal feed production among others. The new FOs focused on olive oil certification and market integration to improve the valuation of olive products. The goal was to link these FOs to create a more integrated agroecological system that promotes sustainable farming practices and value chain development, focusing on three key product areas: animal products (milk and meat), olive tree integration into farming systems, and honey and carob production.

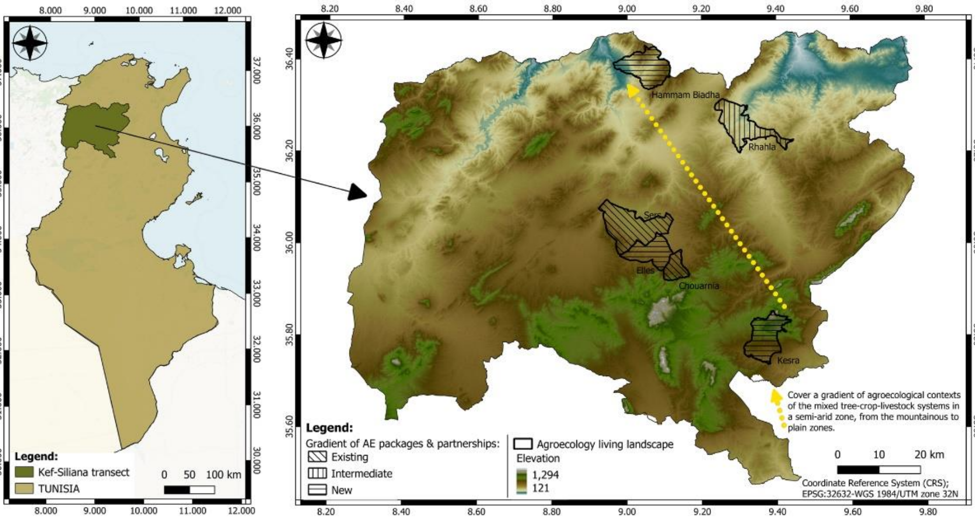


Figure 2. Localization of Kef-Siliana transect in the northwestern Tunisia (@ICARDA)

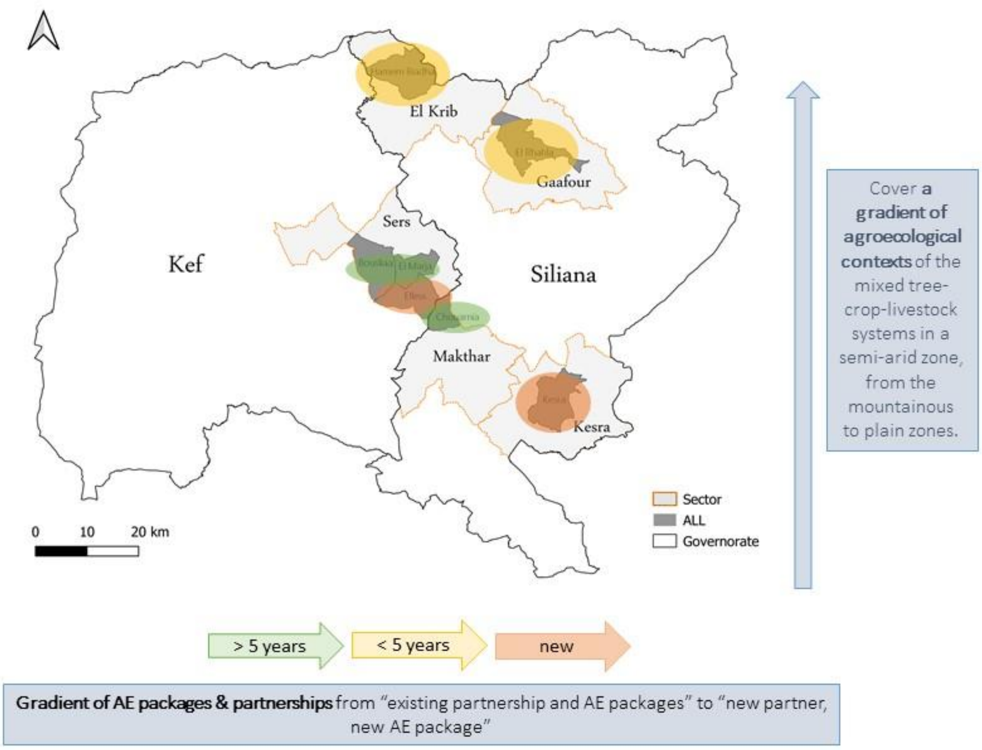


Figure 3. Localization of the Tunisian ALL composed of six farmers' organizations in 2023 (from Alary et al., 2023)

b) Status of agroecology in Tunisia

Table 1 summarizes the main highlights from the context assessment report in link with the 13 principles of the agroecological transformation, with a focus on the mixed crop-tree-livestock systems that are representative of the Tunisian ALL. It is noticeable that this part of the context assessment is not specific to the selected transect. It is more emblematic of the gaps and priorities that are characteristics of the semi-arid zones of Tunisia. Notably, it highlights strengths in recycling through crop-livestock systems, with input reduction focused on low-cost alternatives like biofertilizers. Soil health benefits from reduced tillage and crop residue use, though more farmer involvement is needed. Biodiversity and economic diversification are essential but under-recognized in terms of non-monetary benefits. Social values confront dietary challenges, while governance and participation need more substantial equity and farmer engagement in resource management.

Table 1. Summary of the status of agroecology from the context assessment report (extracted and summarized from Alary et al, 2023)

Principles	definition	Status	Gaps & Priorities
Recycling	The recycling principle aims to enhance the use of local renewable resources, such as nutrients and biomass, while respecting natural cycles.	In Tunisia, mixed crop-livestock systems recycle crop residues for animal feed and manure for soil fertility. National projects like PROSOL and CLCA have promoted technologies to improve residue valorization and grazing practices.	Gaps remain in entirely substituting imported feeds and understanding economic benefits from by-products. Innovations, including leguminous crops and composting, are being explored to mitigate challenges like climate change and rising cereal prices. Water recycling is less emphasized due to limited water resources in the region.
Input reduction	The input reduction principle aims to decrease reliance on chemical inputs, promote self-sufficiency, and reduce negative impacts on health and the environment.	In Tunisia, input use—particularly for barley, concentrates, and fertilizers—has intensified but is now challenged by rising global prices and drought.	Gaps: In this rainfed system, the main input reduction practices should not be found automatically in reducing input use but rather in substituting high-cost inputs with low-cost inputs. Priority innovations focus on composting, bio fertilizers, legume-cereal rotations, and tree plantations to enhance soil fertility and feed autonomy while reducing dependency on purchased inputs.
Soil health	The soil health principle enhances organic matter management and soil biological activity to support vegetation growth.	In Tunisia, studies along the Kef-Siliana transect have assessed soil health through various physical, chemical, and biological indicators, revealing that vegetation cover and reduced tillage can significantly improve soil properties. Research indicates that no-tillage enriches soil organic matter and enhances structural stability, with specific crops like Faba bean benefiting from crop residue management.	Despite progress, gaps remain in addressing soil health indicators that reflect farmers' knowledge and experiences. Priority innovations include integrating crop-livestock systems and understanding farmers' perceptions of soil health to improve agronomic practices and facilitate innovation transfer. Exploring these options with farmers can enhance soil resilience and productivity.
Animal health	The animal health principle encompasses health and welfare, focusing on disease prevention and the wellbeing of animals.	In Tunisia, animal health is managed by several organizations, including the Direction de la Santé Animale and the National Animal Health Surveillance Center, which oversee disease control and veterinary practices.	Farmers often lack knowledge about vaccination schedules and disease prevention, and relationships with veterinarians remain outdated despite improvements. To transition to agroecological practices, innovations are being prioritized, such as enhanced vaccination schemes, environmentally friendly treatments, and improved herd-health strategies. Raising awareness and conducting research are essential for facilitating this shift toward more sustainable animal health practices.

Biodiversity	The biodiversity principle aims to enhance the diversity of plant and animal species to sustain agroecosystems and their functional contributions.	In Tunisia, mixed crop-tree-livestock systems incorporate various species, including wheat, barley, sheep, and olive trees, and biodiversity in forests and pasturelands.	While such diversity exists, gaps include the need for better recognition and valorization of biodiversity, particularly in olive-growing regions facing challenges like low yields and water scarcity. Priority innovations focus on integrating multi-species systems, improving soil biodiversity, and utilizing local knowledge of traditional plants. Additionally, conservation efforts in the olive sector involve identifying local genetic resources and exploring labelling initiatives that reflect traditional practices and the environment.
Economic diversification	The economic diversification principle aims to manage social, economic, and environmental risks through various income sources.	In Tunisia, small mixed-farming systems, which operate on less than 10 hectares, comprise 75–85% of agricultural land and produce over 80% of agricultural outputs. The diversification is crucial for the resilience and adaptation of these farms in semi-arid environments characterized by high rainfall variability.	However, gaps exist in recognizing the indirect non-monetary economic value of co- and by-products from integrated farming systems, as evaluations often overlook the cumulative benefits over time. Priority innovations focus on enhancing economic activities both on and off the farm to strengthen family farms' adaptive capacity and viability in the long term.
Co-creation of knowledge	The co-creation of knowledge principle aims to enhance traditional and scientific knowledge through peer exchanges, facilitating access to agroecological information.	In Tunisia, this principle has evolved from promoting farmer-to-farmer interactions in the 2000s to incorporating local knowledge for co-developing tailored innovations in the 2010s, using participatory approaches and platforms. Key projects like PACTE and CLCA have established participatory methods and knowledge hubs to support innovation and knowledge transfer.	However, challenges remain due to insufficient financing and motivation among governmental staff and a lack of private-sector engagement. The Initiative seeks to leverage these interactions and knowledge-sharing practices to monitor and promote agroecological transformations while integrating the private sector in developing viable business models.
Social values & diets	The social values and diets principle fosters agroecological transitions that honour cultural identities and culinary traditions while promoting healthy, diverse diets.	In Tunisia, the Mediterranean diet is celebrated, but rising rates of obesity and chronic diseases highlight issues like overnutrition and undernutrition, particularly among women and children.	Significant micronutrient deficiencies exist, and the absence of food-based dietary guidelines exacerbates nutritional challenges. While women's empowerment positively impacts dietary diversity, evidence of this effect is inconsistent. Priority is given to improve diet diversity through local foods, increase nutritional awareness, and promote traditional products like carob and honey to enhance social equity and demand for smallholder-produced goods.
Fairness	The fairness principle focuses on improving living conditions and equity in economic exchanges, employment, and intellectual property rights.	In Tunisia, issues of inequity are primarily related to unequal access to assets and decision-making, particularly between men and women, as well as limited access to information and markets.	Research gaps exist regarding market access for agroecological versus conventional products, with a lack of recognition for local products that limits value distribution. Proposed innovations include examining farm-gate prices for agroecological products, assessing value distribution along supply chains, improving access to market information, and addressing wage disparities among agricultural workers by gender and age.
Connectivity	The connectivity principle focuses on fostering exchange and trust between producers and consumers through short supply chains and organizations	In Tunisia, local farm organizations like SMSA and GDA are beginning to promote their products, such as honey and dairy, which are often supported by projects like CLCA.	Gaps remain, particularly in the lack of networks and modern digital tools to capture demand beyond local areas. Priority given to assess connectivity along value chains and among various stakeholders, emphasizing the roles of women and youth.

			Factors influencing connectivity, such as infrastructure and interactions, will also be considered.
Land and natural resource governance	The land and natural resource governance principle emphasizes the importance of institutional arrangements for sustainable management of resources like soil, water, and genetic materials, recognizing the roles of all farmers, especially smallholders.	In Tunisia, most agricultural land is privately owned, facing challenges such as soil degradation from erosion, prompting initiatives like PROSOL to implement conservation techniques. While state-managed forests are accessible for certain activities, they often lack farmer involvement in management decisions.	Gaps remain in financing and broader farmer participation, limiting the impact of conservation efforts. Proposed innovations include involving farmers in sustainable practices, such as cereal-legume associations and improved residue management for soil fertility enhancement.
Participation	The Participation Principle emphasizes the involvement and inclusiveness of all farmers in decision-making processes within food systems, recognizing the roles of various farmer types, especially small-family farmers	In Tunisia, the main organizational structures, like GDA and SMSA, aim to support stakeholder platforms with both public and private sectors.	However, these organizations often lack the necessary knowledge and networks to drive their own development, relying heavily on external support. Priority innovations will focus on enhancing participation in agroecology initiatives at both farm and organizational levels, ensuring representation by sex and age in decision-making. Overall, fostering effective participation is crucial for implementing agroecological principles.

C) Vision to Action Plan: identifying pathways to boost the agroecological transition

In the Tunisian Agroecological Living Lab (ALL), the research team initiated efforts by gathering stakeholder feedback (via a Visioning exercise in WP1) to pinpoint essential elements across social, economic, institutional, and environmental domains, aligned with the transition pathways framework (landscape, regime, niche). This assessment was instrumental in identifying strategies to drive a sustainable agroecological transition while addressing three central challenges:

1) Promoting economic and agro-diversification to enhance resilience against climate change and market price fluctuations, focusing on livestock, honey, carob, and cereal-legume associations.
2) Reducing input purchases through recycling to improve autonomy (self-sufficiency) and resilience.
3) Implementing diversification and recycling strategies to combat soil degradation, utilizing compost, biochar, and crop/tree residue pellets while seeking synergies among crops, trees, and livestock through farm management and market opportunities.

The main findings informed the Theory of Change (ToC) and the Work Plan developed in Tunisia (2023-2024), guiding the development of impact pathways for agroecological transition. Key pathways include:

1. Animal products' value chain from the seed multiplication and forage production/feedstock (with crop/tree residues) to the dairy or meat products marketing; this pathway includes the improvement and diversification of the crop system, the crop-livestock synergy and input reduction and the valorization of local and national products; and mixed forage production around leguminous for soil fertility & health improvement

2. Certified olive tree value chain in integration with all the other activities (livestock-cereal) enhancing the valorization of local products at the national and international markets and the biodiversity at the landscape level;

3. The honey/carob value chains to contribute to biodiversity, economic diversification and local and healthy products for consumers.

Figure 4 illustrates these pathways and highlights interactions within mixed crop-tree-livestock systems in Tunisia's semi-arid regions. The entry points for initiating these transitions include strengthening farmer organizations, forming public-private partnerships for customized forage seed mixtures, analyzing the olive value chain, and favouring economic diversification using traditional know-how (Honey) or endemic varieties (carob). The overall strategy aims to achieve significant impacts, such as improved food diversity, enhanced soil health, and expanded market access, aligning with the sustainable development goals of promoting human wellbeing, biodiversity, and sustainable ecosystems.

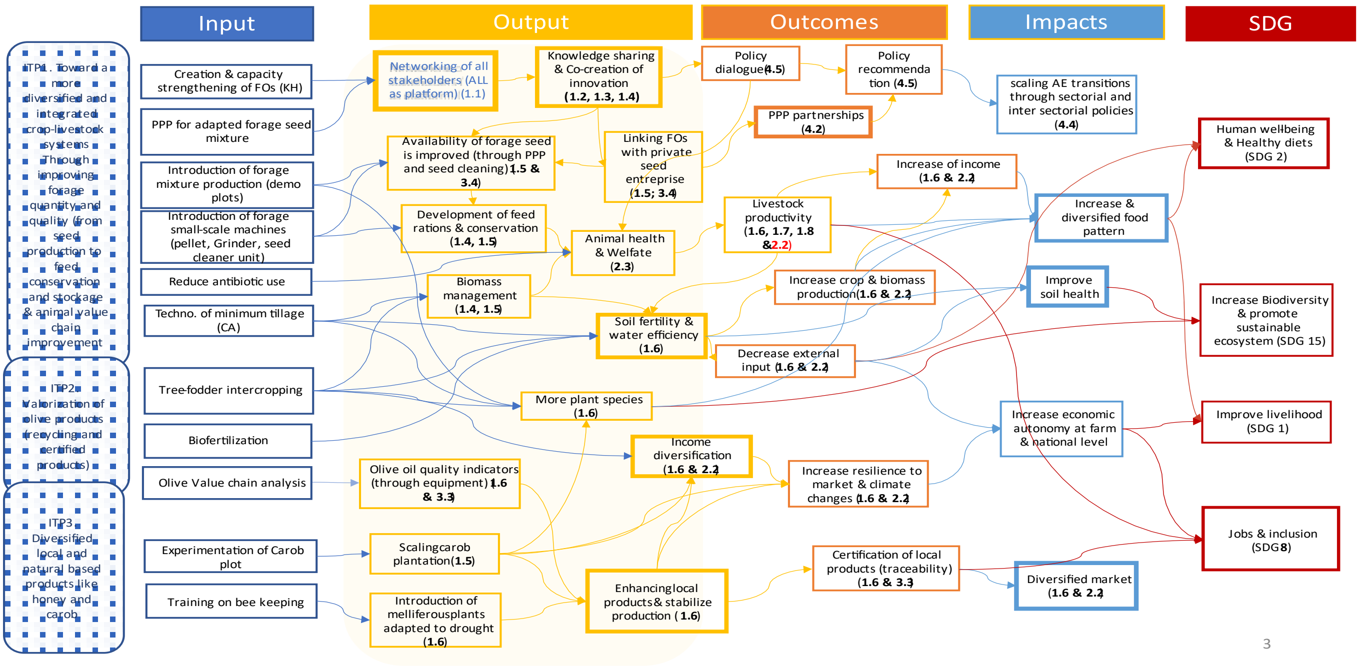


Figure 4. Theory of change elaborated in the kef-Siliana transect (Tunisian ALL)

From the Vision-To-Action developed in Tunisia, three key entry points were identified to boost the agroecological transition:

1. Increase soil fertility for crop and soil health
2. Increase biodiversity & promote sustainable ecosystems
3. Economic diversification & autonomy.

These three key entry points have constituted the main dimensions used to assess the main achievements along the defined transitions pathways with stakeholders (in part 4. Use of the HOLPA results).

HOLPA: Measurement and Methodology

The Holistic Localized Agroecology Performance Assessment (HOLPA) tool is designed to evaluate the comprehensive performance of agricultural systems in their transition toward agroecology. It captures various agronomic, environmental, social, and economic aspects, providing a multi-faceted view of sustainability.

Key purposes of HOLPA include (see HOLPA guideline, Global WP2 team, Jones et al., 2024:

Holistic Assessment: Evaluates various performance outcomes of fields, farms, and landscapes to promote sustainable practices.

Agroecological Transition: Assesses different stages of transition toward agroecological practices, highlighting effective strategies.

Contextual Factors: Identifies socio-ecological elements influencing sustainable farming and food systems.

Guiding Research: Addresses research questions related to the performance metrics of agricultural systems in diverse contexts.

Local Relevance: Balances global standards with localized metrics to ensure meaningful assessments for local stakeholders.

Indicator Integration: Develops comprehensive indicators that account for interdependencies among social, ecological, and economic outcomes.

Practical Framework: Provides a manageable set of indicators to facilitate practical assessments while maintaining depth.

Co-Creation Process: Engages local stakeholders in defining metrics, ensuring the assessment reflects local realities and priorities.

Evidence-Based Transition: Aims to generate evidence on effective agroecological practices and barriers to inform policy and decision-making.

Sustainability Synergies: Focuses on identifying synergies and trade-offs among different sustainability outcomes to enhance holistic performance.

Overall, HOLPA serves as a critical tool in guiding the transition towards more sustainable and equitable food systems by integrating multiple dimensions of agroecological performance.

The development of the HOLPA tool involved a detailed process of extensive reviews, iterative consultations, and participatory research. A variety of existing frameworks and tools were assessed, including the Agroecology Criteria Tool, FAO's TAPE, and various indicator sets. This comprehensive review selected a core set of 18 indicator themes across four key domains: agricultural, environmental, social, and economic. These themes provide a structured approach to evaluate the sustainability performance of farm households, landscapes, and food systems at different stages of agroecological transition. The initial long list of indicators was organized into holistic performance themes for effective assessment (Jones et al, 2024).

At the end, the HOLPA Tool is composed of three main modules: Module 1) Context, Module 2) Agroecology, and Module 3) Performance. The modules 2 and 3 are based on a household and field questionnaire allowing to obtain data to compile agroecological adherence scores and key performance indicators. In the present report, this frame has supported the analysis of the link between the adherence to agroecological principles and the performances for the three key entry points.

Research questions

The present report proposes to jointly analyze the scores of adherence to the agroecological principles in link with the context indicators and KPI performance indicators to discuss (i) the variability between the six communities along the kef-Siliana transect according to the socioeconomic, physical and institutional context; and (ii) and the coherence or gaps between the perception and performances in regards to the three key entry point identified along the impact transition pathways toward agroecological transformation. Table 2 presents how the transitions pathways have been assessed in terms of scale and key priority indicators. Faced with some gaps between adherence scores and performances about agroecology, we propose introducing complementarity analysis that can support a more in-depth approach to the agroecological transformation by referring notably to soil health and biodiversity.

Table 2. Path from impact pathways (V2A) in the Tunisian ALL to the delineation of the strategic priorities and agroecological principles

Transition pathways in the tunisian ALL	Strategic priorities	Level of action along the AE transformation	AE principles
Promoting economic and agro-diversification to enhance resilience against climate change and market price fluctuations, focusing on livestock, honey, carob, and cereal-legume associations.	Strengthen Resilience	Ecosystem	Soil Health, Animal Health, Biodiversity, Synergy, Economic Diversification
Reducing input purchases through recycling to improve autonomy (self-sufficiency) and resilience.	Improve Resource Efficiency	Farm management	Recycling Input reduction
Implementing diversification and recycling strategies through individual and collective management and market opportunities	Enhance and Secure Social Environment	Food system	Knowledge, Social Values, Fairness, Connectivity, Governance, Participation

METHODOLOGY

Localization of the HOLPA tool

The goal of the indicator localization process (ILP) is to co-develop a set of indicators with stakeholders in each ALL that are relevant for and customized to their farming systems in link with selected innovations and respond to the vision and interventions.

In Tunisia, this process has been based on a participatory workshop co-conceived in the continuity of the co-design of innovations with the stakeholders involved in the Tunisian ALL (WP1) (see annex 1).

The participatory workshop involved 24 farmers from the 6 farm organizations (around 4-5 participants who represented the six FOs) composing the Tunisian ALL. At least one stakeholder of research and development partners from the different domains (agronomy, soil and water specialists, animal sector, research & development, socio-economist) was present in each working group per site. In total, 30 stakeholders from local, national, and international levels attended the workshop.

The workshop was organized over one day and a half. The first day was dedicated to the co-design of the innovations and was organized in 3 sessions per site:

1. Discuss the significant challenges in each agroecological site
2. Which sets of innovations can answer the main challenges (packaging of innovations)
3. What are the main issues raised by these innovations?
4. Which solutions (co-design process) are proposed?

This first day allowed us to identify the two prior innovations in the six sites representing the Tunisian ALL (recap in Annex 1).

The main challenges and innovations constituted primary materials to co-conceive the local indicators that respond both to the main challenges and innovations and to the vision of each community.

Figure 5 represents the overall frame for the codesign of local indicators. From the main challenges, innovations, and visions in each community, it was proposed that a list of descriptors be developed. The descriptors are the expected changes in the main farming systems representing each site and this for each domain (social, economic, agronomic, and environment). For the descriptors that are prioritized as the most important by the stakeholder, it was proposed that some indicators be conceived. In the approach, indicators make it possible to express simply the information that reflects an impact. It is derived from the translation of descriptors into quantifiable or qualitatively appreciable indicators.

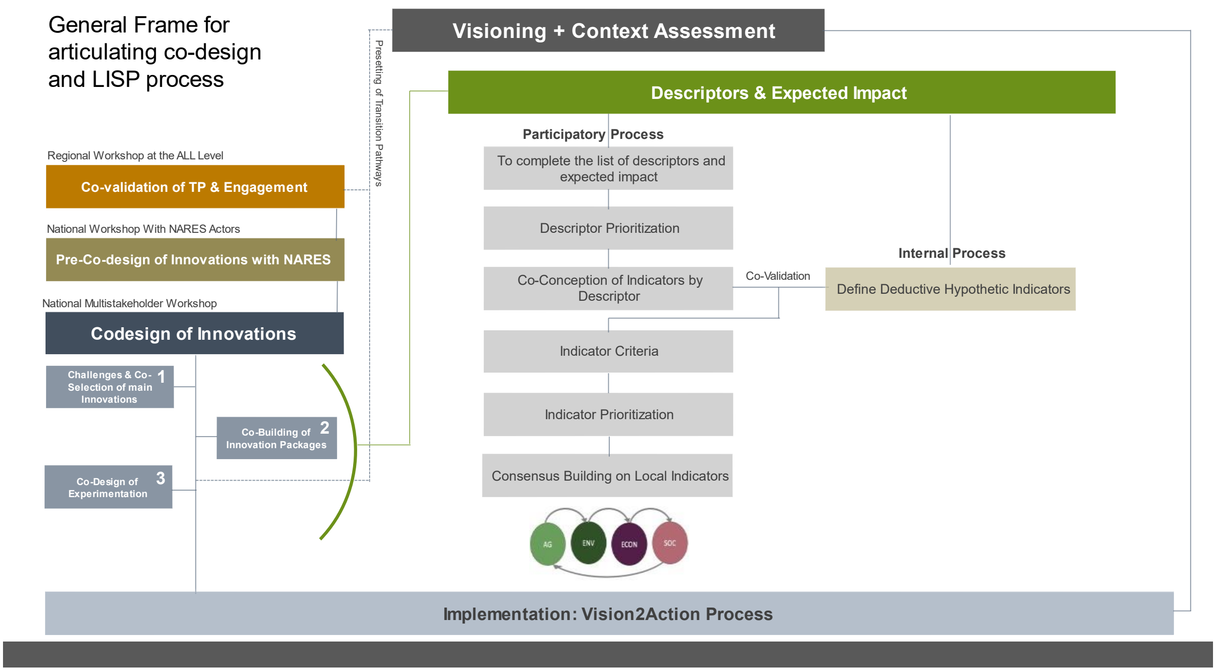


Figure 5. Overall frame for the codesign of local indicators (Presentation co-design workshop)

Table 3 presents a synthesis of the list of local indicators for the Tunisian ALL. We can note that some local indicators are more or less transversal, such as soil organic matter. In contrast, others are very site-specific, such as honey production and its quality in Kesra. We underline the indicators in bold when they answer best the evidence needed by farmers (as recap by the synthesis of the co-design of innovation, see annex 3).

In total, around 30 indicators were proposed by the stakeholders with 8 in agriculture, 6 in economic, 9 in social and 7 related to the environmental domain. The 8 indicators proposed in the agricultural domain are intrinsically linked to the discussed desired innovation in each community. Except for specific products inherent to the farming system in the Tunisian all (like the honey diversity or the marketing valorization of olive oil), all the 5 other economic indicators are already adressed in the global indicators proposed in the HOLPA approach. Over the 9 indicators related to the social domain, two indicators are specific to the Tunisian ALL, i.e., the specific time for hive maintenance and touristic attractivity of the zone. In the environmental domain, we note only one specific indicator related to the use of olive varieties to assess the biodiversity. We can also note that contrary to soil quality assessment, water quality is mainly a qualitative appreciation.

Table 3. List of prioritized local indicators for the Tunisian ALL (in green: at the plot/herd level; 2. In bleu at the household level and in yellow at the landscape level)

	Performance indicators at the plot/herd level		Household -level performance indicators (HOLPA household)		Soil Biodiversity Performance Indicators (HOLPA fields)	
Domain	Chouarnia	El Rhahla	Sers	Hammam Biadha	Elles	Kesra
Agriculture	Animal productivity Forage productivity(/ha)	Forage productivity (/ha)	Amount of milk produced Quantity of forage seeds produced	Yield of olive trees	Plant growth and leaf cover of olive trees Oil quality analysis (degree of acidity) Olive yield (kg.ha); Oil yield (l/100kg of olives)	Quantity of honey produced
Economic		**Production Cost** **Diversity of income** Livestock size	**Production Cost** **Diversité des revenus agricoles**	Valorisation and transformation of olive **Standard of living (well-being)**		**Honey Diversity**
Social	**Adhesion SMSA/GDA** **Dietary change**	**Adhesion SMSA/GDA** The number of women in agriculture	**Adhesion SMSA/GDA/ Inclusion of women** The number of women in agriculture	Employment rate Youth emigration rate	Number of working days available and period (/ha) Number of visitors to the area (for the festival and eco-tourism)	Time spent on hive maintenance
Environment	Soil health and quality (analysis) Soil Organic matter Water Use Efficiency	Soil health and quality (analysis) Rate of use of drugs (antibiotics and parasitoids); Percentage of vaccinations against infectious diseases	Soil health and quality (analysis) Soil health and quality (analysis)	Soil health and quality (analysis) Soil erosion rates Water quality	Soil health and quality (analysis) Local olive varieties (% in nurseries and % in new plantings)	Amount of pesticides applied

Administration of the HOLPA tool

The HOLPA survey implementation in the Tunisian ALL was organized in two phases (see Figure 6): 1) HOLPA household survey over a sample of 167 households selected in the 6 FOs composing the Tunisian ALL; 2) HOLPA field survey based on subsample of farms selected in the HOLPA household sample.

The implementation of the (HOLPA) was divided into two distinct phases (two training sessions and two distinct phases): a household survey and a field survey.

The first phase (October-November 2023) was started immediately after training 10 enumerators selected from the Initiative's partner institutes in Tunisia. The household survey collected detailed information on social, economic, environmental, agricultural, and socioeconomic factors in the six FOs composing the Tunisian ALL. The sample was built on two criteria: at least 25% of women in each community (FO) and households involved in crop and/or livestock activities.

The second phase (February – Mai 2024) takes place with a second training of 9 enumerators selected from the Initiative's partner institutes in Tunisia. The field survey focused on biodiversity, soil health, and crop/pasture health measurement with a group of farmers selected from the HOLPA household sample (Figure 6) from the six FOs composing the Tunisian ALL.

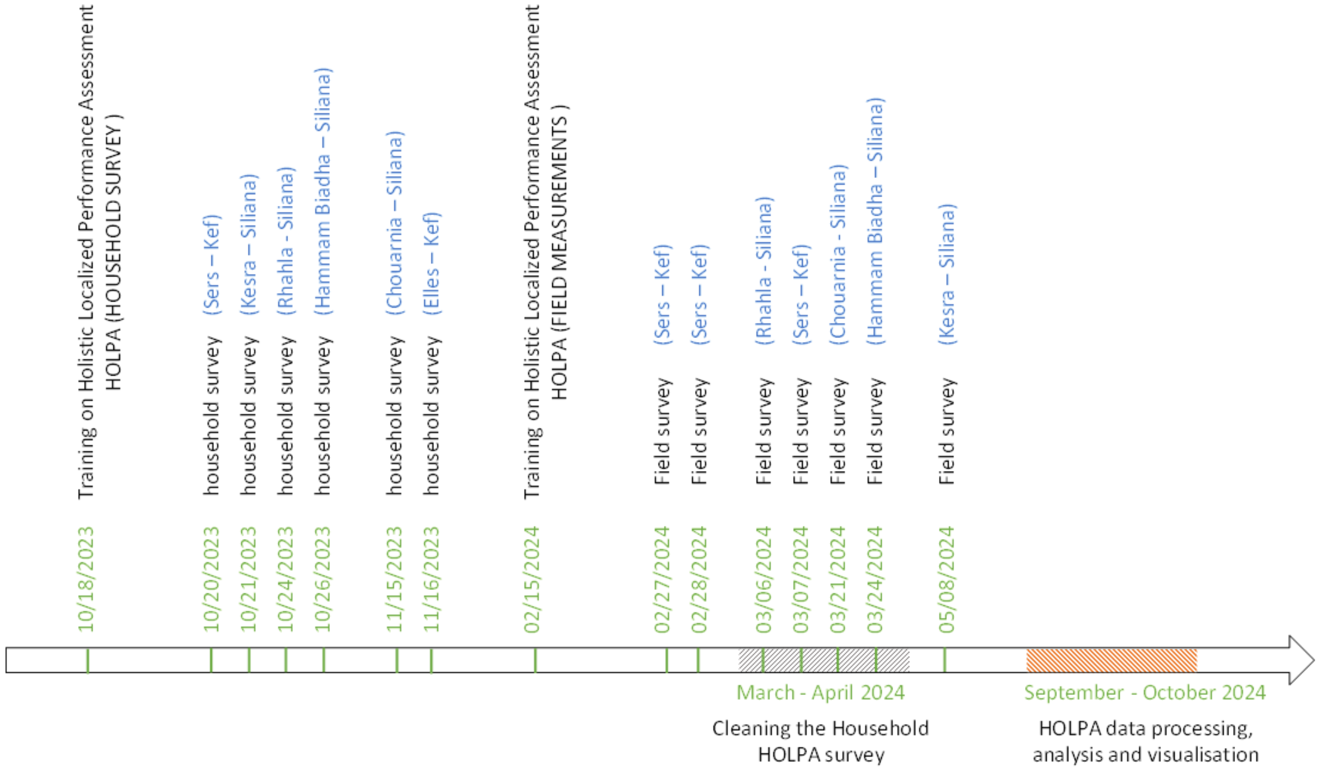


Figure 6. Chronogram of the HOLPA survey implementation in the Tunisian ALL (from 2023 to 2024)

Along with the implementation of HOLPA, we use two tools to facilitate the implementation process, as illustrated in Figure 7.

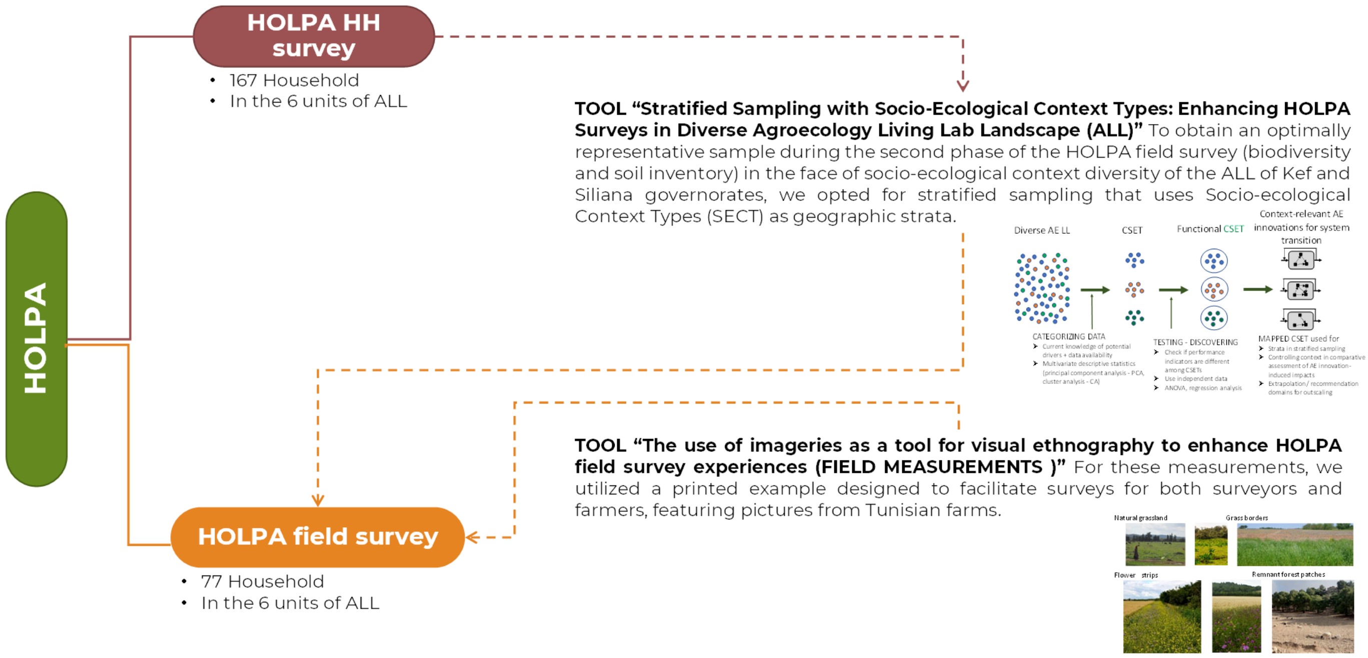


Figure 7. The operational framework of the HOLPA implementation in the Tunisian ALL

Tool 1. Stratified Sampling with Socio-Ecological Context Types: Enhancing HOLPA Surveys in Diverse Agroecology Living Lab Landscape (ALL)

To obtain an optimally representative sample during the second phase of the HOLPA field survey (biodiversity and soil inventory) in the face of socio-ecological context diversity of the ALL of Kef and Siliana governorates, we opted for stratified sampling that uses Socio-ecological Context Types (SECT) as geographic strata (Shiri and Le., 2024a).

The main challenges were:

1) How do we present the diverse ALL with a relatively small sample size?
2) How to control the geographic variations of socio-ecological context in later comparative assessments of AE-related innovations using the surveyed HOLPA data once collected?
3) How to out-scale place-specific findings to large areas?

Our methodological strategy was to use Socio-Ecological context Types (SECTs) to address the HOLPA survey's three challenges and therefore research/assessment. Socio-Ecological context Types (SECTs) is the geographic clusters of overall similarity in 25 variables of socio-ecological contexts (including climate, soil quality constraints, land uses, livestock densities, population density, access to market, and overall economic status) which result from a rigorous spatial analysis study over the involved governorates of the ALL and whole Tunisia. The SECTs were empirically proved to be responsive to overall land degradation and are hypothesized to be sensitive to AE innovation adoptions by farmers/land users. Our previous study (within WP2/AE INT) already mapped and characterized SECTs in ALL of the Kef-Siliana transect.

To formulate an optimal sampling frame for HOLPA survey that presents the diverse ALL with a relatively small sample size (i.e. 167 households and their farming plots), we have used SECTs as geographic strata in the stratified sampling method of HOLPA survey (Figure 8).

The stratified sampling using SECTs as strata helped control the geographic variations of socio-ecological context in later comparative assessments of AE-related innovations. It also allowed us to distinguish farming system changes induced by AE innovation practices from system changes driven by contextual factors, making comparative assessments of AE-induced impacts plausible.

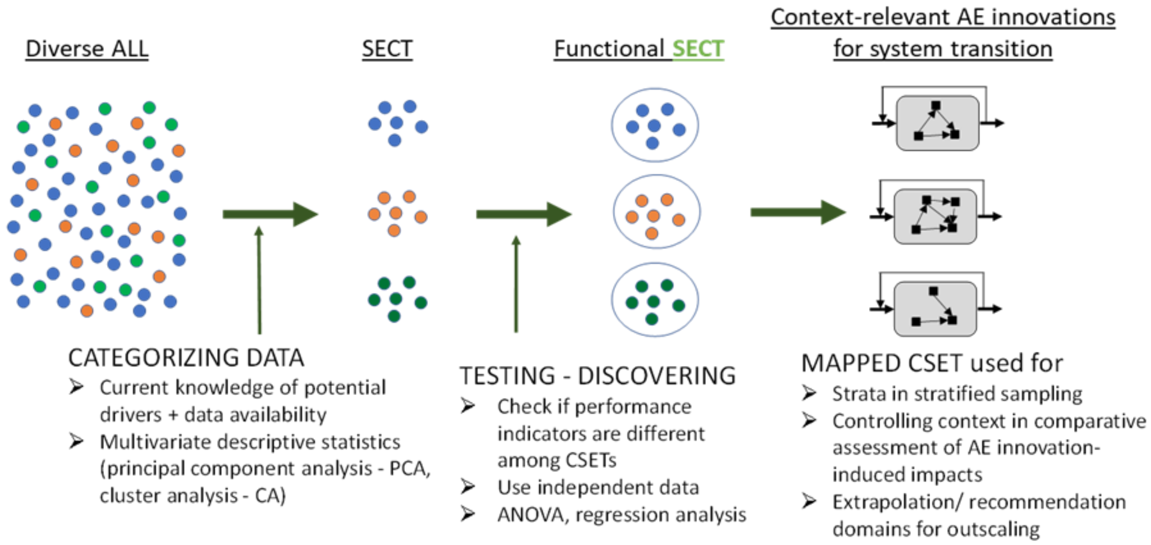


Figure 8. Methodological flow chart of Context Socio-ecological Type (SECT) approach

Finally, SECTs have been used as geographic extrapolation/recommendation domains to support the outscaling of place-specific findings. The enumerators selected in the previous phase were trained for the second phase. The field survey was conducted in February-March 2024 in 77 household farms.

Tool 2. The use of imageries as a tool for visual ethnography to enhance HOLPA field survey experiences (FIELD MEASUREMENTS)

The territory of visual ethnography is considered a key and accessible research methodology in the field of education, surveys and research. The origins and principles of visual ethnography are presented, as well as some of the methods of data collection.

During the farm survey, farmers only provide information about fruit trees in response to questions about the number of trees and species planted on their property, ignoring the significance of forest trees and agroecological infrastructure that play a critical role in the semi-natural environments within their plots. To enhance this investigation experience and obtain more comprehensive and representative data, the "visual ethnography" methodology can be suggested. We used two printed examples (using photos from Tunisian farms or simplified figures), (Appendix 1 and Appendix 2) designed to facilitate the recognition of each type of vegetation in the semi-natural and natural vegetation sections of the household survey and the soil structure, crop/pasture natural enemy abundance, and semi-natural vegetation sections of the field survey (using images from Tunisian farms or simplified schema).

HOLPA Data Analysis

The data collected on KoboToolbox has been transferred into an Excel file for data cleaning. The data cleaning was done in two phases by the ICARDA research team involved in the HOLPA process:

First, harmonization for the names for the localities, the units of measures for quantitative data, or the language when some answers were given in Arabic,

In response to the WP2 global team, a second data cleaning was conducted regarding some parameters linked to land ownership between men and women within the farm household.

The data analysis started with a research team reflection on the vision-to-action design and the relevant indicators that reflect the main expected changes by farmers from the six communities. This reflection used both the results from the visioning exercice in the communities where the main farmers' expectations in terms of social, economic, technical and environmental expectations (or desired futures) are identified and the three impact pathways structuring the agroecological transition in the region (Figure 4). This crossed analysis led to identify key indicators along the 3 impact pathways (Appendix 3) that structured the use of HOLPA along the transition pathways (part 4). After pre-identifying the indicators, each researcher on the team selected a domain (environmental, agronomic, economic, or social) that fit their priority to start the analysis.

RESULTS OF THE HOLPA SURVEY

Module 1: Context

Table 4 gives a rapid overview of the family composition and the household head's characteristics. On average, the family counts around 4.6 members, with a certain equity between males and females of different classes of age. The large gap between male and female concerns the young generation, with a large majority of males in the communities of Kesra, Rahla and Sers oriented to cereal-livestock systems and, at opposite, a large majority of females in the two communities of Hamman Badhia and elles oriented to olive activity.

Most family heads are between 35 and 54 years old, with a low number of young less than 35 years old. Chouarnia and Kesra have a significant difference, with a majority of old family heads in Chouarnia (around 50%) compared to around 19% in Kesra. The age of the family head is largely correlated to the level of education, with a majority of highly educated family heads on Kesra where the young are in the majority.

Table 4. Description of the composition of the family and the characteristics of the household head (168 households)

variable	Modalities	Chouarnia	Elles	Hammam Biadha	Kesra	Rhahla	Sers	Total
Sample		28	7	22	31	22	20	130
Age of the HH head (in years old) (%)	< 35	7%	0%	14%	23%	14%	0%	12%
	35-54	43%	86%	45%	58%	55%	60%	54%
	>= 55	50%	14%	41%	19%	32%	40%	35%
Marital status of the HH head (%)	Married	89%	86%	91%	84%	82%	85%	86%
	Single	11%	14%	9%	16%	18%	10%	13%
	Widower	0%	0%	0%	0%	0%	5%	1%
What is the highest level of school the HH head attended? (%)	None	11%	29%	27%	0%	14%	15%	13%
	Primary	54%	43%	27%	29%	36%	45%	38%
	Secondary	25%	14%	41%	52%	45%	30%	38%
	Higher	11%	14%	5%	19%	5%	10%	11%
Active persons in the household (av.)*	Male children	14%	12%	10%	17%	**13%**	**18%**	15%
	Male adults	31%	35%	31%	35%	34%	34%	33%
	Male adults not of working age	4%	0%	10%	4%	12%	5%	6%
	Female children	15%	**23%**	**15%**	13%	7%	10%	13%
	Female adults	28%	30%	27%	27%	26%	28%	28%
	Female adults not of working age	8%	0%	6%	6%	8%	4%	6%

Legend: *Active persons in the household (av.) : children (<18 years old), Adults in workring age ((≥18 and ≤65 years old), adults not of working age (>65 years old)

The farms along the Kef-Siliana transect are characteristics of the mixed crop-tree_livestock activities (Table 5). The less diversified systems are observed in the community of Elles, which is widely oriented to annual crops and olive trees. Monoculture with perennial crops (intercropping system) is the most developed in Hamman Badhia and Elles, with olive trees) or in Kersa, which has fig and olive trees. The farms in the communities of Chouarnia, Rahla and Sers are less diversified, with a more traditional system oriented to conventional cereal crops (barley and wheat) and ruminants that cover a large majority of semi-arid zone of the country.

Table 5. land and livestock asset per farm (in average) (167 farm households)

Land & livestock assets	Chouarnia	Elles	Hammam Biadha	Kesra*	Rhahla	Sers	Overall total
Land owned (ha)	12.6	5.2	5.5	8.6	9.1	5.0	10.2
Olive (ha)	0.9	0.3	1.5	3.1	0.7	0.2	1.3
Fig (ha)	0.1	0.0	0.0	1.3	0.0	0.0	0.3
Barley (ha)	3.4	1.9	0.9	0.6	3.6	1.2	1.9
Wheat (ha)	5.7	0.4	0.2	0.9	2.5	0.4	2.1
Total cultivated_area (ha)	12.3	4.2	4.2	7.8	10.8	3.6	8.0
Cattle (number heads)	4.8	2.6	1.5	1.1	1.0	1.9	2.1
Sheep (number heads)	31.6	27.1	11.7	24.8	44.0	20.4	26.6
Goats (number heads)	1.6	0.0	0.1	2.6	1.0	1.5	1.3

- We remove one farm with 350 ha of land in Kesra

Figure 9 illustrates the diversification of farm and non-farm activities along the kef-Siliana transect. We can easily see that the degree of diversification out of agriculture is low in this region.

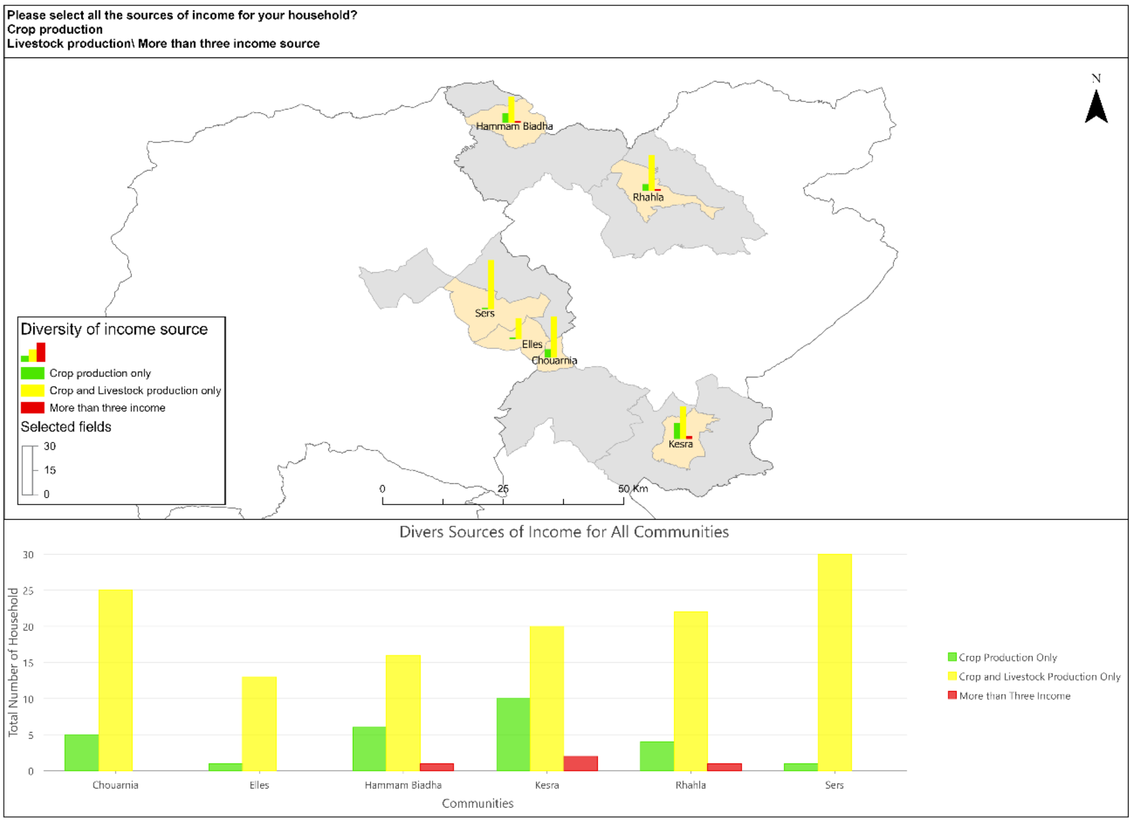


Figure 9. Diversity of economic activity

One of the main challenging factor identified during the context assessment phase was related to soil health. Figure 10 shows variables relating to farmers' perception of soil risks along the kef-siliana transect. We can see that the high risk of soil erosion is mainly localized in the Hammam Biadha and Rahla communities in the Northern part of the transect. Soil fertility degradation highly affects around 8% of the farmers, with a higher percentage in Chouarnia, Hammam Biadha and Rahla where the mono-crop system is dominant. Additionally, 21% of the farmers described their farmland as steep, and 33% described it as moderately steep. Notably, Sars has the lowest overall percentage of steep and moderately steep land combined.

Soil Main Risk

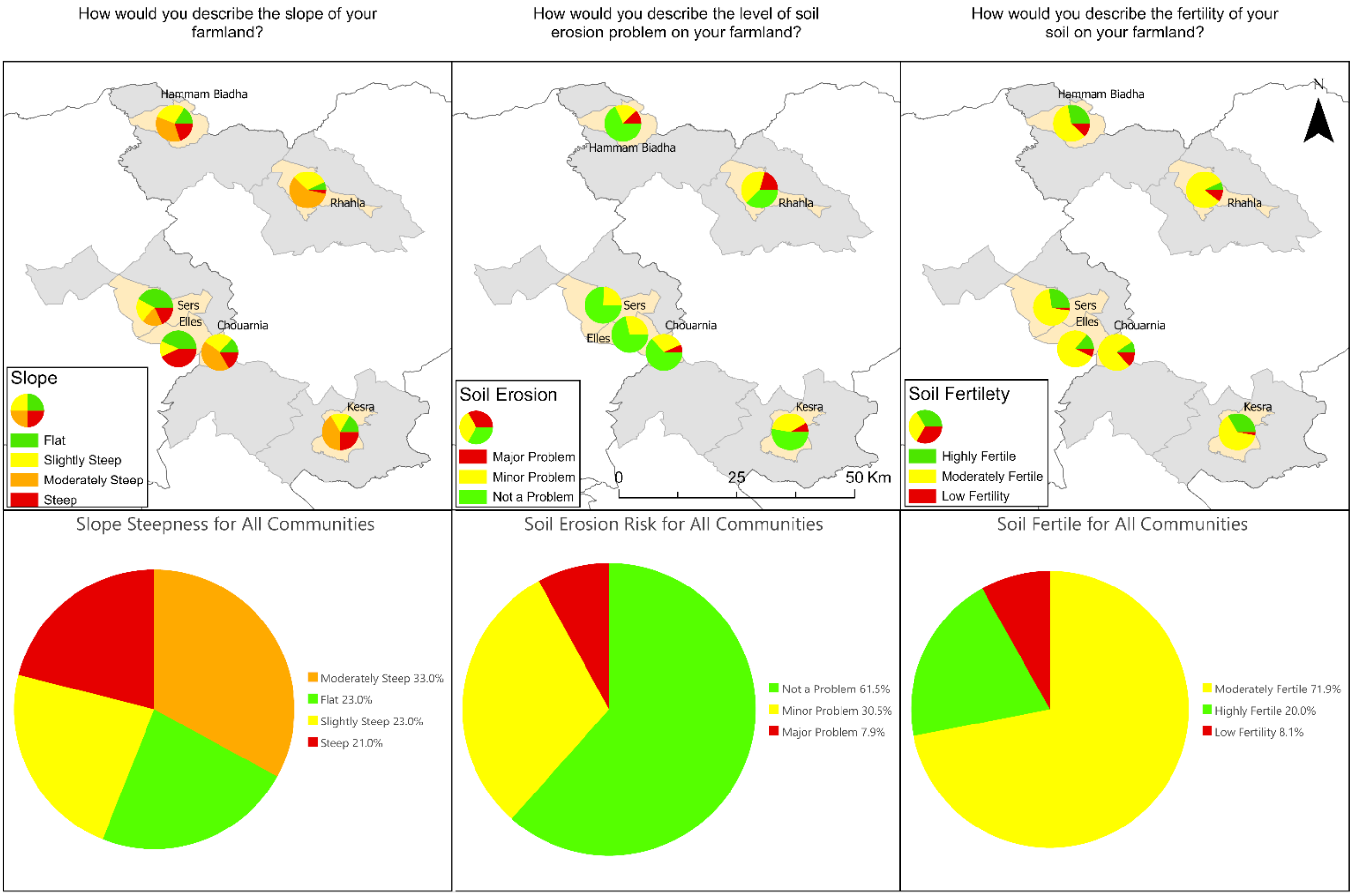


Figure 10. Environmental risks perceived by farmers along the Kef-Siliana Transect (168 farmers)

Figure 11 gives an overall view of physical access to public and private services. Globally the community of Elles is the best served by all the services due to its proximity to the main road, followed by Kesra. The less-served community is Hammam Biadha due to its remoteness from the main road.

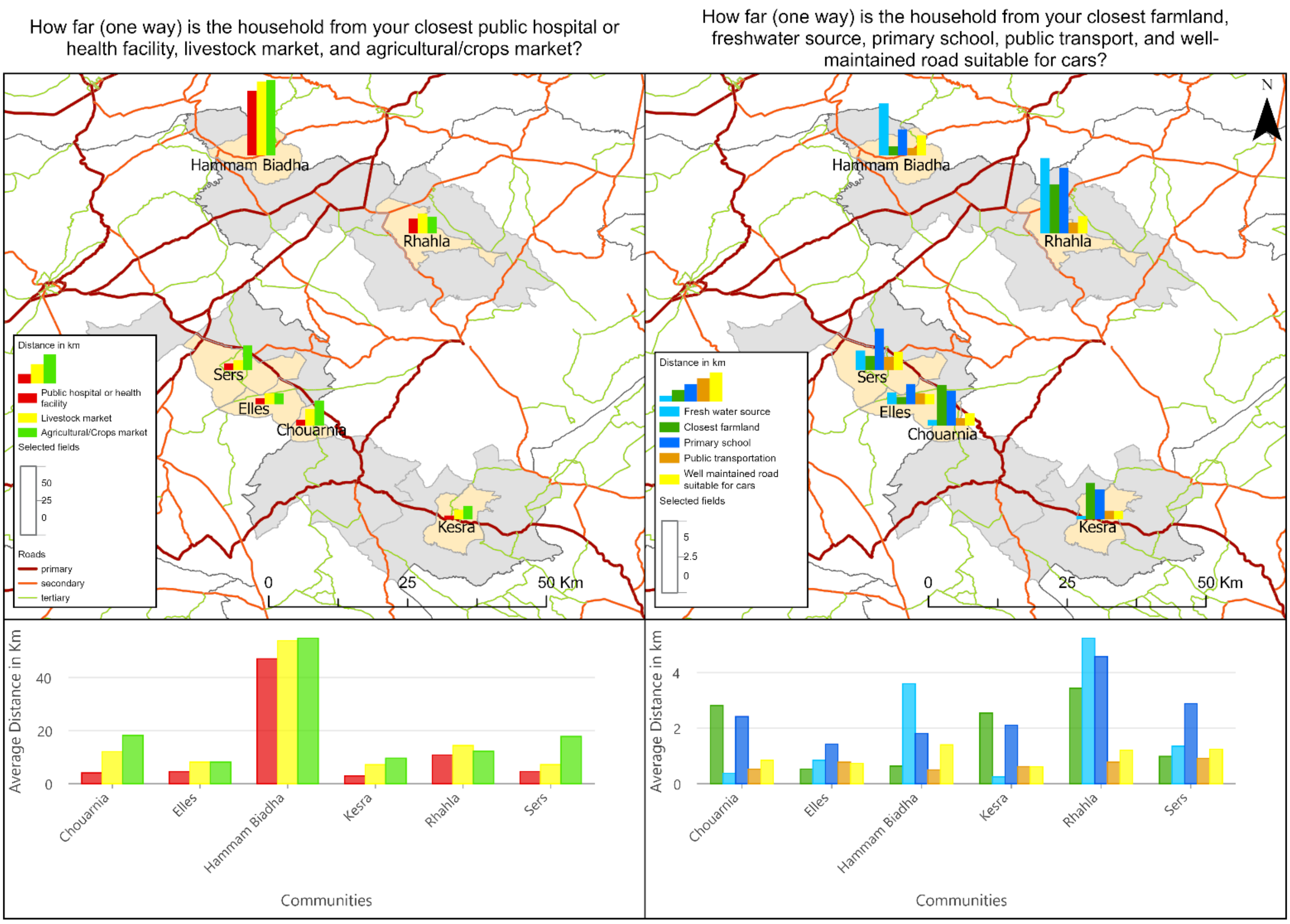


Figure 11. Geographical infrastructure and proximity along the ked-siliana transect (168 farmers))

Module 2: Agroecology Adherence

The HOLPA Tool proposed to assess the alignment of farmers with the 13 agroecological principles as defined by the High-Level Panel of Experts (HLPE, 2019[1]). Each principle is evaluated on a 5-point narrative scale depicting different practices, organization modes, etc. Scores are attributed to each principle throughout a 5-point Likert scale. The 13 principles are grouped under the three strategic priorities identified for each transition pathway in the Tunisian ALL (see Introduction), i.e., 1. Improve Resource Efficiency about input use, 2. Strengthen Resilience, and 3. Secure Social Equity. The three priorities can be operationalized at the three levels of the transition from the ecosystem to the food system. The approach provides insight into how each community composing the Tunisian ALL positions itself about each principle of agroecology along a gradient from 1 to 5.

a) Strengthen Resilience through Soil Health, Animal Health, Biodiversity, Synergy, Economic Diversification

The 'Strengthen resilience' priority addresses agroecological practices that support the adaptability and stability of agricultural systems to withstand environmental stresses and economic shocks. Five agroecological principles have been selected to address this priority, i.e., Soil Health, Animal Health, Biodiversity, Synergy, and Economic Diversification. Each principle focuses on specific practices contributing to farms' long-term stability and viability. The results presented in Figure 12 give an insight of the degree of resilience across communities.

[1] HLPE. 2019. Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. A report by the High-Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security. Rome: FAO.

'Soil health' principle has been identified as a core principle of the sustainability of mixed crop-livestock farm systems in the Tunisian ALL due to the challenges of soil fertility degradation and soil erosion that affect the semi-arid zone of the region. The main component of the 'Soil health' principle includes practices such as using cover crops, organic amendments (e.g., compost), no-till, and crop rotations, with higher scores indicating more effective and sustainable soil management strategies. Across the communities, the average score for soil health practices is 1, indicating basic levels of soil health practices related to the mentioned practices. Rahla and Sers show slightly higher scores that could result from the previous and ongoing development projects around soil fertility improvement through minimum labour or crop rotations over the last 5-7 years. However, this score doesn't include current practices around intercropping that are more extended in this semi-arid region.

'Animal health' is also crucial for resilience, as healthy livestock support economic stability and food security. The 'Animal Health' principle is based on householders' perception of animal wellbeing. The average score for animal health is three over 5, showing medium success in implementing practices to maintain animal health. Sers and Rahla community stand out with an average score of 3.2, reflecting the recent effort, especially on feeding practices through the Initiative. This score reflects the harsh conditions that have affected the animal health in 2022 and 2023, two dry climatic years.

'Biodiversity' is a cornerstone of resilience, supporting soil health, pest control, pollination and overall ecosystem balance. In the HOLPA assessment, biodiversity encompasses the diversity of trees, plants, and livestock species across different landscapes, such as cropland, forests, wetlands, and woodlots. Higher scores indicate a wider variety of species across the various habitats, contributing to a more stable and resilient ecosystem. The communities within the transect achieve an average biodiversity score of 2.8. Kesra stands out with a biodiversity score close to 3.4 for plant diversity, mainly due to its variety of tree and plant species in the different habitats. Rhahla has the lowest score for plant diversity. We can also see that some habitats, such as wetlands and woodlots, show lower biodiversity, highlighting areas for conservation efforts. Preserving and enhancing biodiversity within these various landscapes could further provide long-term socioeconomic and environmental benefits.

The Synergy principle emphasizes the positive agroecological interactions between various farm components, such as animals, crops, trees, soil, and water. Synergies create a balanced ecosystem where each component supports the others, leading to increased resilience, productivity, and resource efficiency. Practices promoting synergy include integrated crop-livestock systems, agroforestry, and sustainable water management. The average synergy score across the communities is surprisingly relatively low (1.6), considering the diversity of crop, tree and livestock activities. It can reveal a modest level of interaction and integration between the activities. The highest effort has been done on pest management.

The Economic Diversification principle evaluates the various income sources available to farm households. Diversified income is well known to reduce risk, stabilize income, and improve resilience against market or climate shocks. The focus here is the range of income-generating activities available to households. Higher scores indicate a well-diversified income base, offering communities a buffer against market fluctuations and other economic risks. With an average score of 1.8, the transect shows a low economic diversification that must be linked to the dry conditions that have limited products and incomes from several agricultural activities.

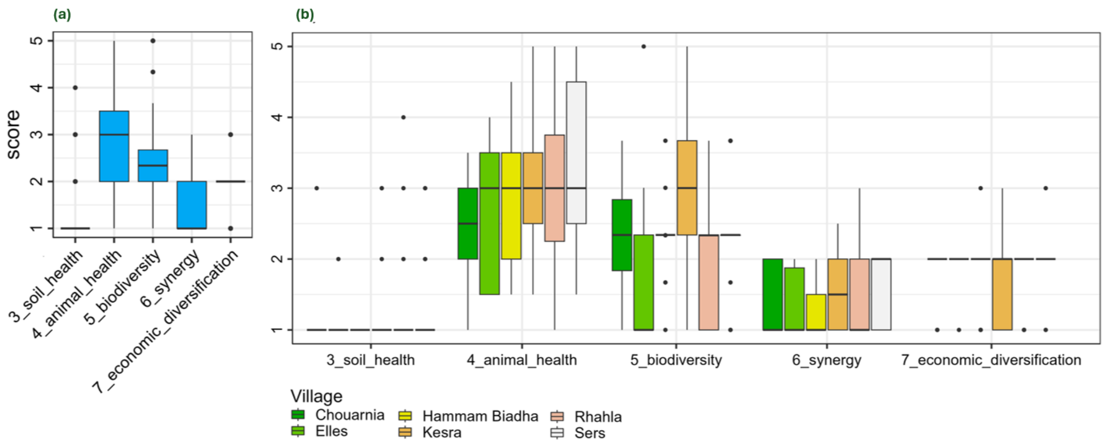


Figure 12: Average Scores related to the Agroecology principles focusing on Strengthening Resilience , i.e. Principles of Soil Health, Animal Health, Biodiversity, Synergy, and Economic Diversification along the Siliana-Kef Transect (a) and by community (b), with Scores Ranging from 1 to 5 to Reflect Adherence to Each Principle.

These first results show a large margin of improvement in the mixed crop-tree-livestock systems of the Tunisian ALL to favour interactions and synergy between agricultural activities.

b) *Improve Resource Efficiency through Recycling and Input Reduction*

Resource Efficiency's strategic priority covers practices that minimize external inputs' use and optimize local resources within agroecological systems. Based on the principles of 'Recycling' and 'Input Reduction', this assessment provides a snapshot of how each community within the Kef-Seliana Transect engages with these practices (Figure 13).

The Recycling principle focuses on how resources are re-used locally, promoting a closed-loop system in agricultural practices. The recycling dimension focuses on energy sources, livestock, manure and compost, and seeds, with higher scores indicating more sustainable, local, or self-reliant practices. Overall, recycling practices are moderately adopted across communities (3 over 5), with specific strengths in manure and compost sourcing (between 4 and 5) but lower scores in energy sourcing (around 1). Elles and Sers show the highest average (3.1), indicating better recycling practices, especially in manure and compost usage. Kesra has the lowest median score (1.0), suggesting potential challenges in adopting recycling practices, particularly in local seed sourcing.

Input Reduction questions assess practices in livestock feeding, disease management, soil fertility improvement, and pest control, where higher scores represent reduced reliance on external inputs. The average score for Input Reduction is consistent across communities (around 2.7). Hammam Biadha has the highest average score (3), particularly for soil fertility and pest management. Generally, soil fertility and pest management practices show relatively wide adoption, while livestock disease management has lower scores, highlighting an area for improvement.

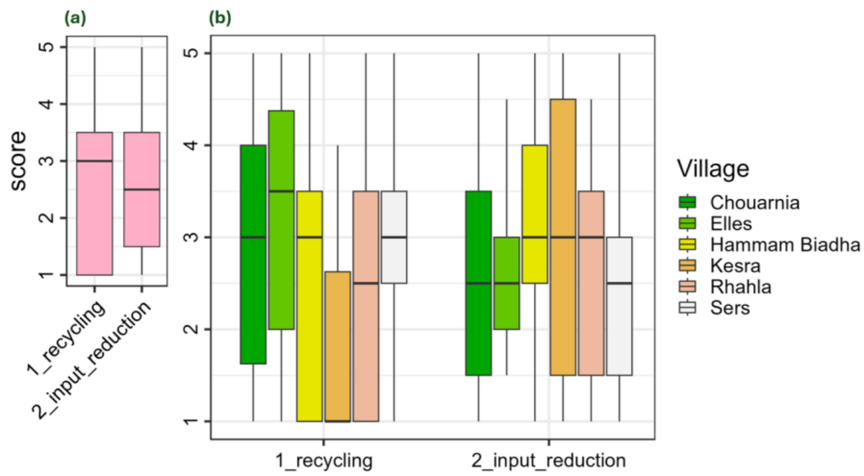


Figure 13: Average Scores of Resource Efficiency Based on Agroecological Principles of Recycling and Input Reduction along the Siliana-Kef Transect (a) and by community (b), with Scores Ranging from 1 to 5 to Reflect Adherence to Each Principle.

The Resource Efficiency results show a high interest in and adoption of practices regarding the preservation of soil and the reduction of purchased inputs through the increasing use of organic resources (manure and compost) and the reduction of chemical products (chemical fertilizers and pest control products). Hammam Biadha and Elles, thanks to training and demos on organic management practices (especially on compost) record the highest adherence to these principles.

However, the level of input reduction about feed supplementation or disease treatment still records a low score between 1 and 2, highlighting an important area of improvement in the mixed crop-livestock systems of the Tunisian ALL.

c) *Secure Social Equity: Knowledge, Social Values, Fairness, Connectivity, Governance, Participation*

The last strategic priority aims to enhance the social and institutional environment to favour adopting agroecological practices along the transformational pathway (Figure 14).

Knowledge sharing has been considered a fundamental behaviour principle to achieve agroecological transition within the Initiative. In the HOLPA assessment, 'knowledge sharing' component encompasses the exchange of information between various actors, including Agricultural Extension Workers, Consumers, Food Traders, Government, NGOs, and Researchers. The focus here was on how well these groups communicate, collaborate, and learn from one another to drive sustainable development. Higher scores in knowledge sharing indicate stronger interactions and more effective dissemination of information. Across the communities within the Tunisian ALL, the average knowledge score is 1.6, indicating very moderate knowledge sharing. The Sers and Kesra communities reveal higher knowledge sharing, particularly with extension service agents in Sers, thanks to their close relationships with development agencies (especially the Office of Livestock and pasturaland, OEP) and consumers in Kesra in link with their agro-touristic orientation. Elles and Hamman Badhia show lower knowledge-sharing scores and mainly limited to government agencies and food trader sectors due to their oriented activity on olive.

The Social Values indicator examined households' access to diverse, healthy, seasonal, and traditional foods, reflecting food security and quality within the communities. Findings show solid access to traditional food, which received the highest average score of 4.3 across all locations, suggesting that communities maintain strong ties to culturally relevant dietary practices. Seasonal and healthy food also scored favourably, with averages of 4.0 and 3.8, respectively, demonstrating a reasonably secure and varied food supply throughout the year. Kesra shows higher scores for all variables included in this principle, reflecting the species diversity of the zone. These results highlight a positive aspect of social capital, as households generally have sufficient access to various food types that support nutrition and cultural practices.

The Fairness indicator evaluated whether respondents felt they received fair prices for various agricultural products, including honey, livestock, and tree-derived products like wood or rubber. Honey producers reported the highest perceived fairness, with an average score of 4.3. Livestock prices also rated fairly, averaging 3.8 across communities. However, there are more contrasted scores regarding wood and other tree products, especially in the community of Sers, with a score of 2.5 compared to around 4 for the different communities. The overall fairness average was 3.9 across most communities, suggesting that a general perception of fair compensation farmers exists, considering the existing market conditions.

The Connectivity indicator explored market access by assessing the proportion of products sold and identifying primary buyers. Results revealed that the share of crops sold was consistently rated 1.0 across all locations, indicating limited diversity or volume in crop market transactions. In contrast, products like honey and livestock showed stronger market connections, particularly in Chouarnia and Kesra, where higher scores were recorded for various buyers. The average score for connectivity was 2.5, with a median of 3.0 across locations, reflecting variability in market access based on product type and location. These results must be put in relation to the prevalent dry climatic conditions in the zone during the last two years that have strongly affected crop production more than animal production.

The Governance indicator assessed household involvement in community decision-making, especially regarding land and resource management. Households reported moderate engagement, with meeting participation receiving an average score of 2.7, indicating that community members are somewhat involved in decision-making processes. Community influence averaged 2.6, suggesting that while some households feel they have a voice, involvement and influence vary across communities. The overall governance average was 2.7 in Chouarnia and Sers, two communities that were the first to develop a farm association. In contrast, the communities Elles and Hamman Badhia which recently established a farm association in their village, register the lowest scores either in terms of participation or influence in decision-making regarding resource management. These findings underscore the importance of strengthening local governance structures to ensure broader, more inclusive decision-making that empowers all households to contribute to community resource management.

The Participation indicator (Farmer Associations' Support) measured farmers' perceptions of the effectiveness of farmer associations in supporting agricultural business. Scores varied widely, ranging from 1.7 in Hammam Biadha to 3.0 in Sers, with an overall average of 2.6. This variation indicates mixed perceptions of the associations' ability to support farmers effectively, with some communities feeling more supported than others. However, the different scores between communities can also be put in line with the date of establishment of the FO. FOs need time and experience to build cooperation and become effective for their adherents or beneficiaries.

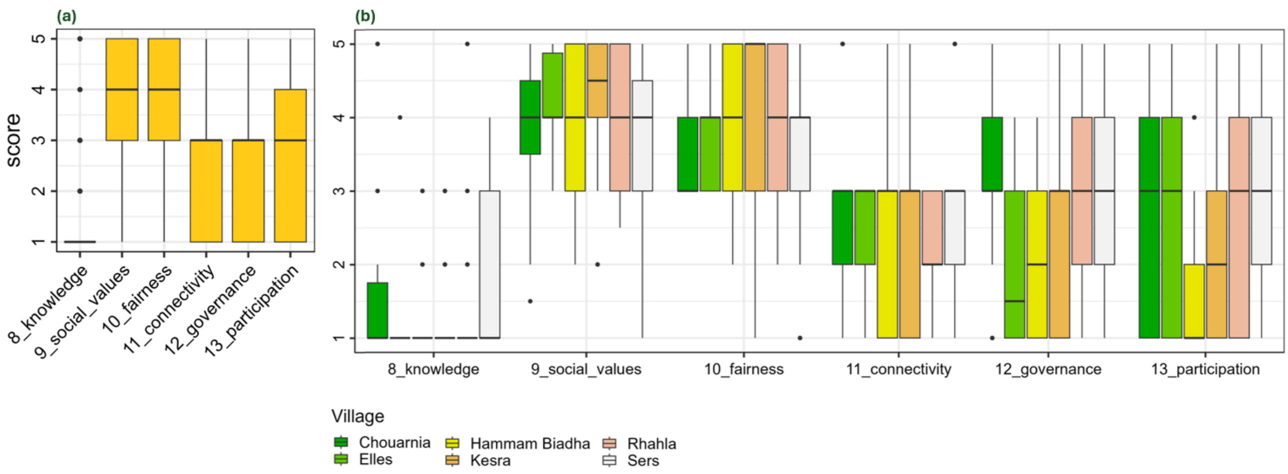


Figure 14. Average Scores of Secure Social Equity Based on Agroecological Principles of Knowledge, Social Values, Fairness, Connectivity, Governance and Participation along the Siliana-Kef Transect (a) and by community (b), with Scores Ranging from 1 to 5 to Reflect Adherence to Each Principle.

In summary, Figure 15 and Table 6 show the six communities' adherence to agroecological principles. First, the communities show a similar adherence profile to the agroecological principles, even if we can note more significant gaps in the principles at the food system level.

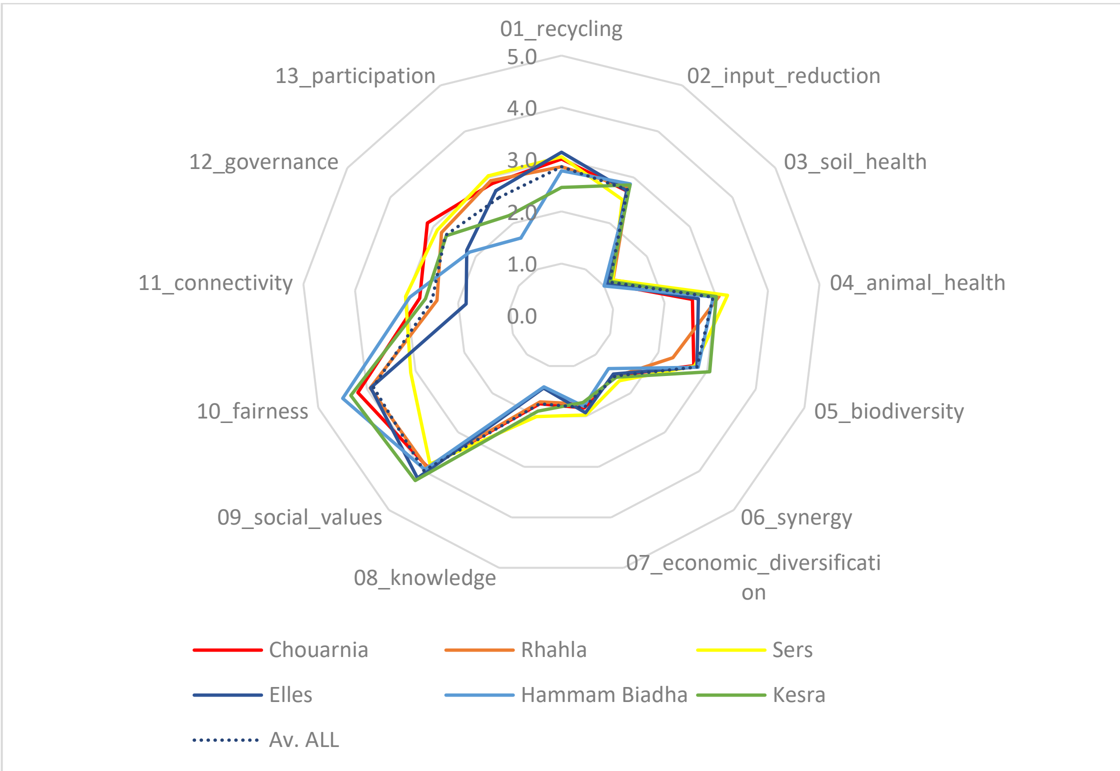


Figure 15. Average Adherence Scores to the 13 Agroecological Principles in the Siliana-Kef Transect, with Scores Ranging from 1 to 5 Indicating Levels of Adherence.

Table 6. Average score of agroecological principles' adherence classified by importance along the Kef Siliana transect

Principles	Chouarnia	Rhahla	Sers	Elles	Hammam Biadha	Kesra	Av. ALL	Priority
09_social_values	3.9	3.9	3.8	4.2	4.0	4.2	4.0	Social
10_fairness	4.2	3.9	3.1	3.9	4.5	4.3	3.9	Social
04_animal_health	2.5	3.1	3.2	2.7	2.9	3.0	2.9	Resilience
01_recycling	3.0	2.9	3.1	3.1	2.8	2.5	2.9	Efficiency
05_biodiversity	2.7	2.3	2.7	2.8	2.8	3.1	2.8	Resilience
02_input_reduction	2.7	2.8	2.5	2.7	2.9	2.8	2.7	Efficiency
12_governance	3.1	2.8	2.9	2.2	2.1	2.7	2.7	Social
13_participation	2.9	2.9	3.0	2.7	1.7	2.2	2.6	Social
11_connectivity	2.7	2.4	3.0	1.8	2.9	2.6	2.5	Social
07_economic_diversification	1.8	1.8	2.0	1.9	1.8	1.7	1.8	Resilience
08_knowledge	1.8	1.7	2.0	1.4	1.4	1.9	1.7	Social
06_synergy	1.5	1.6	1.7	1.5	1.4	1.6	1.6	Resilience
03_soil_health	1.1	1.2	1.2	1.1	1.0	1.1	1.1	Resilience

Highlights of Module 2 results

Module 2 highlights key similarities and differences across communities along the Kef-Siliana transect.
Social values and fairness score consistently high, reflecting strong access to diverse, seasonal foods and perceived market fairness, particularly in Kesra and Hammam Biadha. However, critical challenges include poor soil health (average score of 1.1), limited economic diversification, and weak synergies between crop, livestock, and tree systems. Kesra emerges as a leader in biodiversity due to its agroforestry practices and diverse species, while Sers performs well in governance and participation, supported by well-established farmer associations. Communities like Elles and Hammam Biadha demonstrate strong recycling and input reduction practices, driven by training and development activities into the Initiative Agroecology.
Despite the preliminary progress, widespread issues like soil erosion, low integration of agricultural components, and limited market connectivity persist. Strengthening soil health, fostering knowledge sharing, promoting synergy, and diversifying income sources are essential to advancing agroecological practices in the region. Development initiatives, combined with tailored support for emerging farmer organizations, are crucial to addressing these gaps.
However, we propose to explore the links between the score of adherence and the key performance indicators related to agroecology frame to explore some paths of improvement.

Module 3: Performance

This section explores the relationship between adherence to agroecological principles (Module 2) and overall performance levels (Module 3), as outlined in the research question. By linking agroecology adherence scores, and KPI performance indicators, the analysis aims to identify whether higher adherence to specific agroecological principles correlates with better performance across communities. Key questions include: Are certain communities performing better than others? If so, is it related to stronger alignment with particular agroecological principles?

Agronomic

The agronomic dimension includes three key performance indicators (KPIs): crop, animal, and soil health (Figure 16). Each KPI provides insights into how farms perform under current environmental and management conditions. Notably, the region experienced unusually low precipitation and elevated temperatures during the year, which likely influenced these indicators.

The Crop Health (KP1) indicator measures the percentage of crop production lost or damaged in the last 12 months. The results show high crop loss percentages across all six communities (average 75%), indicating widespread vulnerability across the transect. The harsh climatic conditions—with exceptionally low rainfall and higher-than-average temperatures—likely played a significant role in these losses. Due to the geographical conditions in the mountainous area, the Kesra community had relatively lower losses at 50%, suggesting both natural resilience due to the diversity of habitats and plant variety and the permanent adaptive practices. In contrast, Chouarnia reported the highest crop losses at 90%, indicating a critical need for intervention.

Animal health (KPI2) was measured by the extent of livestock injury, illness, or death due to disease. The average score across communities was 4.00, suggesting animals' resistance to biotic or abiotic stress.

The soil health indicator (KPI3) reflects farmers' perceptions of soil erosion and fertility, measured on a scale from 1 (infertile with significant erosion) to 5 (highly fertile with no erosion). The average score for soil health across communities is 4. The generally positive scores across the transect indicate that farmers perceive their soils to have good fertility with moderate to low erosion risk. However, given the seasonal drought conditions, reduced organic matter and moisture levels may gradually affect soil health. Rahla showed the lowest soil health score at around 3, indicating potential challenges related to erosion or reduced fertility.

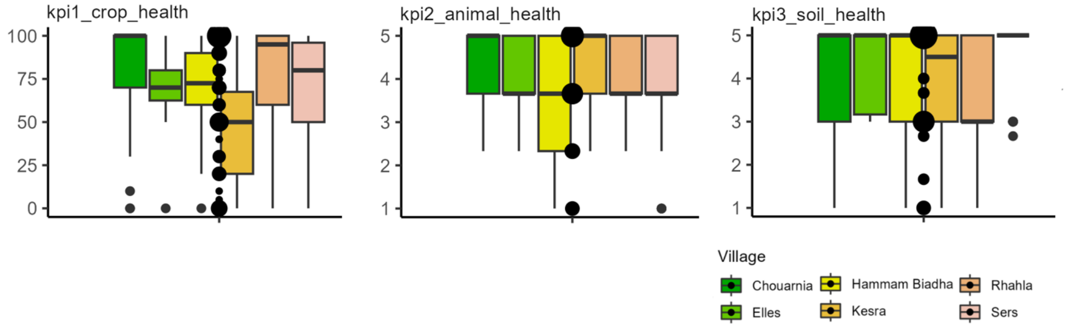


Figure 16: Community-Level Average Scores for Agronomic Key performance : Crop Health, Animal Health, and Soil Health

Environmental

The environmental dimension explores indicators of biodiversity, local agricultural variety use, climate mitigation, and water stress avoidance (Figure 17). These indicators are essential for understanding the communities' contributions to ecosystem health and resilience, as well as identifying areas that require support for enhancing sustainability and climate adaptation.

Animal Diversity indicator (KPI5) rates animal species diversity from 1 (no animals) to 5 (high variety and abundance). The average score across communities was 3. Kesra had the highest score (3.6), suggesting relatively high animal biodiversity, while Rhalia scored the lowest (2.8), indicating limited species diversity.

Tree diversity (KPI6) is rated from 1 (no trees) to 5 (high variety of tree species). Tree diversity scores were moderate, with an average of 2.9. Kesra again stood out with the highest tree diversity score of 3.8, likely reflecting practices or natural conditions that support a greater variety of tree species. Conversely, Elles widely oriented to olive trees had the lowest score (1.7).

Use of Local Varieties and Breeds indicator (KPI7), ranging from 1 (only exotic varieties/breeds) to 5 (only local varieties/breeds), reflects the extent of local variety use, averaging 3.4, with no significant difference between the 6 communities.

Climate mitigation practices (KPI8) were assessed on a scale from 1 (high greenhouse gas emissions, low carbon sequestration) to 5 (low emissions, high sequestration). The average score was relatively low (2.4), indicating that farmers along the Kef-Siliana transect rely on quite neutral practices regarding emissions and carbon sequestration.

Avoided Water Stress indicator (KPI9) reflects the number of months without water stress in a typical year, with higher scores of more than 75 indicating more months without water stress. Scores were relatively high, averaging 75, with Rhahla scoring highest at 85 and Chouarnia scoring slightly lower at 70. Higher scores here may indicate that communities are not regularly exposed to water stress, making them potentially more vulnerable to future droughts due to limited adaptive experience. This aligns with the crop health observations (KPI1), where significant production losses were reported, potentially due to atypical drought conditions. Communities less experienced with water stress could be more affected by climate fluctuations, which may explain the high crop damage percentages across the board.

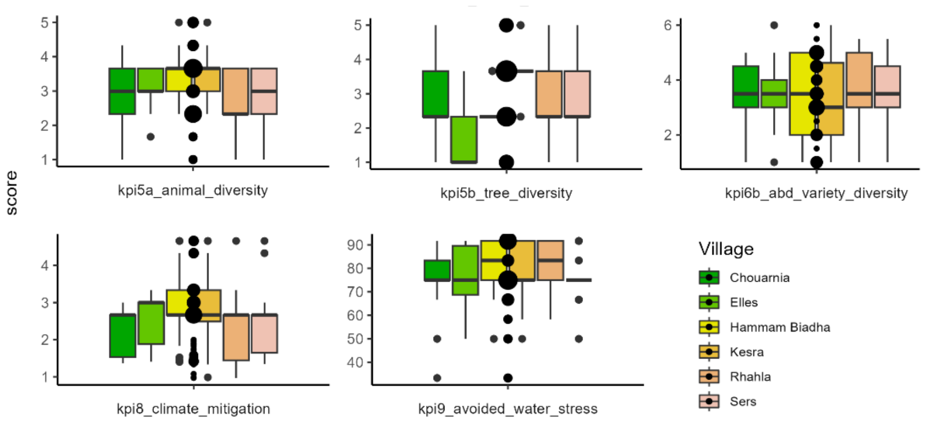


Figure 17: Community-Level Average Scores for Environmental Key performance indicators

Economic

Household Income Relative to Average indicator (KPI11) measures the ratio of household income compared to the average national income. The overall average score for household income was 1.30, indicating incomes below the national income. Kesra stood out with a significantly higher score of 2.11, suggesting better economic resilience or access to income-generating opportunities. Chouarnia (0.88) and Sers (0.93) had the lowest scores, reflecting their vulnerability to drought conditions.

Social

The social dimension assesses the wellbeing, security, and resilience of communities in terms of food diversity, land tenure, and subjective wellbeing (Figure 18). Together, they provide insight into the social foundations that underpin sustainable agricultural and ecological transitions. High social resilience fosters community engagement and investment in long-term environmental practices, making it a crucial element of sustainable development.

Diet Diversity (KPI15) measures the diet diversity on a scale from 0 (no diversity) to 10 (high diversity). The average diet diversity score across communities was 3.54, indicating low to moderate diversity in food groups consumed. Kesra scored the highest at 3.89, suggesting a slightly more varied diet, possibly due to access to diverse food sources. Sers and Chouarnia, with an average score of 3.2, had the least varied diets, reflecting limited access to a variety of nutritious food options.

Perceived security of land tenure (KPI17), rated from 1 (high likelihood of losing access to all land) to 5 (high security in land ownership). Land tenure security was generally high across all communities, with an average score of 4.5. Hammam Biadha had the highest security perception at 4.8, while Chouarnia had a slightly lower score at 4. So, along the Kef-Siliana transect, most farmers feel secure in their land rights, supporting stable, long-term agricultural practices.

Human wellbeing perceived by households (KPI18) measured the degree of satisfaction, from 1 (completely dissatisfied) to 5 (completely satisfied). The average life satisfaction score was 3.9, with Kesra reporting the highest satisfaction level at 4.2. In contrast, Hammam Biadha scored lowest at 3.5, suggesting some communities experience lower satisfaction, potentially due to economic and environmental challenges.

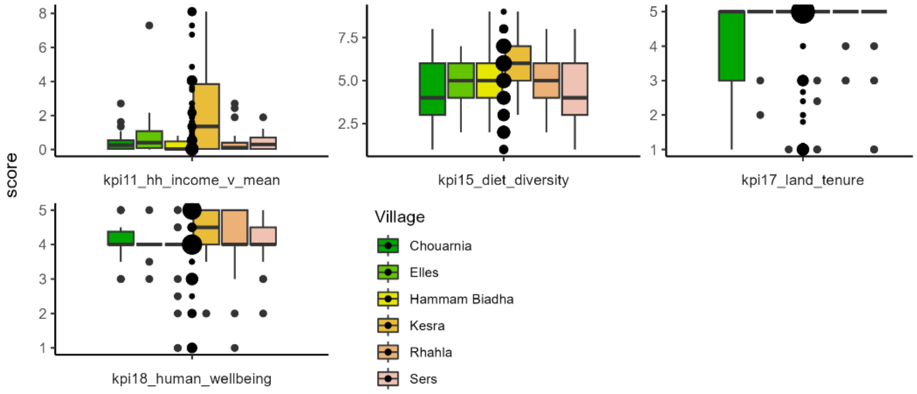


Figure 18: Community-Level Average Scores for Social Key performance indicators

Overall performance indicators

Figure 19 gives an overall view of all the key performance indicators related to agroecology for the six communities. The lower scores are recorded in the economic domain. However, the financial result in the economic domain must be put in relation to the recent drought (2023-24) that affected all the agricultural production, particularly the annual crops such as barley and wheat. The highest variability is observed for tree diversity, with the specific biodiversity observed in kesra.

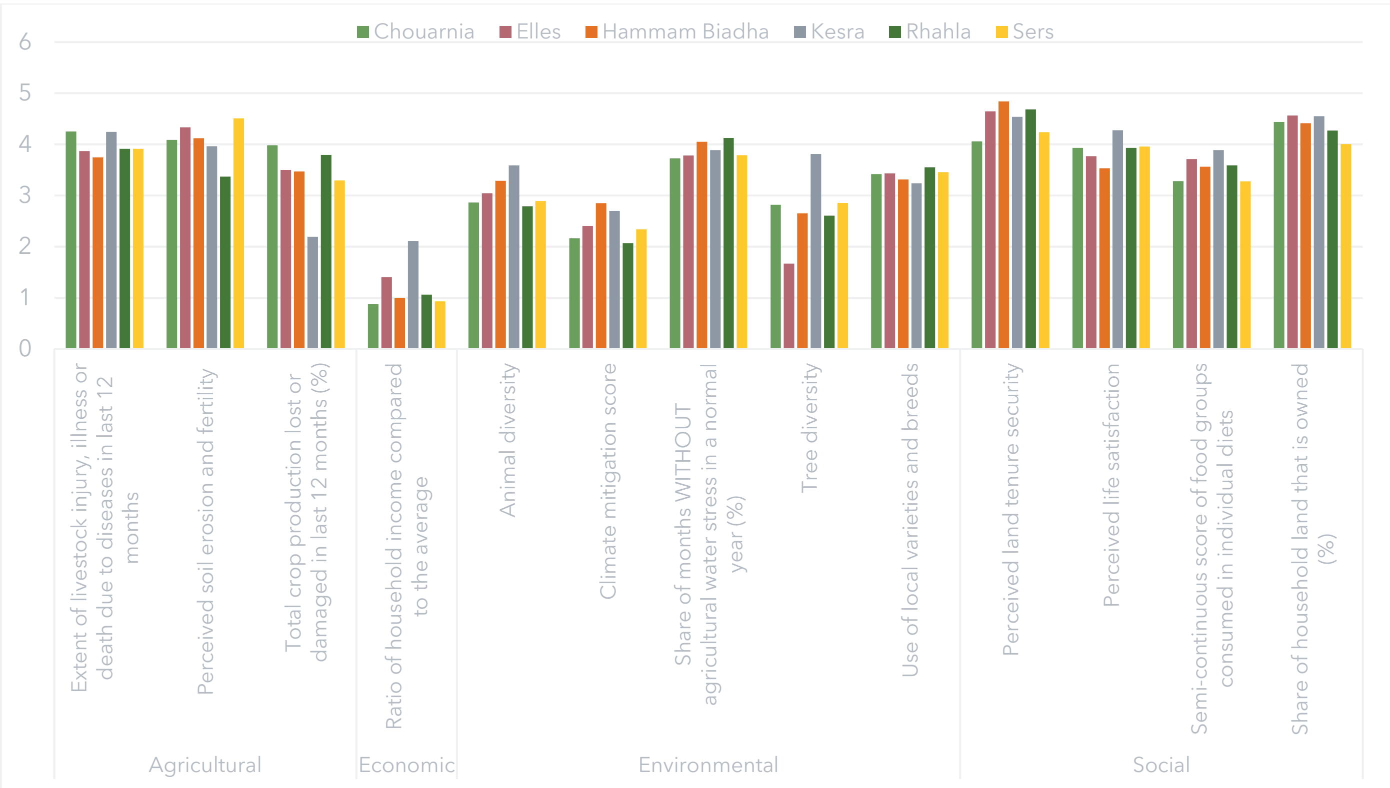


Figure 19. KPI indicators per community for the 13 KPI indicators and per domain (168 farmers)

From these results, a clear relationship between adherence to agroecological principles (Module 2) and key performance indicators (KPIs) (Module 3) emerges. For instance, Kesra, which scored highly on biodiversity and recycling, also performs better in environmental KPIs such as tree diversity and animal diversity. Its economic resilience is reflected in the highest household income scores relative to the other communities of the Tunisian ALL, showcasing how biodiversity and local variety use may contribute to financial stability. Conversely, communities like Chouarnia and Sers, with low agroecological adherence scores, show lower performance in economic and social dimensions, including diet diversity and income, likely due to limited diversification and poor synergy during the last dry year.

Highlights of Module 3 results

In summary, communities with stronger adherence to agroecological principles, such as recycling and biodiversity, tend to exhibit better outcomes in agronomic and environmental KPIs, indicating a positive link between agroecology and resilience to climatic shocks. However, the indicators like soil health and synergy, with consistently low scores across all communities, correlate with higher crop loss percentages and challenges in animal health, opening significant opportunities for improvement. The analysis also highlights the importance of local governance and farmer participation, as seen in the Sers community, where established associations support higher scores in social equity KPIs. Overall, these findings underscore the need to strengthen agroecological practices like soil health, economic diversification, and governance to enhance resilience and performance across all dimensions. Tailored interventions focusing on soil health management, economic diversification, and local governance can maximize the potential of agroecological adherence to improve overall community performance.

USE OF THE HOLPA RESULTS

Identification of key entry points from the V2A

As presented in the introduction (part 1), the visioning outputs developed the impact pathways for agroecological transition in three dynamics connected in the living landscape. To accomplish this Vision-to-Action (V2A) plan, we defined three key entry points resulting from the priorities identified during the visioning exercise (WP1) with farmers, priorities that have been discussed and detailed with various stakeholders in the living landscape (Figure 20).

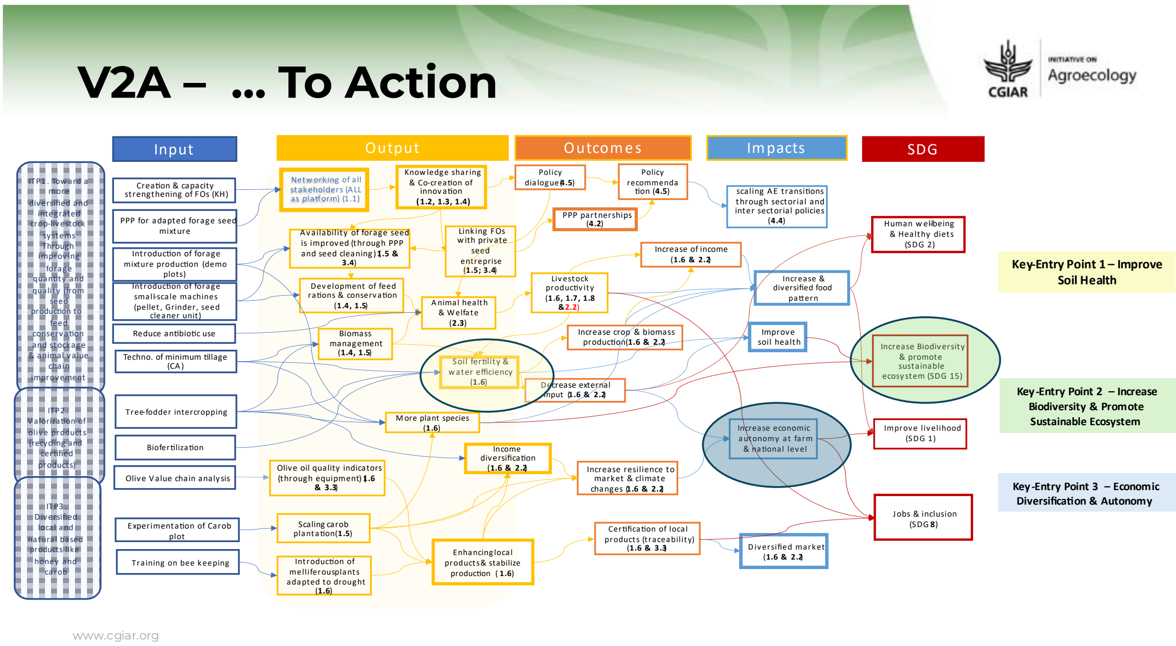


Figure 20. the Vision to Action in the Tunisian ALL and the three key entry points

The first impact pathway (IP1) proposed a path toward more diversified and integrated crop-livestock systems by improving animal products' value chain from the seed multiplication and forage production/feedstock (with crop/tree residues) to the marketing of dairy products. This pathway included the improvement and diversification of the crop system, the crop-livestock synergy and input reduction, the valorization of local and national products, and mixed forage production around leguminous for soil health improvement. In this transition pathway, 'soil health' improvement is at the core of the overall achievement of the transition to more resilient systems.

The second and third impact pathways around 'Certified olive tree value chain in integration with all the other activities (livestock-cereal) enhancing the valorization of local products at the national and international markets' highlights two dimensions of the transition, i.e., the better market valorization of the olive products through the development of a sustainable business model and the use of organic matter for both input reduction and contributing to soil health management. Here, we propose to focus on the economic diversification and autonomy through the 'recycling' and 'input reduction' principles.

The third impact pathway aims to improve the honey and carob value chains to contribute to biodiversity, economic diversification and local and healthy consumer products. This IP's main objective was to increase biodiversity and the promotion of a sustainable ecosystem.

Soil health improvement for a more resilient and sustainable system

The 'soil health' score presented in module 2 and the soil health performance indicator in module 3 (Result section) show contrasting results from the soil health assessment with a low score (around 1) and high performance (around 4-5).

Figure 21 (below) presents the primary results of the soil analysis conducted in the Tunisian ALL. We can see that the soil health score is coherent with the soil analysis in regard to organic matter content, with an average of around 1.5. The Chouarnia community has the highest soil organic content level but also has more significant differences, indicating greater heterogeneity. Rhalha has lower averages and smaller gaps between the three plots, reflecting a lower but more homogeneous performance.

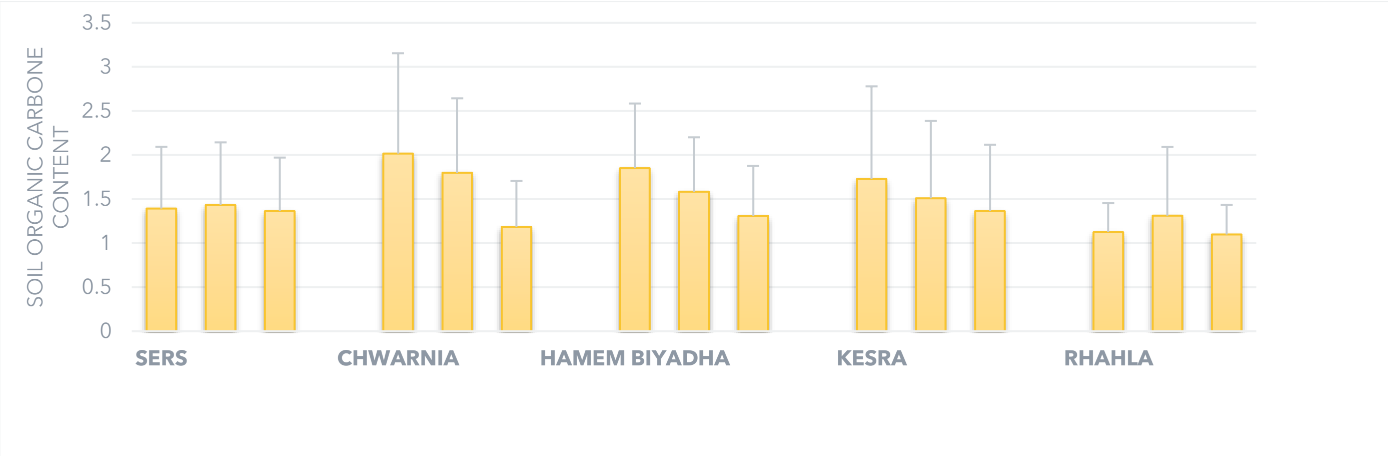


Figure 21. Soil organic carbon content (grams of carbon per 100 grams of soil)

Soil health is vital for sustainable agriculture practices, particularly in Tunisia's semi-arid regions. A comprehensive soil health assessment was conducted by integrating multiple indicators, including soil structure, compaction, depth, residue status, color, odor, organic matter content, moisture levels, surface cover, erosion, invertebrate activity, and microbiological activity. The values of these indicators were reclassified and weighted using two methods: equal weighting and ranking technique. The weighted indicators were then aggregated to deliver a comprehensive evaluation of soil health.

From the SOCLA approach, we proposed to conduct a multicriteria analysis from the HOLPA data set to provide a comprehensive soil health assessement across the study site. 10 sub-indicators are considered to elaborate a holistic and synthetic indicator of soil health assessment, i.e.,

1. **Soil structure:** Determines water retention, aeration, root penetration, and biological activity, crucial for productivity.
2. **Soil Compaction**: Affects root growth and nutrient uptake. Reduced compaction supports better crop yields.
3. **Soil Depth**: Deeper soil holds more moisture and nutrients, essential for sustaining crops in dry climates.
4. **Status of Residues**: Decomposing organic material adds fertility and prevents soil erosion.

5. **Soil Colour, Odour, and Organic Matter**: Characteristics indicating the presence of humus and soil health.
6. **Soil Moisture**: Given Tunisia's semi-arid climate, soil moisture is critical for plant growth.
7. **Soil Cover**: Protects against erosion and helps maintain moisture levels.
8. **Soil Erosion**: Signs of soil loss or disturbance.
9. **Invertebrate Activity**: Presence and activity levels of soil-dwelling organisms.
10. **Microbiological Activity**: Effervescence response to water peroxide application, indicating microbial activity levels.

Each sub-indicators are reclassified into five categories based on likert-scale from Very Poor (VPSH) (1 Point), Poor (PSH) (2 Points), Fair (FSH) (3 Points), Good (GSH) (4 Points) to Excellent (ESH) (5 Points). The soil health indicators were reclassified and aggregated using two approaches: equal weighting and ranking.

- In equal weighting, each factor (soil structure, compaction, depth, etc.) was assigned a weight of 10%.
- In the ranking technique, indicators were weighted based on climate conditions and agricultural practices relevant to Tunisia.

Finally, the sub-indicators were combined and reclassified to provide a comprehensive soil health assessment (table 7).

Table 7. List of soil health sub-indicators used to assess a global soil health indicator

Soil health sub-indicators	**Equal weight (%)**	**Ranking (%)**	**Reason**
Soil Structure	10	20	Influences water retention, aeration, and root penetration are critical for crop growth.
Soil Compaction	10	15	Affects root growth and water infiltration, crucial for managing arid conditions.
Soil Depth	10	15	Deeper soil stores more moisture and nutrients, essential in a dry climate.
Status of Residues	10	10	Organic matter contributes to soil fertility and erosion prevention.
Soil Colour, Odour, and Organic Matter	10	10	Indicates humus presence and overall soil health, affecting nutrient availability.
Soil Moisture	10	15	Critical for plant growth in Tunisia's semi-arid climate.
Soil Cover	10	5	Protects against erosion and helps maintain moisture.
Soil Erosion	10	5	Preventing erosion is crucial to combat land degradation risks.
Invertebrate Activity	10	2.5	Improves soil structure and nutrient cycling, though less immediate impact.
Microbiological Activity	10	2.5	Essential for nutrient cycling but harder to measure compared to other factors.
Total	100	100	

Both assessments—equal and ranking weighting—produced similar results in five out of six sites. However, using the ranking technique, the soil health status of the Hammam Biadha site declined from 'Excellent' to 'Good.' (Figure 21)

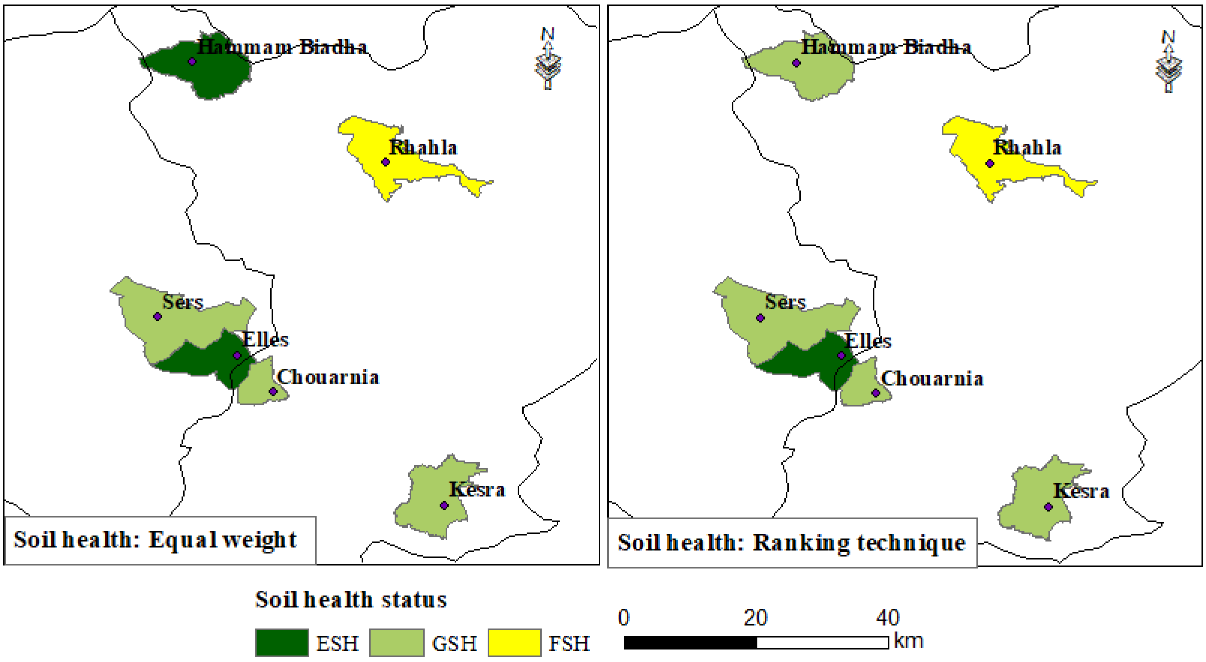


Figure 22. soil health assessment for the two assessments–equal and ranking weighting.

This analysis from the SOC and SOCLA approach in the HOLPA toolkit allowed us to confirm the gaps between the communities into the Tunisian ALL with a higher score for Chournia and a lower score for Rahla. We can see that the method of ranking based on climate conditions and agricultural practices relevant to Tunisia gives contrasting results with the equal ranking or the KPI indicator approach that merits more attention about soil health assessment in each context.

Recycle and input reduction toward a more self-sufficiency system

To assess the impact of "recycling" and "input reduction" adherence principles on the overall KPI performance, we have calculated a global KPI indicator that is the sum of the 13 KPI indicators that have been classified in 4 levels (see Table 8). The descriptive analysis shows that these two principles play a moderate role in the overall performance compared to the principles of 'Fairness' and 'social value'. We can also see that small land-scale farmers who raise cattle achieve the best KPI indicators. So these results reveal that the efforts toward 'recycling' and 'input reduction' are the most dominant in the small land-scale farm oriented to large ruminant systems in Chouarnia and Elles communities.

The farm group with a medium-high KPI indicator gather the largest land owners with a mixed crop-livestock system. We can note that the farm systems oriented to olive trees are mainly in the low and medium-low KPI farm groups, revealing that olive plantation is not an indicator of agroecological diversification.

Table 8. Mean adherence agroecological score by farm groups classified according to global KPI indicator

parameters	Low KPI (<40 points)	Medium low KPI ([40-45[points)	Medium high KPI ([45-50[points)	High KPI (> 50 points)	Total
01_recycling	**2.49**	**2.54**	**2.65**	**2.98**	**2.58**
02_input_reduction	**2.97**	**2.91**	**2.57**	**3.20**	**2.86**
03_soil_health	1.27	1.09	1.08	1.00	1.13
04_animal_health	3.32	2.96	2.62	2.72	2.94
05_biodiversity	2.47	2.33	2.54	1.68	2.37
06_synergy	1.75	1.49	1.52	1.45	1.55
07_economic_diversification	1.86	1.81	1.80	1.90	1.83
08_knowledge	1.89	1.77	1.72	1.17	1.75
09_social_values	3.78	4.03	4.25	3.40	3.99
10_fairness	3.37	3.86	4.08	3.50	3.79
11_connectivity	2.41	2.33	2.58	2.60	2.42
12_governance	2.65	2.71	2.89	2.20	2.71
13_participation	2.49	2.65	2.70	1.70	2.57
Barley_ha	0.82	1.90	3.10	1.70	1.94
cattle_nb	1.38	1.21	3.13	7.90	2.11
cultivated_area_ha	6.47	7.60	11.32	5.10	8.02
Fig_ha	0.64	0.23	0.11	0.00	0.28
Goats_nb	2.08	0.89	1.58	1.10	1.33
land_own	14.34	9.24	8.88	7.60	10.20
Olive_ha	1.75	1.45	0.76	0.40	1.29
Sheep_nb	18.70	32.45	27.25	9.70	26.80
Wheat_ha	1.73	1.24	4.23	1.75	2.10

Biodiversity Toward more diversified and sustainable systems

The third impact pathway aims to enhance plant and breed diversity to support biodiversity, economic diversification and local and healthy consumer products. From the previous results (table 8), it appears difficult to see the real link between the biodiversity adherence score and the global KPI indicator. As shown in Figure 19, we see that the tree diversity indicator is the most discriminant between communities, followed by the animal diversity. Using local varieties or the share of months without agricultural water stress in normal climate years appears little discriminant along the kef-Siliana transect.

However, biodiversity depends not only on farm management but also on biological interactions for designing and managing farming systems in relation to agro-landscapes (i.e. ecosystem). Therefore, the agroecology approach based on biodiversity requires indicators that address the connectivity of fields and semi-natural habitats (Jeanneret et al., 2024). To achieve this, all possible data sources must be exploited to enhance the understanding of landscape configuration. Photography can fundamentally contribute to this understanding, as it is an often-overlooked source of data in ecology. However, they have occasionally served as a data source in several research fields in ecology, such as landscape ecology (e.g., to track long-term land cover changes (Depauw et al., 2022) 20072009. Figure 23 proposes a representation of agroecological infrastructure by community to understand the biodiversity at the agro-landscape level using the 924 photos issued from the field HOLPA survey.

The variations in land cover types illustrate the ecological diversity in the Kef-Siliana transect (Shiri et al., 2024) and the significance of different natural habitat and semi-natural habitat structures in supporting local biodiversity (all details in Shiri et Le, 2024 b).

Several sustainable and biodiversity-supporting practices, such as establishing hedgerows or live fences, creating home-gardens, mulching, maintaining natural strips or vegetation, and employing pollinator or flower strips, as well as the pull-push method, were not practiced by any respondents during HOLPA HH survey. Overall, there is a limited adoption of agroecological practices for the studied sample, highlighting areas for potential intervention and capacity building to promote more diversified and sustainable farming systems.

The Kef-Siliana transect is characterized by a great diversity of environments and ecosystems and important spot of biological diversity. In the period ranging from 2017 to 2022, significant changes were observed in the distribution of natural areas. However, habitat loss in the transect becomes severe due to numerous synthetic/anthropogenic and natural causes. For instance, while natural habitat area expansion is increasing, the area faces several threats including land degradation due to agricultural expansion, overgrazing, deforestation, and frequent fires, which overall, unbalance the ecological system.

Landscape metrics analysis unfortunately shows negative trends, at Kef-Seliana transect level and at the ALL level. This homogenization can have ecological consequences, such as reduced habitat availability, decreased ecosystem services, and lower resilience of the landscape aggravated by the observed limited semi-natural diversity (further details about the method can be found in Shiri and Le, 2024b). These two complementary analyses of land cover dynamics and landscape metrics were essential to offer a deep dive into biodiversity assessment and add a landscape dimension highlighting the importance of such methods. This approach of mixed assessment is often promoted and encouraged in landscape ecology research field.

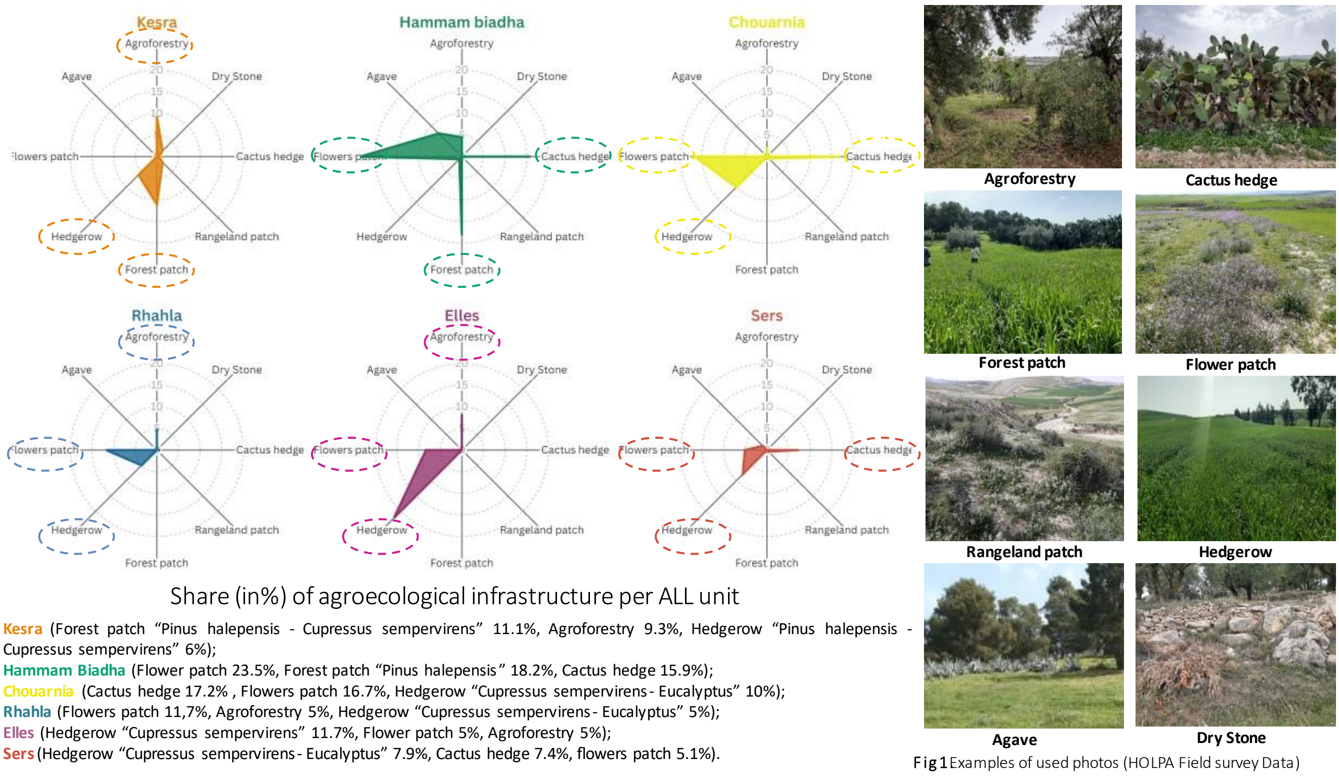


Figure 23. Share (in%) of agroecological infrastructure per ALL unit (from Shiri et al, 2024b)

LESSONS LEARNT

The HOLPA surveys and analysis processes have offered integrated and multidisciplinary approaches to the agroecological processes in the Tunisian transect that allowed researchers and developers involved in the process to appropriate a more holistic approach to the agroecological transition regarding the 13 principles. Around 17 researchers and developers have been trained and sensitized to the holistic approach of the agroecology transformation through the HOLPA process. One of the main positive feedback of applying the HOLPA survey has been to illustrate and understand the importance of the diversity of agricultural practices and farmers' perceptions of soil health. The second positive feedback was the farmers' involvement in the overall agroecological assessment, which gave more pertinence and interest to the data collection process, particularly regarding developers involved in this process.

Photo 1. Around 17 researchers and developers engaged in the HOLPA process

The analysis of the agroecological adherence scores and performance indicators in the global HOLPA approach gives a relatively coherent view of agronomic performances along the agroecological transition about crop and soil health. The biodiversity approach, notably at the landscape level, can require in-depth analysis from photos or soil analysis, as shown in the analysis of the results given in the V2A.

The most problematic domain would be the economic approach. Firstly, the economic performance indicator based on the estimation of the overall potential financial resources compared to a minimum threshold at the national or regional level is highly dependent on the climate and market conditions of the year of data collection without addressing the medium and long-term effect of agroecological transformation (notably in terms of diversification and viability). Secondly, this approach hardly captures the economic benefit of the agroecological transformation that is not necessarily valorized through the market.

CONCLUSIONS AND NEXT STEPS

The Agroecology Initiative proposed a holistic approach through HOLPA, allowing sustainability, equity, and resilience across food systems to be addressed using agroecological principles. The study in Tunisia targeted semi-arid areas (transect Kef-Siliana), emphasizing mixed farming systems and value chains for livestock, honey, carob, and olive products. The Holistic Localized Agroecology Performance Assessment (HOLPA) offers wide perspectives to capture multi-dimensional agroecological performance, emphasizing agronomic, environmental, social, and economic domains. Indeed, the engagement of stakeholders through participatory workshops to co-create localized indicators ensured the coherent links between the selected innovation process and its assessment.

HOLPA provided robust insights into adherence and performance but highlighted gaps in economic metrics and biodiversity at the landscape level. More specifically, the main results show how soil health is at the core of the overall resilience of the mixed farm systems in the semiarid zones. However, biodiversity was regionally more diverse, with tree diversity being particularly significant in some areas. The results also show that farmers faced economic challenges exacerbated by drought, with limited diversification in income sources. However, farmers have kept relatively strong cultural ties to traditional diets. On a social perspective, the indicators of governance and participation remain relatively low and need important improvement. Overall, results indicated a moderate alignment with agroecological principles, with variability among communities, especially concerning social and institutional aspects.

Related to the KPI, the results reveal relatively reduced adoption of landscape-level agroecological practices with limited economic impacts from external shocks such as climate stress and market conditions. Working on innovations at the landscape level is essential to enhance the benefits of innovation adoption at the farm level. So, collective management of the resource need investments.

We can also see that HOLPA can improve awareness and capacity among farmers, researchers, and developers, fostering a collective commitment to agroecological transitions, as observed during the restitution workshop of WP2. All farmers presented during the workshop showed their interest in the follow-up of the indicators for both their farm piloting and advocacy of their activities at the local level (notably in the respective FO, where most farmers operate as active members, even decision-makers). In the short term, we propose developing an Atlas informing policy for broader agroecological transitions.

However, the HOLPA process also raises some issues related to its application as a monitoring tool for long-term impact assessment due to the important investment required in capacity and financial resources. Beyond this resource consideration, it is proposed to develop more comprehensive metrics in economic and social domains that capture the demand of stakeholders, particularly in terms of economic benefits, employment, and collective dynamic and engagement in the FOs, as proposed in the local indicators that we have not presented in this report. Regarding biodiversity assessments, the research team developed innovative approaches using context-specific metrics that could enhance the HOLPA with its local-specific approach.

REFERENCES

Alary, V., Frija, A., Ouerghemmi, H., Idoudi, Z., Rudiger, U., Rekik, M., ... & M'hamed, H. C. (2022). Context assessment for agroecology transformation in the Tunisian living landscape.

Depauw, L., Blondeel, H., De Lombaerde, E., De Pauw, K., Landuyt, D., Lorer, E. & De Frenne, P. (2022). The use of photos to investigate ecological change. Journal of Ecology, 110(6), 1220-1236. https://doi.org/10.1111/1365-2745.13876

Jeanneret, P., Aviron, S., Alignier, A., Lavigne, C., Helfenstein, J., Herzog, F., Kay, S. and Petit, S., 2021. Agroecology landscapes. Landscape Ecology, 36(8), pp.2235-2257. https://doi.org/10.1007/s10980-021-01248-0

Jones, S. K., Sánchez Bogado, A. C., Lamanna, C., Dickens, C., Geck, M. S., Wickramaratne, C., ... & Sibanda, T. Holistic Localized Performance Assessment (HOLPA) Tool for Collecting Locally Relevant and Globally Comparable Evidence of Agroecology's Effects on Nature and People. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4891979

Marzin J; Bonnet P; Bessaoud O; Nu C T. 2016. *Study on small-scale agriculture in the Near East and North Africa region (NENA): Overview.* Doctoral dissertation, CIHEAM-IAMM; FAO.

Marzin J; Bonnet P; Bessaoud O; Ton-Nu C. 2017. Study on Small-Scale Family Farming in the Near-East and North Africa Region: Synthesis. FAO, Rome.

Shiri, Z., Le, QB., 2024a. Mapping Contextual Similarity Units of Agroecosystems for Agroecological Scaling toward Achieving Land Degradation Neutrality, (technical report, Agroecology Initiative, accepted)

Shiri, Z., Le, QB., 2024b. The Eco-Landscape Approach for Landscape Restoration (technical report, Agroecology Initiative, accepted)

Shiri Z, Frija A, Rejeb H, Ouerghemmi H, Le QB. Data on the Land Cover Transition, Subsequent Landscape Degradation, and Improvement in Semi-Arid Rainfed Agricultural Land in North–West Tunisia. *Data*. 2024; 9(8):96. https://doi.org/10.3390/data9080096

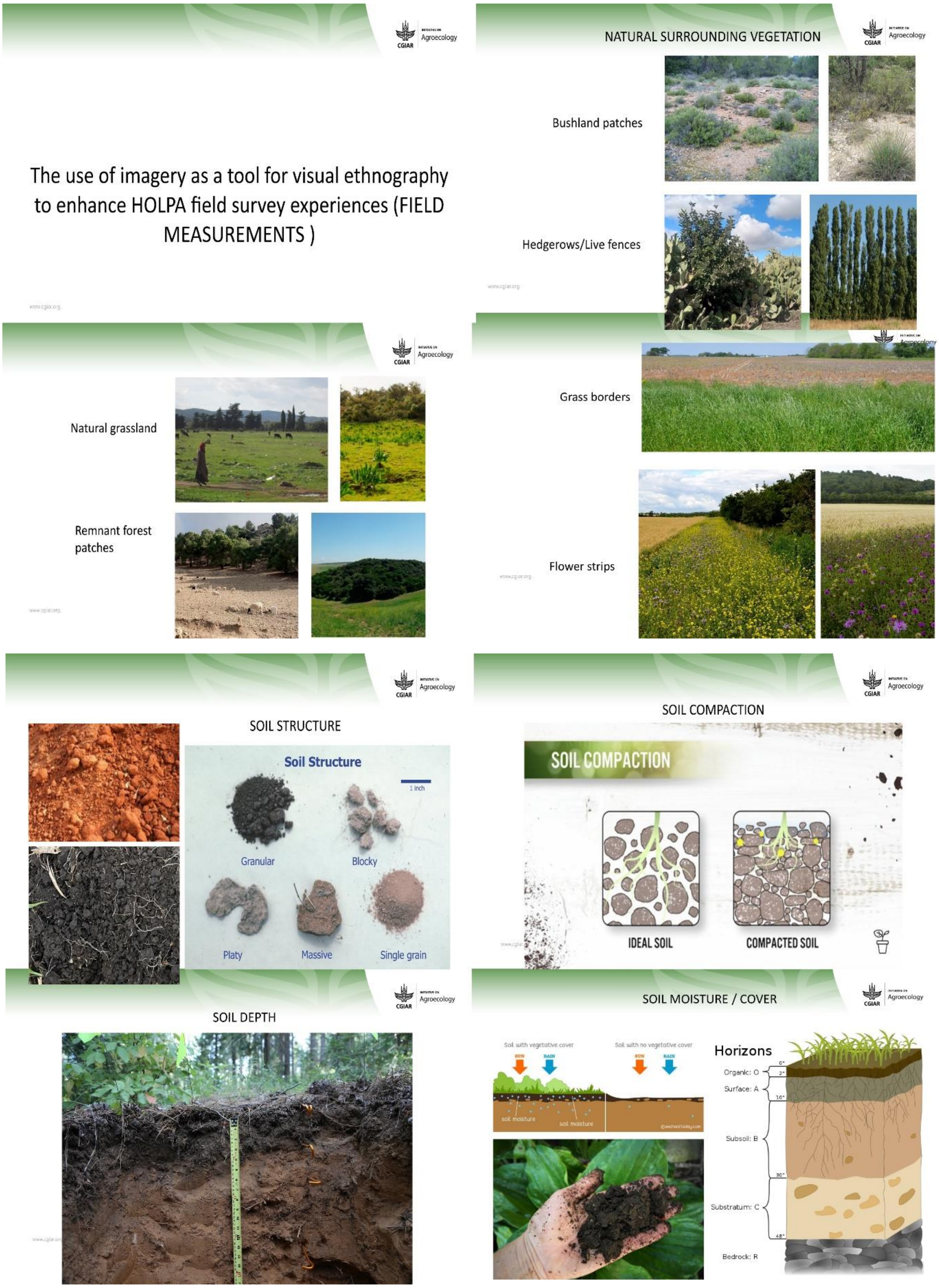
ACKNOWLEDGEMENTS

We would like to express our sincere gratitude to the dedicated team of enumerators whose efforts were instrumental in successfully collecting data for the HOLPA survey. Our thanks go to Zahra Shiri, Ons Tebourbi, Wael Toukabri, Mariem Barbouch, Hazem Cherni, Ines Gharbi, Asma Mahfoudhi, Najet Sliti, Faten Khadraoui, Yassine Fadhly, Marwa haj Ahmed, and Haïfa Mannai. Their professionalism, commitment and hard work were invaluable in ensuring the quality and reliability of the survey results.

Appendix 1

Figure A1. Additional Tool (For the semi-natural and natural vegetation, we were using a printed example developed to facilitate the recognition of each type (with pictures from Tunisian farms)).

Appendix 2: The use of imagery as a tool for visual ethnography to enhance HOLPA field survey experiences (FIELD MEASUREMENTS)

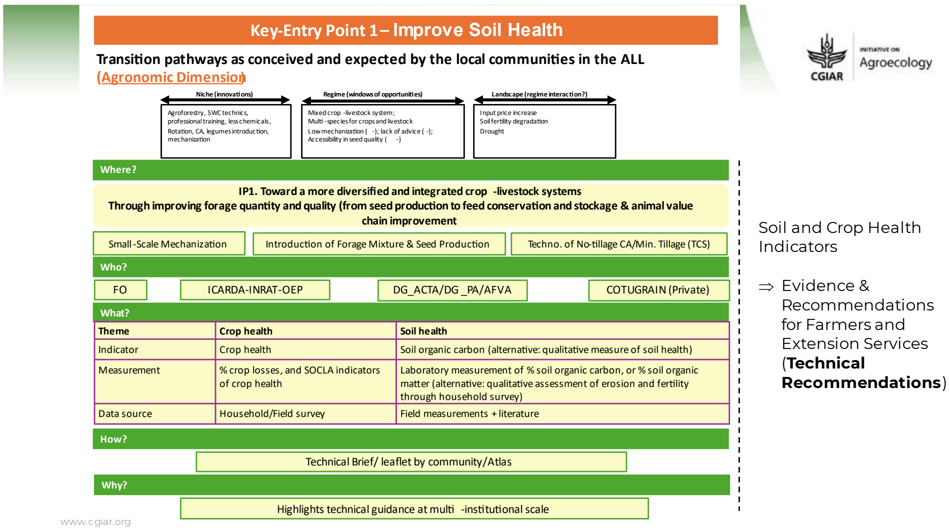


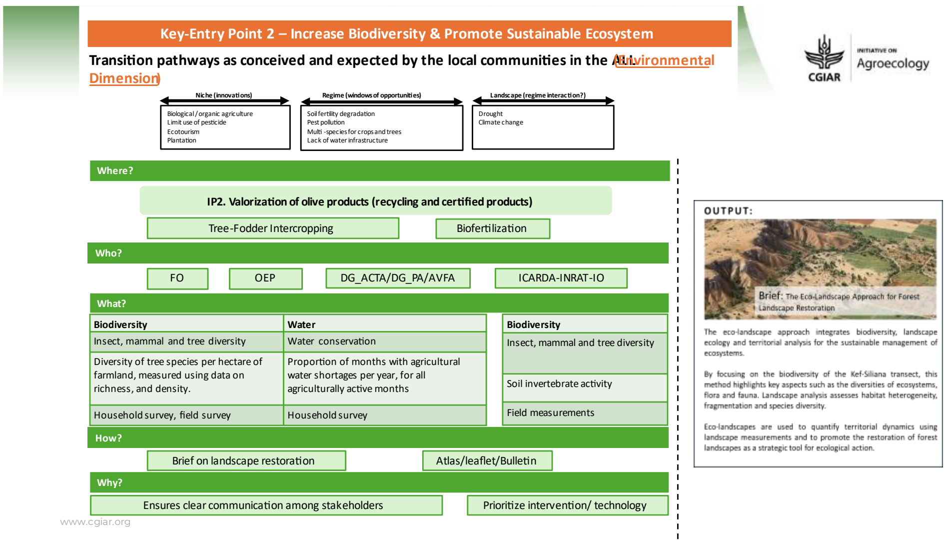

THE SOIL INTERVEBRATE ACTIVITY

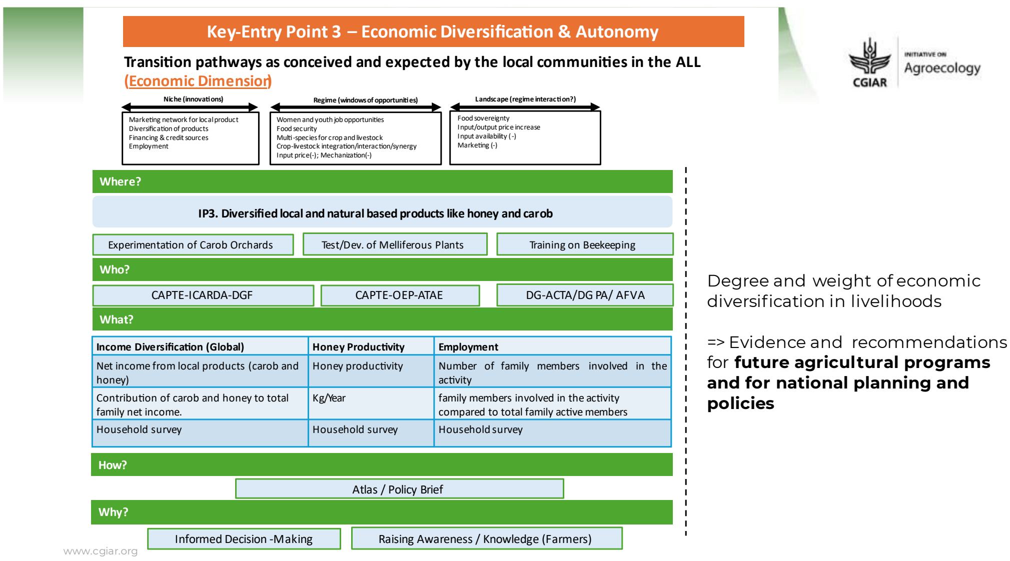

CROP/PASTURE NATURAL ENEMY
ABUNDANCE
PEST PREDATORS
hover fly (not bee)


WEED PRESSURE

Appendix 3. Pre-identification of the indicators from the Visioning to Action (Presentation 4th Sept 2024, Initiative Agroecology, WP2)







Véronique Alary, Senior scientist- Agricultural economist, v.alary@cgiar.org; veronique.alary@cirad.fr

Wael Toukabri, Researcher in soil science, waeltoukebri@gmail.com

Zahra Shiri, PhD in ecology, z.shiri@cgiar.org

Layal Atassi, Researcher in geoinformatics, L.Atassi@cgiar.org

Abeyou Worqlul, Researcher in Biological and Environmental Engineering, A.Worqlul@cgiar.org

Haithem Bahri, Professor, Soil scientist, haithem.bahri@ingref.ucar.tn

Mariem Barbouchi, Soil scientist, barbouchi.meriem@yahoo.fr

Zied Idoudi, Research associate, agro-economist, Z.Idoudi@cgiar.org

Bao le Quang, Agricultural Livelihood system Expert, Q.Le@cgiar.org

Hatem Cheikh M'Hamed, Reseracher in agronomy, hatemcheikh@yahoo.fr

Maryline Darmaun, Researcher in agronomy, maryline.darmaun@ird.fr

Aymen Frija, Senior scientist- Agricultural economist, A.Frija@cgiar.org

CGIAR is a global research partnership for a food-secure future. CGIAR science is dedicated to transforming food, land, and water systems in a climate crisis. Its research is carried out by 13 CGIAR Centers/Alliances in close collaboration with hundreds of partners, including national and regional research institutes, civil society organizations, academia, development organizations and the private sector. www.cgiar.org

We would like to thank all funders who support this research through their contributions to the CGIAR Trust Fund: www.cgiar.org/funders.

To learn more about this Initiative, please visit this webpage.

To learn more about this and other Initiatives in the CGIAR Research Portfolio, please visit www.cgiar.org/cgiar-portfolio

INITIATIVE ON
Agroecology

Véronique Alary, Senior scientist- Agricultural economist, v.alary@cgiar.org; alary@cirad.fr

Zahra Shiri, PhD in ecology, z.shiri@cgiar.org

Wael Toukabri, Researcher in soil science, waeltoukebri@gmail.com

Layal Atassi, Researcher in geoinformatics L.Atassi@cgiar.org

Abeyou Worqlul, Researcher in biologiocal and environmental Engineering, A.Worqlul@cgiar.org

Haithem Bahri, Professor, Soil scientist, haithem.bahri@ingref.ucar.tn

Zied Idoudi, Research associate,agro-economist, Z.Idoudi@cgiar.org

Mariem Barbouchi, Soil scientist, barbouchi.meriem@yahoo.fr

Bao le Quang, Agricultural Livelihood system Expert, Q.Le@cgiar.org

Hatem Cheikh M'Hamed, Reseracher in agronomy, hatemcheikh@yahoo.fr

Maryline Darmaun, Researcher in agronomy, maryline.darmaun@ird.fr

Aymen Frija, Senior scientist- Agricultural economist, A.Frija@cgiar.org

We would like to thank all funders who support this research through their contributions to the CGIAR Trust Fund: www.cgiar.org/funders.

To learn more about this Initiative, please visit this webpage.

To learn more about this and other Initiatives in the CGIAR Research Portfolio, please visit www.cgiar.org/cgiar-portfolio

CGIAR INITIATIVE ON Agroecology