


PREPARING THE NEXT GENERATION OF PROFESSIONALS FOR RESILIENCE IN AGROECOSYSTEMS

The research of the “SARe Master of Science” students
AY 2021/2023

Edited by
Lamberto Lamberti
Philipp Debs




CIHEAM Bari

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CIHEAM, International Centre for Advanced Mediterranean Agronomic Studies, is an intergovernmental organization whose missions are education, research, and cooperation. It comprises thirteen member countries from the Mediterranean region (Albania, Algeria, Egypt, France, Greece, Italy, Lebanon, Malta, Morocco, Portugal, Spain, Tunisia, and Turkey). CIHEAM's General Secretariat is based in Paris and CIHEAM Bari is the Italian Institute of the organization, with the other three institutes based in Montpellier (France), Saragoza (Spain) and Chania (Greece).

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Foreword

Sustainable development of agriculture and agri-food systems can only be pursued through the participation of people, and a key step is the mobilization of youths. They must be prepared and motivated to become the new professionals who will facilitate the transformation of rural areas. They need to be provided with a solid background concerning the theories, concepts and principles that will drive the processes towards sustainability. But most importantly, they need to develop skills and competencies to adequately catalyze and facilitate these processes.

Against this background, we design and deliver our Master program in Sustainable Agroecosystems and Resilience at CIHEAM Bari. We select young students from different countries and ensure them a wide exposure to the actors in the field of agriculture and food production, from both the academic and the non-academic sector. Through practical activities, teamwork, field research, we guide them towards a transformative learning, shaping their hard and soft skills, wishing to see them soon become protagonists in their professional activities for sustainable development.

Maurizio Raeli

Director of CIHEAM Bari

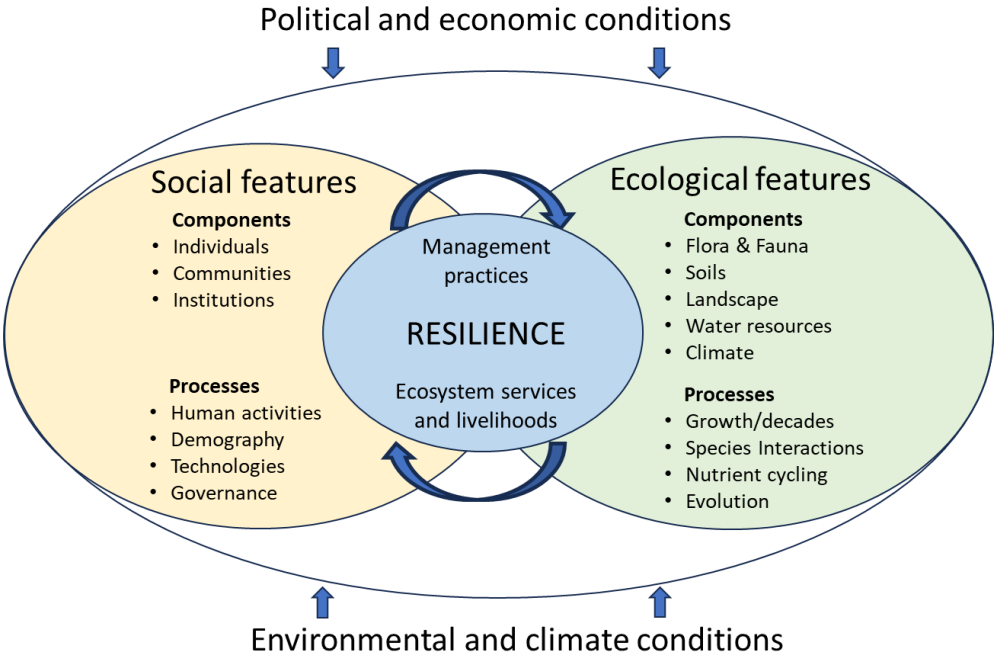
Introduction

CIHEAM Bari launched in 2021 the Master of Science in Sustainable Agroecosystems and Resilience (SARe)[1] to develop young professionals' capacities to face the agricultural challenges of the next decades and promote agroecological transition in rural areas. It lasted 20 months in total, with the first half mainly devoted to students' formal instruction and the second half to developing field research in the students' home countries. In the A.Y. 2021/2023 the course graduated 8 students with different university backgrounds coming from 5 countries: Albania (1), Lebanon (2), Kenya (1), Tunisia (3), and Morocco (1).

Agroecosystem and resilience perspective

The Master recognizes the importance of developing agriculture according to an ecosystem resilience and agroecological perspective.
Agricultural areas are considered to be complex ecosystems:

- which have specific ecological and social features;
- which are under constant perturbation and transformation due to complex factors (political, social, economic, environmental and climatic);
- which have to deliver ecosystem services (regulating, supporting, provisioning, cultural services) and support the livelihoods of local communities;
- whose evolution heavily depends on the decisions, interactions and actions of local people and societies.



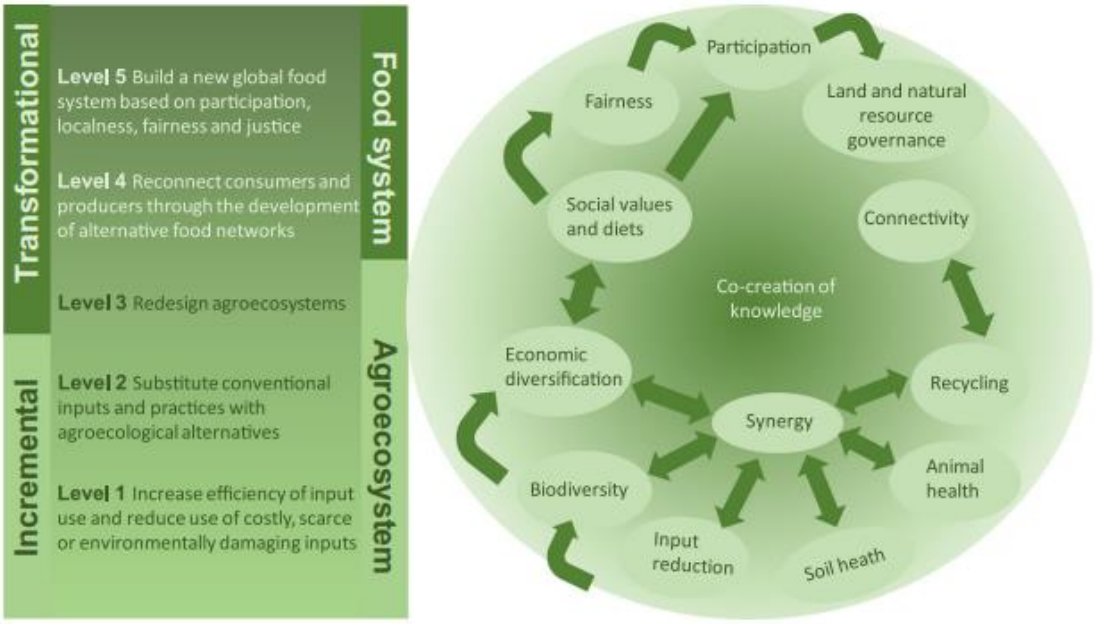
A complex ecosystem, adapted from Virapongse et al. 2016

Local people and societies, influence the quality of their ecosystems with all their expressions and through the processes that they have determined. They are viewed as the key actors who must

[1] For more information about SARe Master: https://www.iamb.it/education/masters/sare/

contribute to the construction of resilient ecosystems by driving the transformation of their territories and building their properties to face disturbances and maintain the ecosystem qualities.

As far as agriculture is concerned, the social features of a territory are expected to facilitate the dissemination of green and inclusive values and processes. We recognize that the transformation of agroecosystems towards sustainability and resilience must go through the application of key agroecological principles that pursue: the efficient use and development of inputs and technologies, more diversified and connected farmlands and landscapes, local/alternative networks and community participation, and a fair and just integration between farming and food systems.



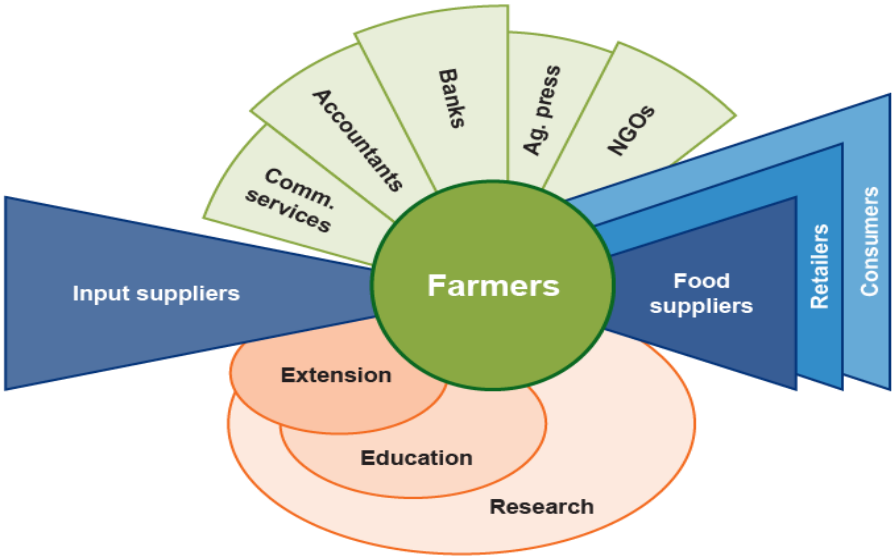
Transition levels towards sustainable food systems and related consolidated principles of agroecology, source: Wezel et al. 2020.

Agroecosystem actors

These processes require the mobilization of a complex network of actors who, together, would promote good agricultural practices and develop agri-food systems that preserve or improve ecosystem qualities. The actors involved in agricultural development within an ecosystem can be numerous and may differ according to the considered ecosystem. The Agricultural Knowledge and Innovation System (AKIS) is an inclusive framework that illustrates the variety of agricultural actors who support agricultural development with different responsibilities and roles.

Farmers take central stage as direct managers of the farmland and producers of goods. Their decisions and actions are determined by their capacities and access to information, knowledge, and technologies, and therefore their interaction with a range of actors. Market and value chain actors are main drivers of agricultural change, as they demand products with specific qualities and provide the necessary inputs. Other drivers of change include the stakeholders who provide assistance and/or empower producers, such as extension services, farmers' associations, non-governmental organizations, micro-finance organizations; or those who provide education and research, such as vocational training schools and research projects.

It is worth mentioning that key stakeholders can also be non-agricultural actors, for example institutions with environmental or social missions, such as nature parks, which need to find a convergence of interests with the farmers who live in the area, or citizens' groups who support farmers' networks respecting agroecological principles.



AKIS framework, source: EU SCAR (2012)

Students' research

Learning from agroecosystem actors is a fundamental step for understanding the challenges to forward resilience concepts and promote agroecological transitions. Actors work in specific territories, face problems, respond to changes and opportunities, and have different motivations. They struggle to achieve their goals through complex relationships and networks.

It is under this framework that we guided our students throughout their Master research. They studied cases related to problems or challenges within specific agroecosystems in their home countries, of concern for small scale farmers, pastoralists, local institutions and organizations. They focused on issues related to food products and value chains, natural resources management, innovation systems and agricultural services. They implemented their research interacting with key actors, observing their workplace and territories, administrating questionnaires, managing group discussions, and interviewing key informants. Students challenged themselves with the analysis of complex phenomena in order to understand the causes and effects; the role of stakeholders and their networks; the behavior of farmers and their vulnerability or resilience in their territories.

The present document provides an overview of the research carried out by our students. It briefly describes the scope of their research, the methods used to collect information, the main findings, and the list of the selected references. The aim is to help disseminate the valuable experience of our students, who have worked with passion and determination, to understand the challenges of agricultural development in their territories; to inspire youths who see themselves, in the decades to come, actively engaged in contributing to the spread of green and inclusive agriculture.

Lamberto Lamberti

Assessing land management sustainability in Preza village - Albania

Author: Arsid Pambuku (Albania)

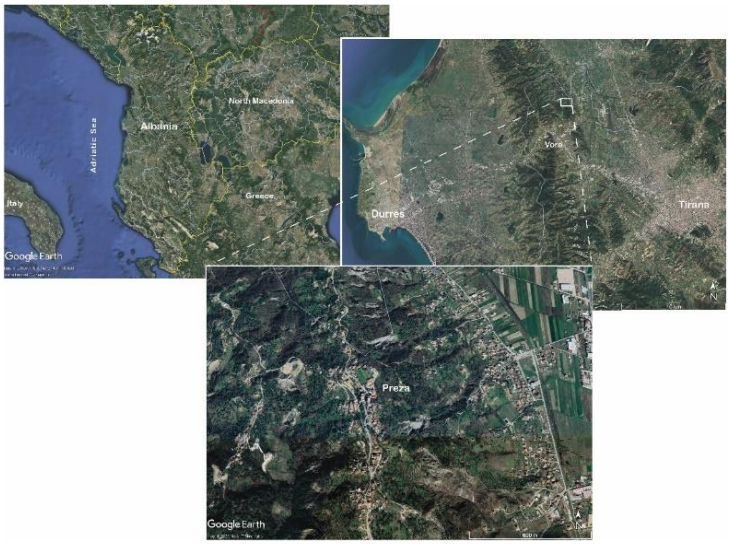
Supervisors: S. Lushaj (POLIS University, Albania), P. Zdruli (CIHEAM Bari, Italy)

What were the research background and objective?

In the last decades Albania is experiencing significant changes in rural areas due to a huge flux of people to cities, in particular of youths, seeking new jobs or education opportunities. Consequently, rural environments went through massive changes, with a deterioration of infrastructures and services. Agriculture sector has also been impacted, with people going out of the sector and with an increasing surface of abandoned lands, often associated to land degradation. It is evident that such processes must slow down.

There is the need of a conscious and integrated kind of development, including sustainable land use planning, improving land management and its protection from degradation.

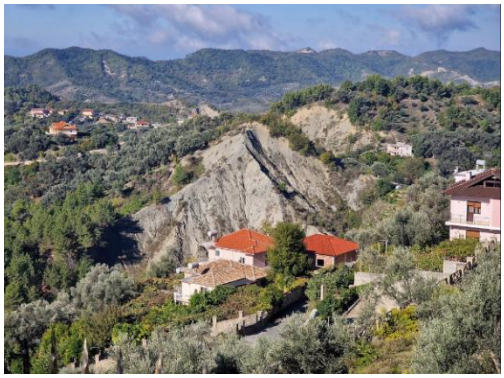
Preza is a village close to Tirana that has a hilly landscape. It is a well-known area recognized for the quality of its landscape and cultural heritage where, in contrast with the national data, there is a lower rate of uncultivated lands and a good agricultural landscape. The main cultivated crop is olive, and the olive oil production is considered of high quality.



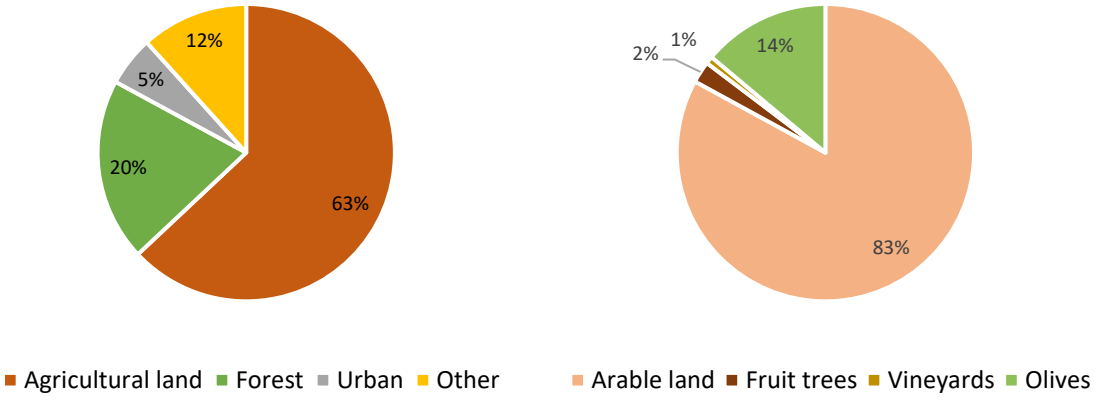
Location of the study area (Pictures taken from Google Earth)

For these reasons, Preza territory has been considered for the present study as an area where it was worth to study the agricultural sector and get views on its sustainability; to explore how farmers consider farming and the challenges they see for the future.

How was the research implemented?



The research focused on the territory around Preza village. This is Preza administrative unit, part of Vora municipality, located between Tirana and Durrës. Its territory covers a total of 2560 ha, out of which 1613 ha (61%) are agricultural land. The terrain in the village is composed by hilly and plain parts and it is mainly cultivated with olives, different annual crops, and vegetables. It has an average annual temperature of 13,5°C, with precipitation of around 1000 mm/year. In contrast with other rural areas, there have been in the territory an increasing of population, from 6.600 people in 2001 to about 7.500 in 2021.



Main land cover types in Preza administrative unit (left)
Area occupied by crops compared to total agricultural area in Preza administrative unit (right)

The research included a preliminary review and analysis of data and information from official sources related to socio-economic and natural conditions and land use of Preza administrative unit, aimed at providing a detailed characterization of the territory under study.

Once the territorial landscape was laid out, the research went deeper to thoroughly understand the situation of Preza regarding agricultural and land use, to get a grasp of the real situation and understand all the factors which help or hinder the capabilities of local inhabitants and farmers to achieve decent livelihoods. For this purpose, there have been many field visits to talk with informants, including the head of the administrative unit, agricultural experts, farmers, and local entrepreneurs. Many other conversations and meetings have been held with institutions which have some competences in Preza village, in agricultural or closely related sectors.

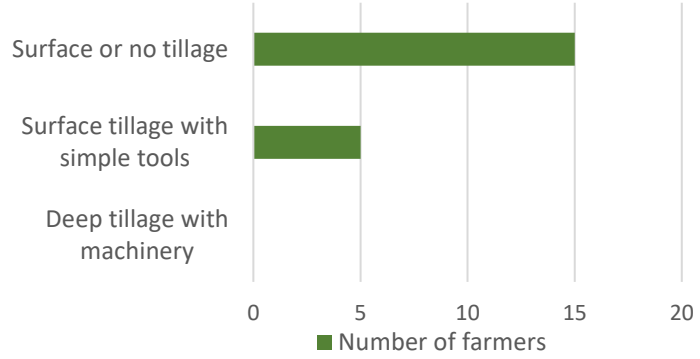
Finally, a small survey among local farmers was implemented, taking inspiration from SAFA (Sustainability Assessment of Food and Agriculture Systems) framework. It was administered to 20 farmers, out of a local community of around 250 farmers. The questionnaire included 19 questions, the first three general, the others split between bio-physical and socio-economic questions. The survey method was that of snowball collection, meaning that a farmer was suggesting the next one to be interviewed.

What were the main findings?

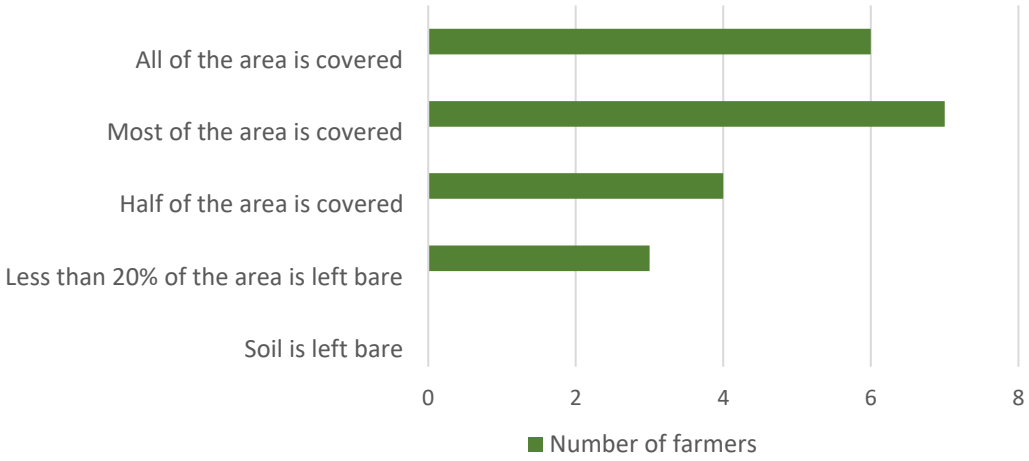
The research has allowed to get important information that help to understand some features of the agricultural sector in Preza territory.

Farmers have diversified livelihoods, not only based on agriculture. Their daily activities are in the nearby villages and in Tirana, thus making farmers being not far from their lands, so they are more able to invest time and resources in their agricultural activities. In fact, the area presents only 1.2% of uncultivated land, compared to 4.19% in the whole administrative area.

Most of the farmers informed that they have good soil qualities, due to a reduced use of chemical inputs and for the application of sustainable land management such as minimum tillage and/or soil coverage practices.

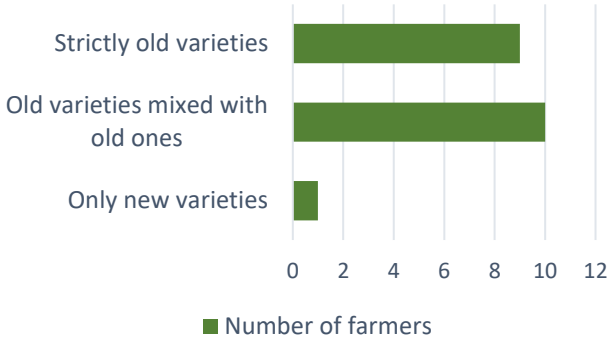


Tillage practices



Soil covering with a cover crop or plant residues

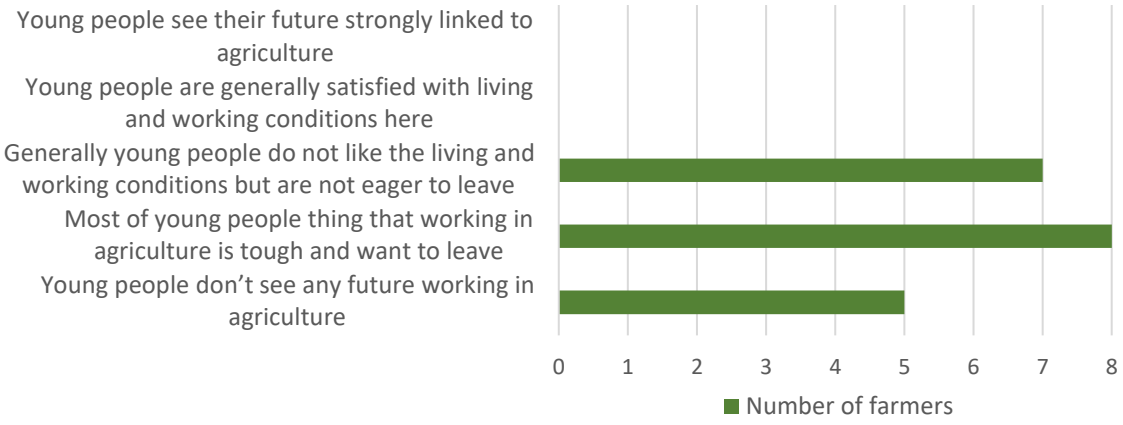
Olive trees are confirmed as the most important crop in Preza and there is an increasing of the area under olive cultivation, mainly to produce olive oil (increase of 11% since 2014 and 20% from 1991). Farmers have preserved the old century varieties and planted other new ones. Customers who buy Preza olive oil are from local communities and from surrounding cities. These are traditional clients, and an increasing number is attracted by the word of mouth.



Use of old and new olive varieties

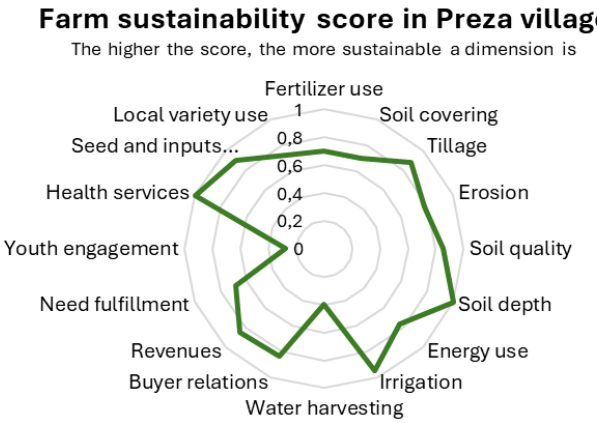
Farmers recognize the importance of advisory services for their farming activities. They give value to the technical assistance given by the existing agricultural pharmacy, that advise about input use, soil managing techniques, seeds and more. Most of the farmers take advantage of the professional advice to carefully use the inputs in a rational way.

Related to incomes, most of the interviewed farmers informed their revenues from farming in the last five years were higher than the covered costs. They also highlighted that a big problem is the uninterest of youths to work in the agricultural sector.



Youth involvement in agriculture

The tentative of assessing farm sustainability gave interesting figures, that however would need additional research since the number of interviewed farmers was low. The aggregation of data gave a high-level score (about 0.8) of farm sustainability, mainly related to the use of good land management practices, quality of soils, access to services, relations with customers and remuneration. The figure confirms that the main problem that threaten the future of farms are the lack of interest by youth toward agricultural activity.



Farm sustainability score in Preza village

It was concluded that:

- Preza territory has quite unique geographic, natural, and historical features. Even though it cannot escape some of the problems the rural areas generally face in Albania, it seems it can tackle them differently. It is probably a combination of few factors that has helped Preza village preserve its identity, tradition, and overall attractiveness, namely: the terrain, the lack of major population replacement, and the proximity to bigger urban centres.
- The maintenance of good land management practices is providing a very good soil health, crops productivity and landscape quality.
- Farming, in particular olive trees cultivation, is ensuring livelihoods and in particular contributing to create a strong cultural identity of farmers and of Preza village too.
- The low interest of young people towards agriculture and in the village life in general is the most pressing issue for this area. It is very difficult for Preza to be immune from the national trend of rural-urban movement trajectory, and external migration.
- It would be worth to undertake a bigger survey with SAFA model to make a deeper analysis about the sustainability of local farming systems.

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Cassava innovation system in Kenya: the case of Kilifi Sub County

Author: Sylvia Aluvanze (Kenya)

Supervisors: J. Ndiso (PWANI University, Kenya), E. Nerilli (CIHEAM Bari, Italy), L. Lamberti (CIHEAM Bari, Italy)

What were the research background and objective?

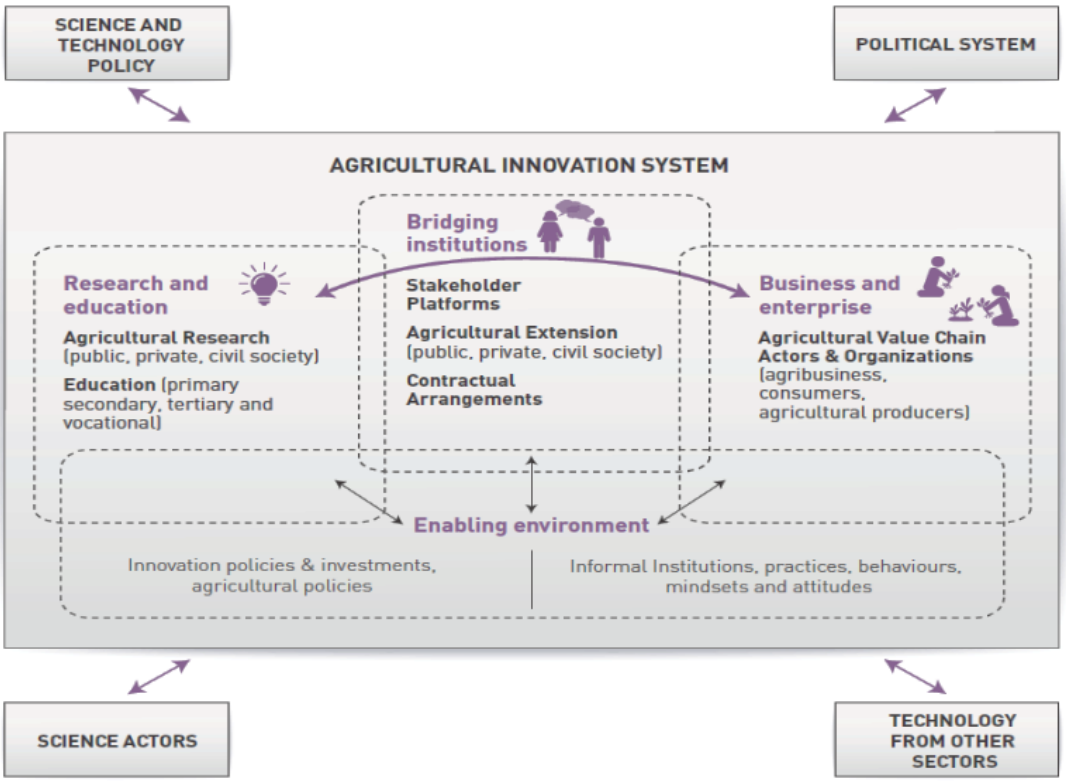
Kenya covers about 582,646 km^2 among which 89% of these lands are Arid and Semi-Arid (ASALs). Here livelihoods are fragile and agriculture, the main activity for millions of smallholders, is impacted by climate change. They depend on rainfed agriculture as a main source of income, and the reduction of rains or the intensity of events, make them more vulnerable and less resilient.

Cassava (*Manihot esculenta crantz*) is a staple crop, whose tubers are an important source of starch and other nutrients for rural communities in many developing countries. It is a crop already cultivated by farmers in ASALs, since it requires low inputs in terms of water and fertilizers. It is propagated from stem cuttings, making planting material low-cost and readily available. The cultivation cycle is pretty long, 8-10 months, starting from cuttings transplanting in springtime and tubers, once harvested, have a very short life (3/4 days), unless properly processed. Local farmers usually invest very small surfaces, even few plants in gardens, and use harvests for home consumption or selling in spot markets. They use local varieties, low productive and nowadays extremely impacted by viruses' diseases (Cassava Mosaic Virus - CMV and Cassava Brown Streak Disease - CBSD).

As a way for improving the resilience of smallholders in ASALs, the government is managing programs that encourage cassava cultivation and commercialization. These are principally based on the use of cassava improved varieties, already diffused in other similar agroecosystems, that ensure high yields and are tolerant to viruses; and of tubers processed products, mainly chops and flours, that ensure longer shelter life and can be marketable with good profits to processors.

This is a challenging process that needs the coordinated action of a range of actors that work for the creation of farmers' awareness on new varieties, the availability at local level of propagating materials, the presence of organized processors and the creation of a demand for processed products. The literature identifies these actors, and their actions, as the Agricultural Innovation System (AIS), dividing them in the domains of research and education, bridging institutions, business, and enterprise.
Thus, the present study aimed at exploring how cassava cultivation is developing in ASALs, answering to the following questions:

- How do farmers consider cassava cultivation, in particular cassava commercial varieties?
- What are the main features of cassava value chain (VC)?
- Which are the AIS actors facilitating cassava value chain development?

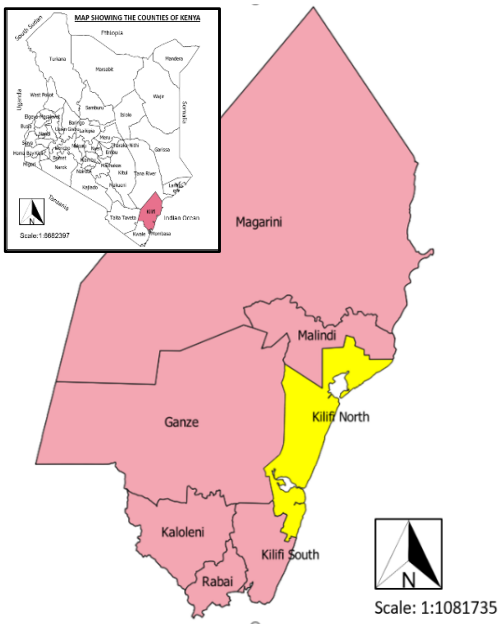


AIS conceptual diagram (Tropical Agriculture Platform, 2016)

The study was implemented in the framework of the Go Blue project managed by CIHEAM Bari, that had a component on cassava value chain development in Klifi County. The results of the research can be useful to learn lessons and orient policies and programs on cassava VC development in the case study area.

How was the research implemented?

The study area was in Kilifi North Sub County that is administratively divided in 7 wards, that are the place where Ward Agricultural Offices are active within farmers' communities.



Map of Kilifi County Highlighting the study area- Kilifi Sub County

This territory is classified as ASAL agroecosystem and falls within the coastal lowland semi-humid transitional agroecological zone suitable for the cultivation of a variety of crops, including cassava. The annual precipitation in the area is on average of 1200 mm with a mean temperature of 24°C.

In the last years there have been many interventions in the territory for supporting cassava value chain development through National programs and international non-governmental organizations actions. One of this is the Agricultural Sector Development Programme (ASDSP) managed by the regional Department of Agriculture, that works with smallholder farmers and in coordination with other regional entities and international organizations.

The research used a qualitative approach, and was based mainly on:

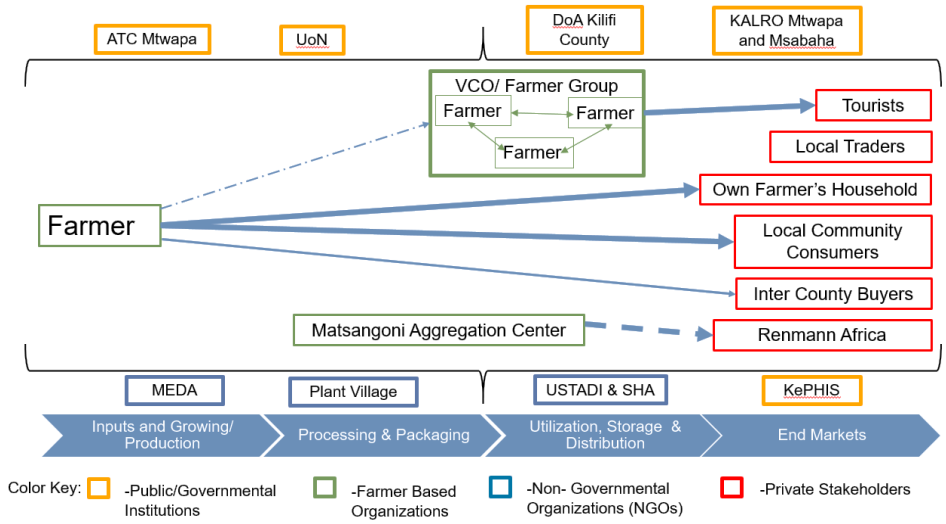
- Field observations: visits to farmers who cultivate cassava and/or propagate cuttings, and to processing units managed by farmers for cassava transformation.
- Semi-structured interviews to informants: 9 informants were interviewed with the scope to understand the role of different actors in the value chain and their connection to farmers. Informants belonged to University, NGOs, DoA/ASDSP; private company, Agricultural Training Center; Country Steering Committee on cassava.
- Interviews to farmers: 25 farmers were interviewed to get information on their investments and perspective on cassava cultivation. They were from Sokoni, Tezo, Matsangoni, Dabaso and Watamu districts.
- Focus group: one focus group with 8 farmers was organized within a community managing cassava processing unit to discuss about challenges in processing units' management.

During the interviews, information received from respondents were mainly recorded in a notebook and its synthesis conveyed later for their analysis. A value chain graph was outlined according to the informants' responses, describing the kind of linkages among actors, the strengths and weaknesses. The stakeholders were analysed in terms of their support to farmers and VC development, looking at how they are connected to one another and how they function to achieve specific and common objectives. The data analysis was done also with the support of diagrams to highlight how the AKIS framework looks like. The findings were presented in narrative form with the help of pictures, tables, and maps.

What were the main findings?

The research showed that smallholders farmers have an interest in cassava in Kilifi Countee. They cultivate it in small plots and numbers in households' gardens, using the local variety Kabandameno. This kind of cultivation is mainly managed by women. Farmers appear aware of the opportunities that may come from the cultivation of commercial varieties, in particular of Tagirika, considered much more productive and resistant to diseases. However, there is a diffused feeling among farmers that it can be risky to invest high surfaces with cassava commercial varieties due to the recurrent droughts in the last years, and the fear that high harvest can remain unsold. In fact, commercial farmers seem still few in numbers. Someone of them were encountered, one was a woman, and visited on their fields. They had between 1- and 2-acres field size, planted with Tagirika variety, someone having hired the field. They were proud to show their plants in good status and with an abundant tubers production, almost ready for harvest, and do not show to be much worried about markets.

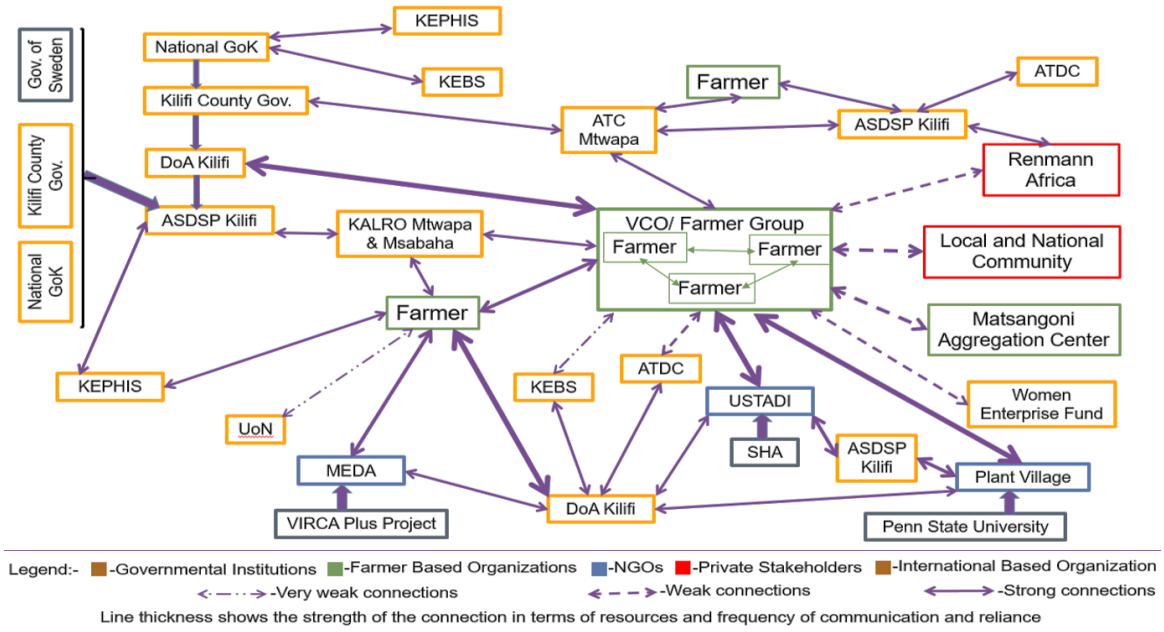
Looking at the value chain, farmers mainly use harvests for household's needs or direct selling to local communities. There are efforts to develop small scale processing units managed by farmers' communities organized in Value Chain Organizations. These have been set up through Governmental programs and NGOs and equipped with assets to process tubers into chops or flours. Three units were visited, and only one showed a complete set of technologies and the capacity to process and package tubers. From the discussions it came out that the provision of raw material and their transportation to the processing unit are the main challenges. Raw materials are mainly provided by NGOs, who bought these from commercial farmers. Final products were also mainly purchased by NGOs and to a less extent sold to the local community of farmers. Examples of industrial and privates' cassava processing were not found.



Cassava value chain in Kilifi North sub-County

Farmers are also important in the multiplication and distribution of Tagirika cuttings. Governmental programs and NGOs have worked to train and cluster farmers' groups on the propagation of certified Tagirika cuttings using a modern and productive technology. Even in this case it seems that cuttings are prevalently purchased by NGOs, for distribution and selling to farmers.

Through the discussion with different stakeholders, it has been possible to come out with a draw of the AIS actors for cassava, highlighting that is very much centred on the empowerment of small farmers. Key actors are the Department of Agriculture, Agricultural Training Centre of KARLOO, and a number of NGOs, that represent the bridging institutions, who facilitate innovation processes in cassava through farmers' training on cassava commercial variety propagation, cultivation and processing. As said, these also provide equipment and technologies to some communities for strengthening the processing phase. For the domain of research, a key role is played by the research centre of KARLOO, who is providing certified material to farmers who propagate cassava.



AKIS map of Cassava Value chain in Kilifi North Sub County

In conclusion, the research showed that cassava is considered an important crop for smallholders in Kilifi County, and that farmers, even if interested to cultivate commercial varieties since are very productive, are still prudent in their cultivation since they are not sure to be able to place in the market higher quantities of tubers; and they still feel exposed to climate events such as droughts.

The value chain is still in an early stage and depends on the actions of governments and in particular of NGOs. Their efforts focus mainly on the empowerment of small farmers, and support them in cuttings propagation, cultivation, and tuber processing, also facilitating the commercialization of products.

Their presence is essential in the next years to further push and build the value chain in a way that it can works out on market mechanisms. For this purpose, it is essential to develop the processing sectors, at the farmers' community level or in the small cities and villages, to create a persistence demand for tubers and their final processed products.

It is known the existence of cassava processing units managed by farmers in other ASALs territories. Visits can be promoted for sharing experiences and inspiring farmers.

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Regenerative land management practices to improve soil quality in mountain areas of Lebanon – the case study of Aley district in Mount-Lebanon

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What were the research background and objective?

The farming sector in Lebanon faces environmental and socioeconomic challenges. Most of farmers are suffering for getting inputs, such as fertilizers, foodstuff, and fuel, and experiencing a high drop of agricultural incomes. Agriculture, in addition, is conditioned by the topography. Around 65% of the country have mountainous landscapes, with steep slopes and valleys of different size. Lands are over-exploited, through grazing, quarrying, urban areas development and farming as well. The absence of strategic land use planning processes and land fragmentation are obstacles to reach food security in a country that faces a severe crisis.

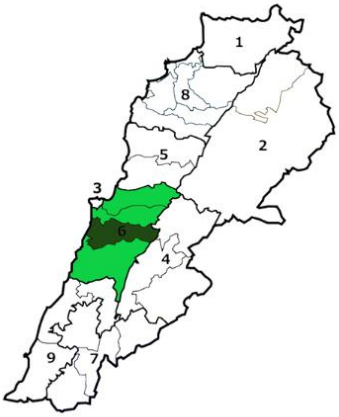
In this context it is important to take care of farmland in a way farming relies less on external inputs, but still keeps land productivity. Soils must be properly managed in a way they remain vital, fertile, and stable, thus providing water and nutrients to crops, facilitating the overcome of drought periods, or resisting to storms, hence increasing the resilience of the farm ecosystem. Soils have an inherent regenerative capacity to resist exogenous and endogenous disturbances. This is a product of the past and the present soil management and could be indicative of possible soil responses to reverse soil degradation or resist to future disturbances. With this regard, many are the sustainable land management practices that, through organic inputs integration, tilling practices, land covering, nutrient cycling, may contribute to keep soil resource alive and neutralize land degradation. The adoption of these practices is, however, conditioned by many factors, bio-physical and socio-economic.

Within this framework, this study aimed at investigating what are the regenerative practices adopted by farmers in Lebanon; to which extent these practices improve soil qualities in comparison to conventional practices. The research focused on Mount-Lebanon territory, where 50% of farmers have very small farmlands in mountainous landscapes.

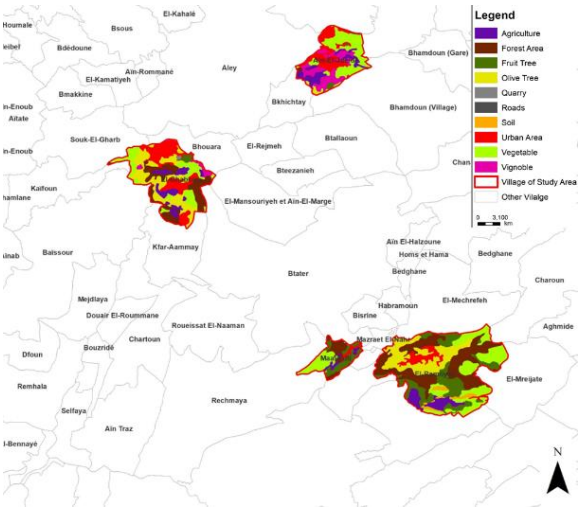
How was the research implemented?

The study area consisted of 4 municipalities in Mount-Lebanon governorate, specifically Aley district. The Mount-Lebanon region has an abrupt and rugged topography characterized by valleys

and deep clefts, with steep slopes that form drainage basins for waterways and springs. The landscape is diverse, featuring natural vegetation and agricultural activities.



Mount Lebanon and Aley district



Map illustrating the land use pattern in the four municipalities of the study region

The methodology relied on qualitative and quantitative data collection. Research activities were conducted over two periods: a first phase of field work (August-September 2022) for qualitative assessment and a second phase (November-December 2022) for quantitative assessment and experimental analysis.

Interviews containing both open-ended and close-ended questions were carried out with 26 farmers to gather information about socio-economic data, farm history, adopted soil management practices and practices involved in the cropping system. Snowball sampling was used due to the sparse distribution of respondents in the region. The focus was on small-scale agroecosystems growing vegetables and fruit trees.

Through the interviews it was possible to identify the regenerative and conventional practices adopted in the farms and categorize them into regenerative, neutral, and conventional.

List of regenerative and conventional practices implemented by farmers in the study region

Regenerative practices	Conventional practices
Conservation (No-tillage) or reduced	Excessive tillage practices
Compost amendments/green manure	Synthetic fertilizers
Crop rotation	No crop rotation
Intercropping/mixed cropping	Monoculture
Cover crops	No cover crops
Improved irrigation technique	Furrow irrigation
Organic or biological pest and diseases treatment	Pesticide treatment (herbicides, insecticides, etc.)
Mixing crop and weed residues with soil, usage as organic mulch, or in composting	Burning or eliminating organic residues

It was possible, at farm level, through scoring each regenerative practice (+1) and each conventional (-1). Farmers ranked between 5 and 2 were classified as regenerative, between -2 and -5 conventional, between -1 and +1 neutral.

A qualitative approach was used for the assessment of soil management sustainability, scoring soil health according to 7 indicators selected from the Latin American Society for Agroecology (SOCLA) indicators, and from the 'Tool for Agroecological Performance Evaluation' (TAPE).

Indicators used for the qualitative analysis

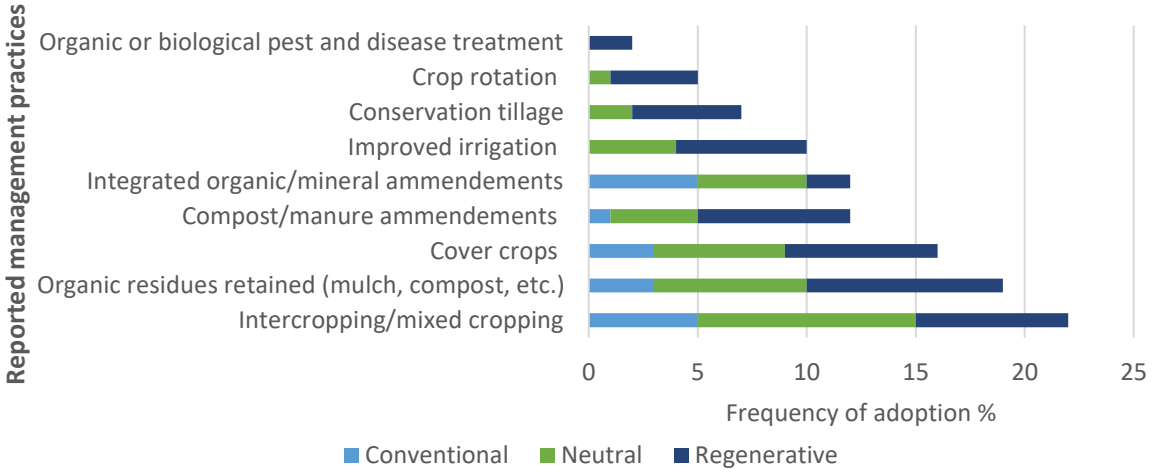
Indicator	Established value	Characteristics	Field score
Structure I1	1-3	Loose soil, powder exhibiting no visible aggregates	
	4-6	Small amount of aggregates, readily breakable	
	7-10	Well formed aggregates, difficult to break	
Status of residues I2	1-3	Organic residues decomposing slowly	
	4-5	Presence of last years' decomposing residues	
	7-10	Heterogenous nature of residues, most are well decomposed	
Color, odor, and OM I3	1-3	No presence of humus with pale and chemical odor	
	3-5	Moderate amount of humus, light brown, odorless	
	6-10	Abundant humus, fresh odor, dark brown	
Crop diversity I4	1-3	Monoculture covering 80% of cultivated area	
	3-5	Two to three crops/tree species	
	6-10	More than three crops and varieties	
Soil cover I5	1-3	No crops, bare soil	
	3-5	Vegetative cover or residues covering less than 50% of land	
	6-10	Vegetative cover or residues covering more than 50% of land	
Erosion I6	1-3	Severe presence of small gullies or fallen stone walls	
	3-5	Evident but low erosion signs	
	6-10	No visible signs of erosion	
Invertebrates' activity I7	1-3	No earthworms	
	3-5	Few earthworms	
	6-10	Abundant presence of earthworms	

For the quantitative assessment, a stratified sampling was used to select five farms from each category. The Soil Management Assessment Framework (SMAF) was implemented, involving a three-step process: indicator selection, interpretation, and integration into an index. Bio-indicators like soil mineralization rate and earthworm abundance, as well as chemical indicators like available phosphorus, exchangeable potassium, organic matter, and pH, were utilized.

Soil sampling was performed according to standard methods for the near surface (0–15 cm) and that sampling design is appropriate for the area to be assessed. Five sub-samples were collected, then mixed well to obtain a homogeneous composite soil sample. Soil characterization parameters were performed to identify soil texture, soil type and total calcium carbonate $CaCO_3$.

What were the main findings?

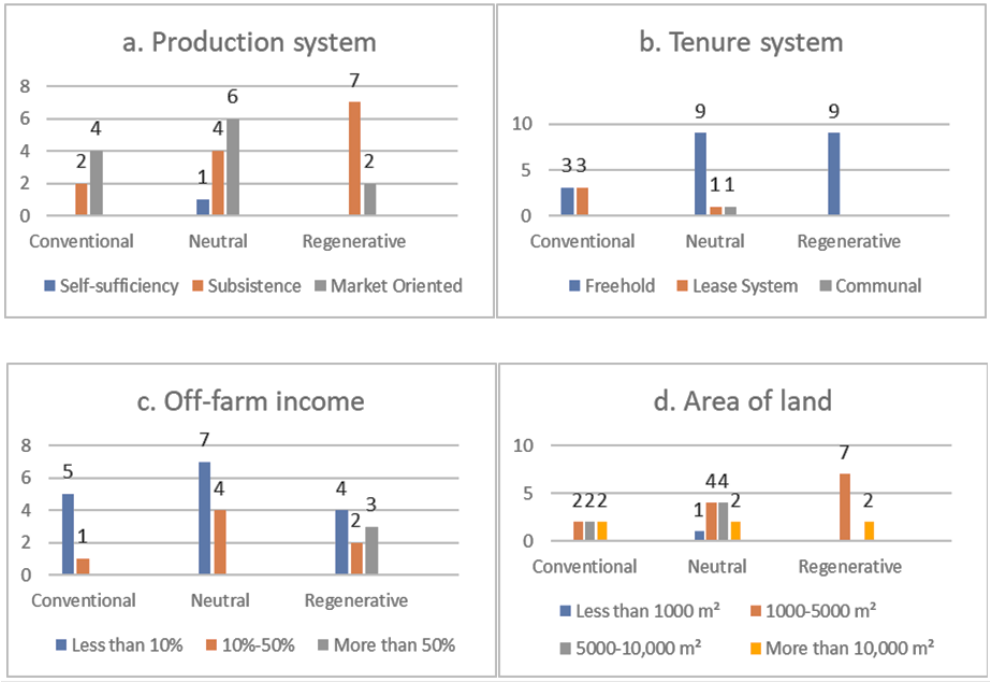
The survey allowed to identify the main land management practices adopted by farmers, and to classify them into 6 conventional, 11 neutral and 9 regenerative farms. The below graph represents the range of regenerative practices and their adoption by the three farm categories. Most of farmers are adopting intercropping/mixed cropping to diversify their products and address economic challenges. Retention of weeds and crop residues is another common low-cost strategy. Only a small part of farmers uses reduced or no-till practices due to their reliance on herbicides in some cases. A large number of farmers grow cover crops in winter for diversification and about the half of them rely solely on compost and manure due to cost increases. Practices requiring significant investment, like improved irrigation and conservation tillage, are less popular. Regenerative practices are weakly adopted in conventional farms. Farmers face risks of soil degradation and water erosion but cover crops and combined practices can help to mitigate these challenges.



Distribution and frequency of regenerative soil management practices adopted by respondent farmers (n=26)

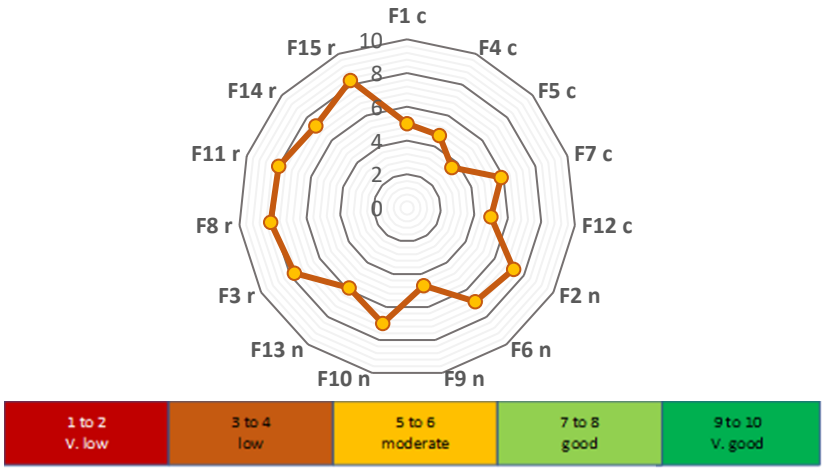
Farmers look very much different in terms of socioeconomic features. The one leading regenerative farm were landowners, mainly with farmland within 1000 and 5000 m^2, are older than the farmers from conventional farms, and relying more on off-farm incomes. On the contrary, conventional, and neutral farmers were more market oriented and, in some cases, leased. The qualitative assessment of soil health was implemented in 15 farmlands through soil and land coverage observation.

Observations of land cover and residues, soil agglomerates, crop diversity



Characteristic of respondents' farmers

Indicators were scored according to their characteristics and a final index calculated. It showed that the adoption of sustainable management practices by regenerative farms correspond to high value of soil health, while conventional practices scored lower values, with neutral farms in the middle.



Radar chart showing distinct soil management sustainability among 15 of the studied farms (F). c: conventional farmers, n: neutral farmers, r: regenerative farmers

The analysis of soil samples of bio-indicators (soil mineralization rate, earthworm abundance, available phosphorus, exchangeable potassium, organic matter, and pH) confirmed that sustainable land management practices in regenerative farms are improving the soil quality. The elaboration of the Soil Quality Index (SQI) confirmed the lowest levels of soil quality for conventional farms, while for the regenerative one the highest.

SQI corresponding with agroecosystems apiece, mean SQI corresponding with categories apiece (c: conventional, r: regenerative, n: neutral), and statistical features.

Code	SQI	Code	SQI	Code	SQI
F4c	0.07	**F10n**	0.17	**F8r**	0.39
F12c	0.04	**F9n**	0.27	**F14r**	0.67
F7c	0.01	**F6n**	0.34	**F3r**	0.45
F5c	- 0.15	**F13n**	0.89	**F15r**	0.54
F1c	0.29	**F2n**	0.49	**F11r**	0.43
Mean SQI	0.05	**Mean SQI**	0.43	**Mean SQI**	0.49
Std. Dev	0.16	**Std. Dev**	0.28	**Std. Dev**	0.11
Min	-0.15	**Min**	0.17	**Min**	0.39
Max	0.29	**Max**	0.89	**Max**	0.67
Median	0.04	**Median**	0.33	**Median**	0.44

The main conclusions of the study are the following:

- Sustainable land management practices are used in the case study area and concretely contribute to improving the soil quality;
- Combining regenerative practices can provide synergistic benefits and increase profitability.
- According to the interviewed farmers it seems that the practices are mainly applied in farms less market oriented (risk aversion) and by aged farmers, with long experience;
- Additional investigations must be implemented to understand more about the effects of land management practices on crops production and income generation, over the years, and understand how these contribute to the resilience of the system;
- Additional investigation is also needed to see which are the main drivers and determinants for farmers to adopt sustainable land management practices;
- The qualitative assessment results about the soil quality were confirmed by the lab analysis and the calculation of the SQI, and can be considered as an efficient, cost effective and rapid approach to undertake even larger sample.

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Opportunities for local foodstuff production for small ruminants breeding in Lebanon

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What were the research background and objective?

Agricultural sector in Lebanon is extremely dependent from the importation of agricultural inputs. The prolonged economic crisis and inflation, together with the Covid 19 pandemic, are limiting the inputs importation and their access by farmers and increasing the vulnerability of Lebanese farms. This suggests the importance to increase the production and use of agricultural inputs from Lebanon, in a way to have more resilient Lebanese farmers and farms.

The small ruminants' dairy sector is an important one in Lebanese economy. Sheep and goats have been intrinsically a component of Lebanese landscapes for hundreds of years and breeds like Baladi or Shami for goats, or Awassi for sheep, are recognized as very important and specific of these areas. Small ruminants breeding produces a consistent part of the country milk and still thousands of families rely on this activity. Breeding is particularly important in marginal regions and contribute to income generation for local communities. In particular, the sector is very important in southern and northern regions, which are among the poorest in the country and where small ruminants' dairy production is a primary means of subsistence and a significant source of revenue.

Sheep and goats for milk production are commonly bred through semi-sedentary or sedentary systems and in semi-extensive way: flocks are daily moved for grazing near the farms or around a village territory and have access to stubble and fallow fields, communal rangelands, private or hired pasture lands.

The use of foodstuff is a diffused practice to intensify and improve milk production and is done mainly with imported staff. Nowadays these inputs are largely imported from other countries and represent a high investment cost for breeders, for most of them unbearable in time of economic crisis, like Lebanon is experiencing right now.

This study has hypothesized that the local production and use of foodstuffs, would be an important step for keeping high the productivity and quality of small ruminants' milk production, allowing for important economic, social, and environmental results. Local organizations like "Go Baladi" are currently working on developing a locally cultivated forage mixture as a potential substitute for imports. Additionally, the University of Balamand has initiated research on crops suitable for the

market, suggesting a favourable mix of barley, oats, alfalfa, and vetch for small ruminants. These crops are proposed since require minimal intervention and can grow from season to season without incurring additional practices or costs.

With this regard, the main research objective has been to assess to which extent the local production of these products as foodstuff may impact on the small ruminants' producers and systems.

How was the research implemented?

Location Map of North and Akkar governorate

The research has focused on small ruminants' breeders from three different regions of Lebanon: Akkar, North Lebanon, and Bekaa. These are territories where small ruminants' breeders are common and where poverty levels are high.

The core of the methodology was the implementation of the Integrated Development and Economic Assessment (IDEA) method. Thus, IDEA was used to evaluate the potential impact of local foodstuff production for small ruminants on the sustainability of small ruminants' farm systems across three dimensions: agro-ecological, socio-territorial, and economic. Using 30 selected indicators, assigned with specific weights, the assessments analysed various components meaningful for the qualification of each dimension.

List of 30 selected indicators for IDEA method

Agroecological		Socio-territorial		Economic	
Diversity	A1: Annual or temporary crops	Products and land quality	B1: Quality of foodstuffs	Viability	C1: Available income per worker
	A2: Perennial crops		B3: Processing of non-organic waste		C2: Economic specialization
	A4: Animals		B4: Space accessibility		C3: Financial autonomy
	A5: Enhancement/conservation of genetic heritage		B5: Social involvement		C4: reliance on subsidies
Organization of space	A8: Organic matter management	Space organization	B6: Short trade		
	A11: Stocking rate		B7: Services, multi activities		
	A12: Space fodder area		B8: Employment contribution		
Farming practices	A14: Effluent processing		B9: Collective work		
	A15: Pesticides and Vet products		B10: Probable farm sustainability		
	A16: Well-being	Ethics and human development	B11: Contribution to food balance		
	A19: Energy dependence		B12: Training		
			B13: Labor intensity		
			B14: Quality of life		
			B15: Isolation		
			B16: Reception, hygiene, safety		

Part of data were collected through the analysis of sources from governmental and international organizations, relevant databases, regarding poverty levels, unemployment rates, and agricultural production.

Interviews were used to collect primary data. For the purpose, 24 small ruminant breeders, applying semi-intensive small ruminants' breeding, were selected on the base of their collaborations with international organizations and preliminary visits. Interviews aimed to gather detailed information about their activities, practices, and challenges, and discussing conditions pre and post to the introduction of local foodstuff for their animals.

What were the main findings?

The IDEA method allowed to describe and compare scenarios before and after the introduction of new crops for foodstuff production.

It showed that the adoption of the cultivation of new crops may generate positive changes on many indicators related to agroecological and social-territorial dimension, while keeping the economic dimension without significant impacts.

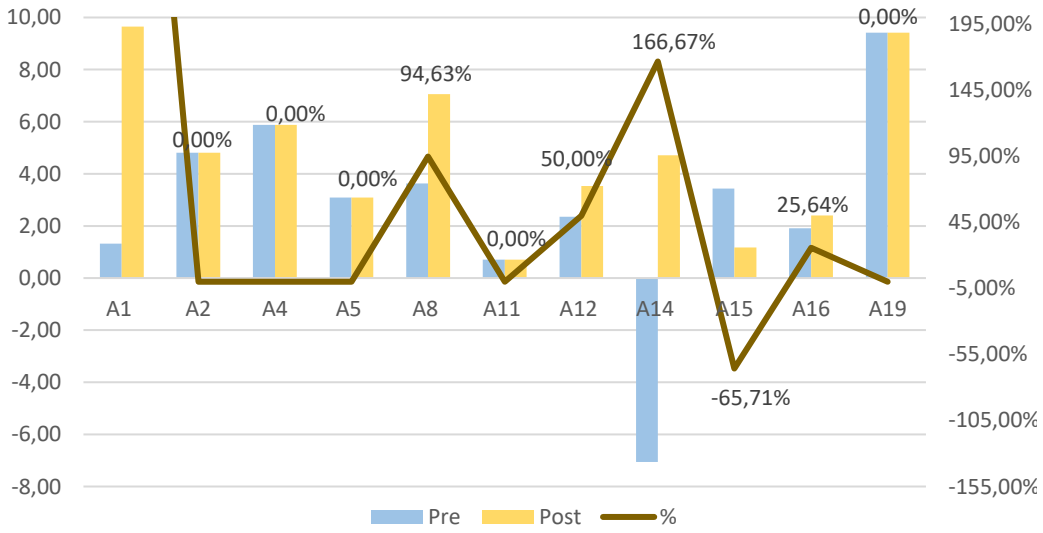
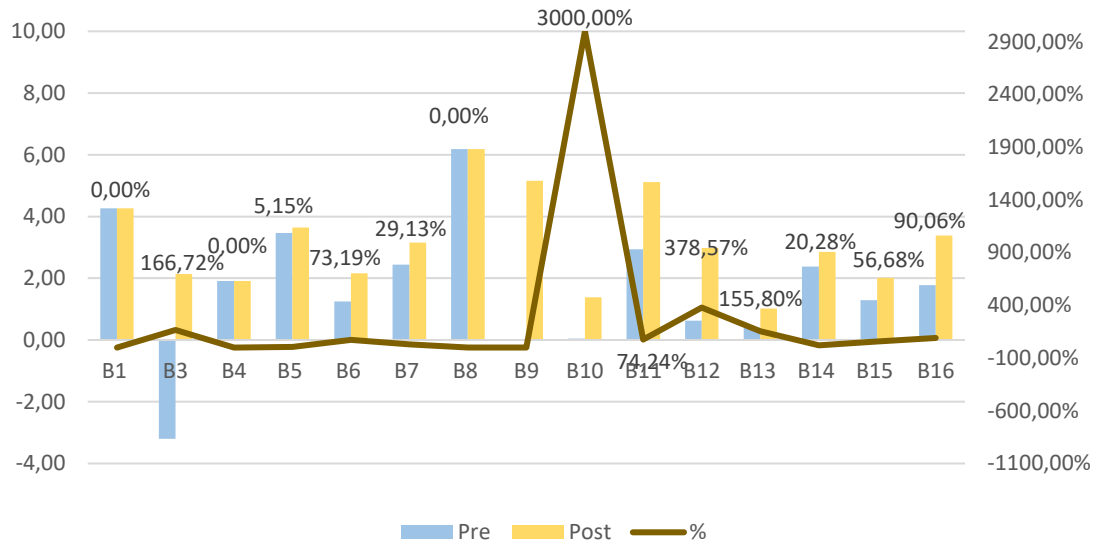
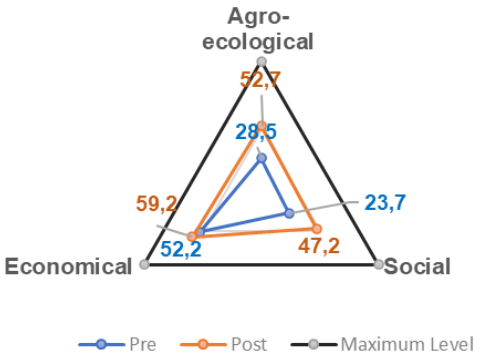


Diagram showing the differences between before and after innovation



Statistical analysis for the differences between before and after innovation

The synthesis of the indicators figures pre and post the adoption of local products as foodstuff for small ruminants, confirm that the introduction of the new crops in the cultivation would be a substantial step towards the sustainability of farms.



Differences before and after the innovation

It was concluded that:

- enhancing farm sustainability requires a holistic approach that considers social, economic, and environmental aspects. While the IDEA method provided valuable insights, additional research is needed to fully understand the effectiveness of feed innovation in Lebanon's small-ruminant sector. Alternative models may be necessary to comprehensively analyze the economic impact of agricultural activities and compare different sustainability approaches.

- improving the availability of local produced foodstuff is a crucial step for the sustainability of small ruminant (SR) farming in Lebanon. By focusing on innovative feeding practices and strategies, the sector can experience substantial growth and sustainability. However, to fully realize the potential of these opportunities, supportive policies and interventions are needed.

- effective policies are essential to prioritize investments in research and development, promoting the adoption of advanced feeding techniques and technologies. Additionally, there should be a focus on enhancing local forage production and reducing dependence on imported inputs. This can be achieved through incentives and subsidies for farmers who adopt sustainable forage cultivation practices and employ efficient feeding management strategies.

- capacity-building programs and knowledge transfer initiatives should be established to educate farmers about best practices in SR feeding systems. Training programs can cover topics such as balanced nutrition, optimized feeding schedules, and proper management of feed resources. By

equipping farmers with the necessary knowledge and skills, they can make informed decisions regarding their feeding systems, leading to improved productivity and profitability.

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The future of pastoralism in High Atlas: the case study of M'Hamed commune

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What were the research background and objective?

Drylands of the High Atlas have been home to many Amazigh communities for centuries. These communities have settled livelihoods based on a mixture between agriculture and livestock activities, including nomadism and semi-nomadism: the low flat land of the valleys was used to grow cereals, mainly barley and wheat with some families raising crossbreed cattle, while the surrounding lands were used for livestock herding, mainly sheep and goats.

Thus, animals have been always a pillar asset in Amazigh's livelihoods. Transhumance practice has allowed these communities to adapt to the constraints of the High Atlas territories, such as the remoteness and marginality of lands, the climate rigidity, and the shortness of cropping seasons. Herders were used to move livestock out of their homesteads for months, to go to places where pastures and water were available. This has also brought to the development of indigenous knowledge and of cultural and social behaviours, basic for building communities' livelihoods and keeping the coexistence of different groups in harsh territories. A well-known institution is Agdal, with territories including rangelands and pastures collectively managed with oral norms and rules by pastoral groups and tribes with the aim to ensure services, in particular pastures and water for feeding animals.

In the last decades, there has been a sharp transformation of the Amazigh pastoral communities in the High Atlas. Urbanizations, services, and infrastructure development have determined a loss of importance of pastoralism, with people and youths migrating outside these territories, or with an increase of farmed areas. Livestock depends more on integrated nutrition, with feedstuff bought in markets. Pastoral communities have changed their old practices. Local livestock breeds have been increasingly replaced with modern ones and transhumance is much less practiced, with the abandonment of the Agdal system. Many authors link these processes to a decreasing capacity of the local communities to take care of their territories and resources in a sustainable way and to build resilient livelihoods. For instance, the replacement of local breeds with modern ones is increasing the dependence of breeders on external inputs; the abandonment of collective management of pastures and rangelands, is determining overexploitation and land degradation. These changes are also determining the loss of indigenous knowledge and institutions that for

centuries governed Amazigh communities' livelihoods and that are an important part of the local heritage.

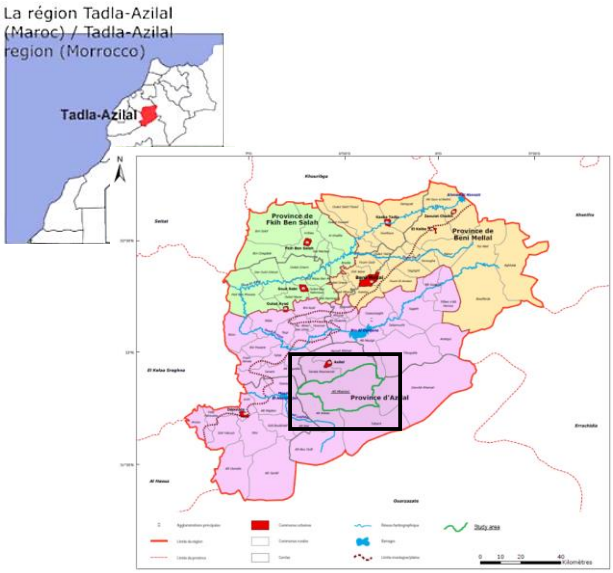
The present research had the aim to explore how Amazigh pastoralists in High Atlas do still consider pastoralism. Specifically, it wants to answer to the following questions:

- What factors act as determinants, discouraging pastoralists from continuing animal breeding activities?
- How are pastoralists adapting their livelihoods to changes?
- How is Agdal system considered?
- What is the future of pastoralism in the next years?

The results could guide actors who are working with the local communities in High Atlas for the improvement of local Amazigh livelihood and the preservation of their knowledge system and cultural heritage.

How was the research implemented?

The research used a case study approach. It was implemented in the commune of Ait M'hamed in the region of Béni Mellal-Khénifra, province of Azilal, only 20 km from Azilal city. It takes its name from the Ait M'hamed tribes (of Ait Aâtab) who predominantly live in the region. The population, which numbered 23,696 according to the last census in 2014, is dispersed over an area of approximately 300 km².



The location of Ait M'hamed commune inside the Beni Mellal-Khenifra region

Climate is semi-arid with rainfall of 550 to 700 mm per year, with cold and snowy winters and dry summers. Soils are poor and superficial with a high sensitivity to erosion. The Minimum average temperature varies from 4 to 10 °C, while the maximum average temperatures are between 20 to 40 °C.

Ait M'hamed is traditionally beneficiary of three agdals, with other tribes, which are: *Igourdane, allouz* and *talmest*. Each agdal has its own characteristics regarding the period of closure, capacity or number of animals and management mode.

The research started with a preliminary literature review, in part provided by local organizations and associations, in particular the Global Diversity Foundation (GDF) and the Moroccan Biodiversity and Livelihoods Association (MBLA), which manage many projects and research in the concerned territory and on pastoralism.

The main tool was the organization of a field survey from early November to December 2022, to collect data and different information related to small ruminants and the different pastoral activities done by pastoralists, as well as the opinions and the perspectives of the locals on the changes happening and their expectations on the future of pastoralism.

Historical Agdals of the Ait M'hamed tribe and its characteristics

Agdals of the Ait M'hamed tribe and its characteristics					
Agdal	**Operating period**		**Number of Total heads (Sheep and goats)**	**Other information**	**Management**
Allouz	17 June	17 March	20 000	It is a common Agdal between Ait Isha and Ait M'hamed, it was opened for the first time in 1930.	The Agdals are managed by *aarafs* ("Oral laws or Customs") which must be respected by all the tribes and all breeders. To apply these laws and properly manage the Agdals, each tribe chooses its own *nouabs* ("representatives") to form a kind of council of Agdal. The *Nouabs* are also responsible for determining the Agdal rest period (opening and closing). *"Barrah"* is the person who announces the dates opening and closing of Agdal in the *Souk* (Market). For each of these agdal, there are at least three guards *mqdems* responsible for guarding and recording of offenses committed by the breeders. The *mqdem* is paid in kind, on a percentage of the number of livestock.
Talmest	17 May	17 March	25 000	It is a common Agdal between the tribe of Ait Abass and the tribe of Ait M'hamed.	
Igourdane	17 April	17 March	1 700	The opening dates and closure of this Agdal are still respected by both tribes' beneficiaries (Ait M'hamed and Ait Atta); There are no conflicts between the breeders and oral laws managing the Agdal are still valid.	

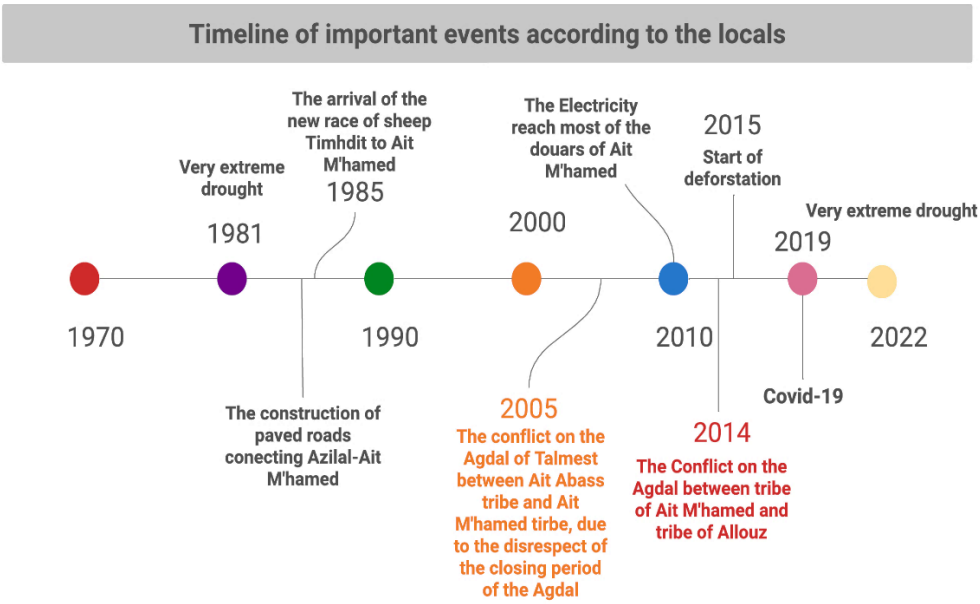
Thirty-one pastoralists were interviewed from 15 different villages around the commune of Ait M'hamed. They were mainly older than 40 years, with a prevalence of men older than 55 years. They had mainly flock of sheep and goats with less than 50 animals, a smaller part had more than 50 herds, and only a minority had more than 100 heads. All of them cultivate cereals and some also vegetables and/or fruit trees (nuts and apples). The majority said that pastoralism is the bigger part of their income.

Interviews were done in the local dialect of the region (Amazigh), followed by an open discussion phase. With the help of the local members of MBLA, we moved around the villages of the commune to the rangelands used by the pastoralists for grazing, and in some cases to the houses, and sometimes in the local livestock market that made it easier to meet shepherds that are there to sell/buy their sheep or goats. A focus group was also implemented in the village with pastoralists of different ages which proved to be very important and essential to the research, since it provided a rich discussion full of substantial valuable data.

What were the main findings?

The study highlighted that animals are still important in the local livelihoods. However, pastoralists say that there has been a massive decline in the number of animals that herders breed and in households keeping breeding as a main activity in livelihoods.

Through a discussion with pastoralists, it was possible to define a timeline on the major determinants they consider have impacted on livestock breeding and pastoralism in the last 40 years.



The different important events that impacted Ait M'hamed commune

The following determinants have been identified by respondents as very important events that have influenced the importance of pastoralism in their community:

- recurrent droughts, with a lack of rain and the changes in the patterns of precipitation, that determine water scarcity in dry times and a steady decrease in animal productivity, and of the number of livestock that can live in such difficult environmental conditions;
- construction of the paved roads: in particular between Azilal and Ait M'hamed in the 80s, the improvements of roads, started a wave of migration of families from the villages to the city (Azilal), opening the way to a new demographic shift in the rural population in the area, thus reducing the manpower that is willing to continue in the same work and job that their families used to do for centuries which is pastoralism and the growing of animals in this case;
- conflicts over the Agdals: their tribe has been repeatedly in conflict with others which caused the closure of the common Agdal, with a loss of key areas for feeding animals.
- deforestation: the cutting of forests in nearby terrain made lands vulnerable to degradation and the loss of biomass and a decrease in the resources that can provide it for animals;
- COVID-19 pandemic and its effects on the local and regional markets and on the purchasing power of the households. As an example, many families didn't have the ability to buy sheep or even a goat to celebrate the occasion of Eid Al-Adha, which took away and prevented a

major source of income for all the pastoralists and herders;

- the replacement of local breeds with modern ones: the introduced breeds require more feed and feedstuff and are much more vulnerable to diseases.

As livelihood strategies, livestock breeding seems nowadays to be less attractive compared to other activities and less served by services. Many farmers prefer to invest in farming activities, like fruit crops and vegetables, that provide higher profit instead of "*…bother with livestock raising and with the difficulties and harsh labor that comes with it, such as staying up all night in cases of giving birth, and the lack of veterinarians doctors and medical supplies, in addition to the high risk of animals perish, all of that for a low profit at the end...". M*any of them started planting trees such as apple trees, walnuts, and almonds with more than 15% already owning and investing in orchards of the different mentioned trees. Farmers agreed about the high costs of feed and fodder, as the main reasons for their bad expectations for the future situation of pastoralism in the area, together with the restriction they received for the use of an Agdal due to the conflict with another tribe. Also, the elders said that going to the Agdal's needs strong mindsets and determination and that youths today are not available for this activity. Most of the elder pastoralists lost hope that young generations will keep and/or restore their old and traditional practices, finding it unlikely to happen especially in the given harsh unsupportive local conditions.

Pastoralists are expecting the upcoming days and months to be harsh, especially with all the bad periods they experienced in recent years, especially with the lack of support from the state.

In conclusion, the study showed that pastoralists in Ait M'hamed commune consider pastoralism still as an important activity that, however, is losing importance, under the pressures of socio-economic and bio-physical factors. The reduction of good profits that come from livestock breeding and the harshness of the activity are discouraging factors, mainly for youths. However, herders still consider their knowledge and practices related to animal breeding very important and needed for the sustainable development of the livestock sector and as a key part of local cultural heritage. External support is needed for these communities to organize programs and activities that add value to livestock breeding preserving cultural values and Agdal systems.

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Analysis of the response of small-scale producers to micro-finance programs in Tunisian coastal communities

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What were the research background and objective?

Tunisia is a country where small scale producers in rural areas are still numerous and an important part of the national economy. They suffer for an increasing poverty and the scarcity or absence of services reduce their investments in productive activities and their livelihood opportunities. Many programs focus on facilitating the small producers' access to finances to support the start-up of new activities or the upgrading of existing one, to generate incomes for investors. The rate of success of these programs is measured evaluating the impacts of these activities on the beneficiaries and local economy. However, it is supposed that these kinds of programs go beyond the delivery of technologies and the start-up of new activities and would be supportive of changes in the mindsets of beneficiaries, determining new behaviors, individual and social, in favor of community resilience too.

Nemo Kantara is a project executed by CIHEAM Bari. Since 2020 it worked to strengthen the resilience of communities in selected coastal areas of Tunisia, promoting the development of local economies and of the human and social capitals. It targeted fishermen, clam women collectors, farmers, and youth, who have constraints to access and invest in modern and sustainable technologies for their activities. Key activities of the project were the management of a micro-finance program with the provision of grants, microcredits and trainings for individuals or groups of people. Beneficiaries presented micro-projects in the fisheries and farming sectors and the selected one have been activated by Nemo Kantara through grants and micro-credits. The project aimed also to set up a monitoring system of beneficiaries to make it possible the analysis of the program impacts. It required the acquisition of numerous and complex data and the use of models for their processing. At the time of the research, the micro-finance program was at the stage of the first financial support and technologies delivery to applicants, and the organization of trainings to beneficiaries.

List of grant-funded projects in the region of Gabès

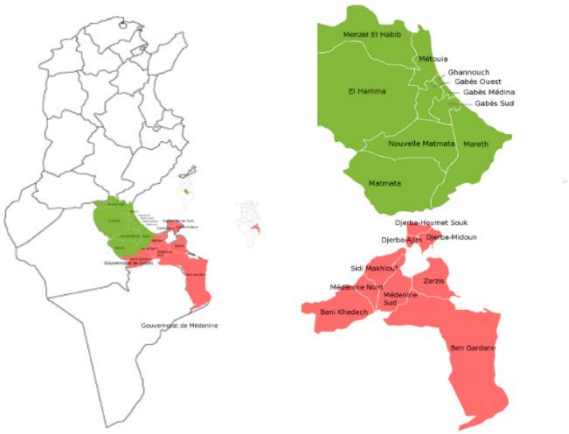
Project	City	Sector	Activity
Collective	Chott El Awamer	Agriculture	Valorization of oasis dates
Collective	Zarat	Fisheries	Ice making unit
Collective	Ghannouch	Fisheries	Refrigerated transport
Collective	Ghannouch	Fisheries	Ice making unit
Collective	Zarat	Fisheries	Design workshop for metal traps for blue crab fishing
Individual	Zerkine	Agriculture	Arboriculture
Individual	Zarat	Agriculture	Animal feed production unit in the oasis
Individual	Alaya	Agriculture	Grinding and packaging unit for spices and cereals
Individual	Zerkin	Agriculture	Cultivation of peppers in a greenhouse
Individual	Kettana	Agriculture	Cultivation of peppers in a greenhouse
Individual	Gabès	Agriculture	Valorization of oasis dates
Individual	Chott El Awamer	Agriculture	Quail breeding
Individual	Ghannouch	Agriculture	Milk processing unit, "El Marai"
Individual	Zerkine	Craftsmanship	Saponification unit, "Taki"
Individual	Zarat	Restoration	Seafood restaurant, "Soltana"
Individual	Zerkine	Restoration	Traditional restaurant, "Zwina Food"
Individual	Limaya	Services	Aromatic plant distillation unit, "Aycha Bio"
Individual	Zarat	Services	Plastic crushing unit
Individual	Zarat	Services	Distillation unit and preparation of "Baya bio" cosmetic products

Thus, the present research was organized in the framework of NEMO Kantara, and aimed at contributing to understand how the micro-finance program is inducing changes in their beneficiaries. It has analyzed how the micro-finance program's beneficiaries are responding as recipients of grants and credits, in terms of changes in mindsets and behaviors.

How was the research implemented?

The study was carried out in two coastal governorates in the South-East of Tunisia, Gabès and Médenine, territories of Nemo Kantara project, where poverty rate and unemployment are very high and where the project has delivered micro-finance services.

The main tool used for data collection was a survey conducted in six delegations in the Gabès governorate and 10 delegations in the Médenine governorate. Data were collected through questionnaires saved automatically on an online platform (SurveyMonkey), which were designed by category of beneficiaries: the



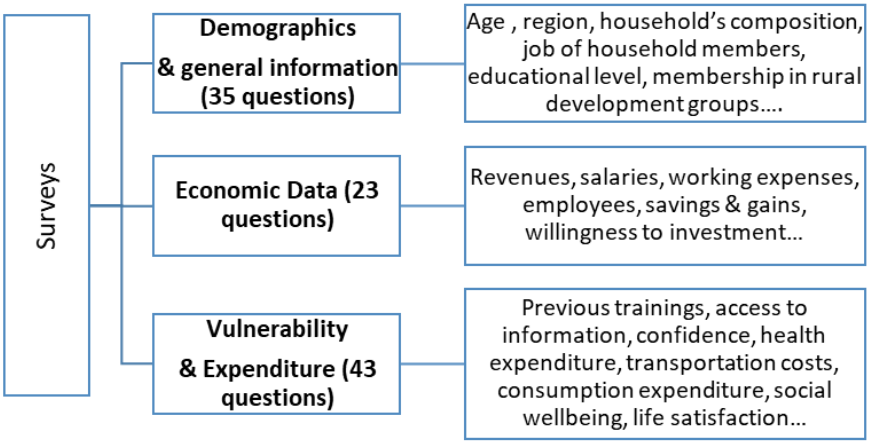
Study area - Gabès and Médenine governorates (south-eastern Tunisia)

beneficiaries of grants, the beneficiaries of microcredits, and the control group (who have not received forms of financial assistance).

Distribution of surveys by period and group type

Group type	Region	Period	Number of surveys
Grants beneficiaries	Médenine	July 2022 & December 2022	20
Grants beneficiaries	Gabès	July 2022 & December 2022	20
Microcredits beneficiaries	Médenine	January 2023	125
Microcredits beneficiaries	Gabès	January 2023	50
Control group	Médenine	January 2023	100
Control group	Gabès	November and December 2022	100

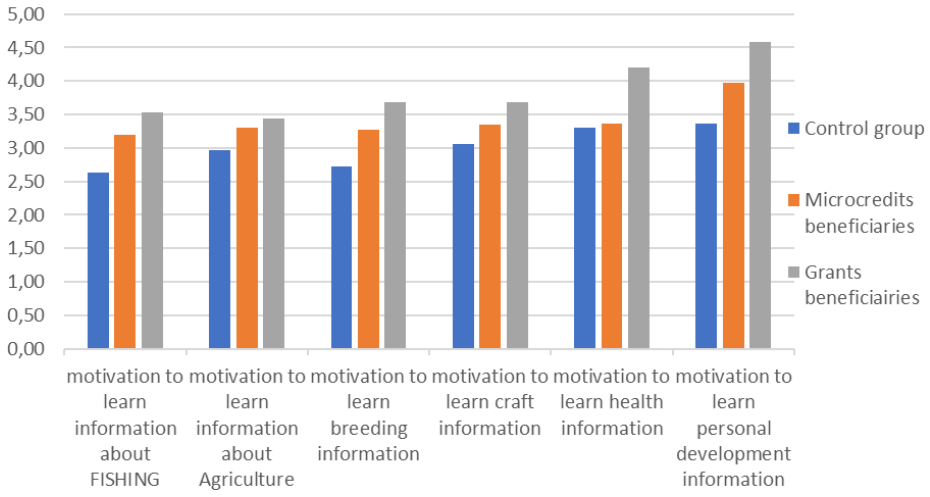
The survey allowed to collect information into 3 main domains and many variables: demographics, economic data, households vulnerability and expenditures. SPSS (Statistical Package for the Social Sciences) and a SEM (Structural Equation Model) were used to analyze data and understand the influence and correlation of different variables.



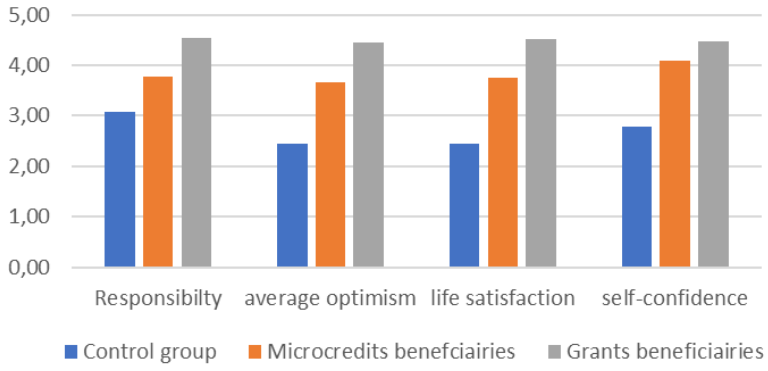
Indicators and variables measured by the survey

What have been the main findings?

The survey enabled to describe the profiles of micro-finance program beneficiaries, comparing them to control groups. Interesting insights came out that enable considerations about on the effectiveness of the financial interventions. For instance, the results revealed that the three surveyed groups (beneficiaries of grants and of credits and non-beneficiaries), similar in terms of socioeconomic features (age, instructions, household assets, household's members, etc.) have differences in terms of social behaviors, most probably deriving from the participation to the micro-finance program. The program's beneficiaries appear with more motivations to invest in knowledge and more confident about the future challenges.

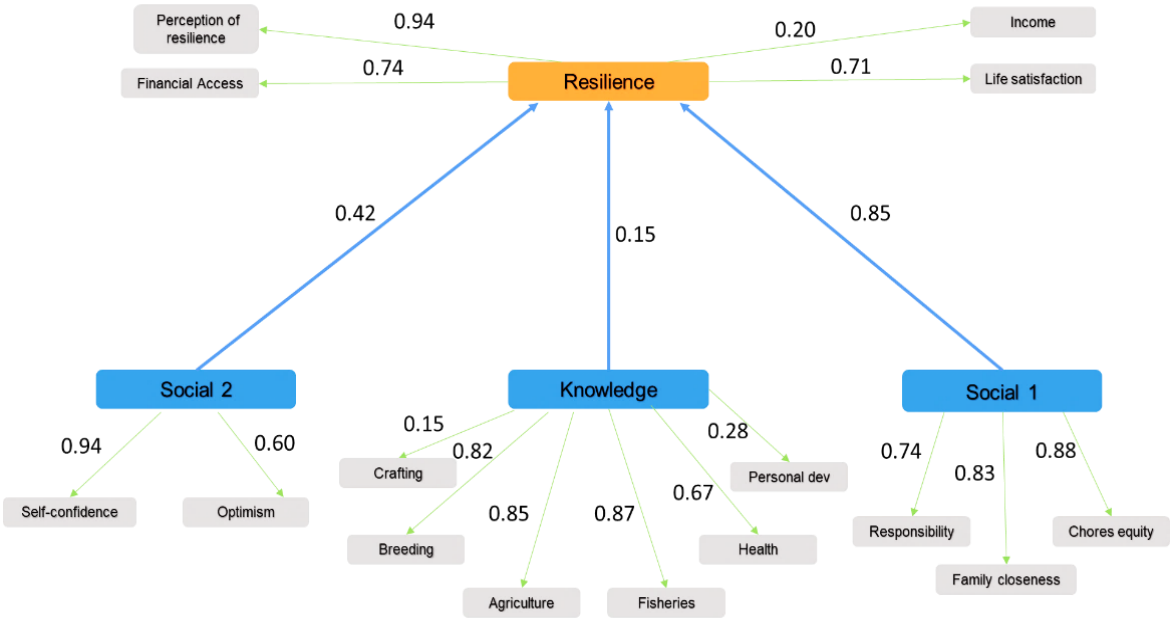


Tukey test for knowledge



Tukey test for the social wellbeing perceptions

The use of SEM model allowed also to speculate on the contribution of the micro-finance program to the community resilience. It highlighted that aside the influence of grants and credits, the acquisition of knowledge and the feeling of beneficiaries of an improved of social wellbeing, are key factors that make a community more resilient.



Path model for the structural analysis

In conclusion, the study shows that grants and micro-credits program have positive impacts on the mindsets of the beneficiary communities since the beginning stages and that can induce positive development of both human and social capitals. Having a monitoring system since the beginning of programs is very important to survey the process and guide decisions. However, an effective monitoring system, needs financial resources for data collection and expertise for data analysis and communication.

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Understanding smallholder farmers' resilience in Oasis Agroecosystems of Tunisia - The case study of Hezoua

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What were the research background and objective?

Oases in Tunisia are very important ecosystems in arid and Saharan zones, with high ecological and cultural values and important socio-economic functions. During centuries these has been strategic sites in the commercial routes and nowadays are areas where agriculture is a key sector that provides products for local and in particular for external markets, generating jobs and incomes for local populations.

Two typologies of oasis can be distinguished. The traditional oasis, that developed around water springs and where microclimate conditions have been favorable to date palms cultivation, traditionally in association with a wide range of crops including fruit trees, vegetables, and forages. The second are the new oasis, areas where the government in the last decades, invested in services and infrastructures, for mobilizing water resources from deep aquifers and to settle down pastoral communities, giving them new land for cultivation. Farms are prevalently of small size and fields mainly specialized on date palm cultivation.

Nowadays agricultural activity in oasis is under thread. Causes include the scarcity and over-exploitation of water resource and land degradation, the raise of crop phytosanitary problems, in a context of climate change. Naturally, these threads have impacts on farmers and influence their behaviors and decisions. These may affect smallholders, that for their nature are very exposed to stress and shocks related to agricultural activities.

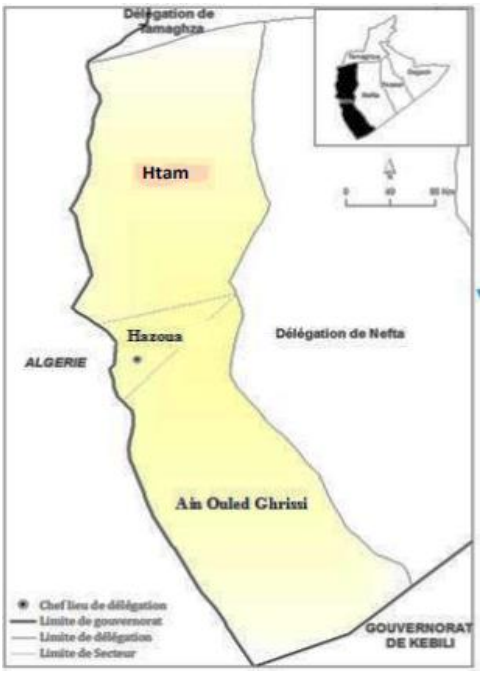
Accordingly, the study chooses to investigate on the resilience of small-scale farmers in oasis system and collect their perception about the main disturbances that are affecting their farming activities; understand the kind of adaptations, adjustments and changes adopted in their fields; identify factors and determinants that influence smallholder's resilience levels.

The results can encourage the emergence of a common reflection between researchers, decision-makers, operators, and farmers as well, on the impacts of support programs in agriculture and on the development or related policies with a resilient thinking perspective.

How was the research implemented?

The research was implemented in the delegation of Hezoua administratively attached to Tozeur governorate. It is located in the south-west of Tunisia on a strip of the Tunisian-Algerian border. On the climate front, the selected area is in the upper pre-Saharan bioclimatic stage with a temperate winter characterized by the presence of two seasons: a dry and arid season lasting 6 months of the year, and a semi-arid season with low and irregular rainfall. This pre-Saharan climate has wide temperature variations, a very high evaporation rate and high luminosity.

Hezoua is a new oasis that falls in an area traditionally characterized by pastoral activities. Over the last decades, through various programs and projects for agricultural development and improvement of the population's living conditions, the government promoted the settling down of transhumant pastoralists, who have shifted from massive livestock breeding to intensive oasis agriculture based on the water exploitation from deep aquifers. Palm dates are largely the main agricultural products, produced in monoculture of the Deglet Nour variety. Fragmented smallholder farms are predominant (around one hectare), with farmers organized into agricultural development groups (GDAs) for the management of irrigation systems (there are 15 for the whole area). These famers are nowadays facing problems in date palms cultivation, related to the availability of water for irrigation and climate change.



Map of Hezoua delegation

The research approach started with a preliminary review of bibliography to collect information on ways to measure farmers' resilience. A list of indicators was selected, originally 75 in numbers, then reduced at 36 through the work of an experts panel from the Touzer governorate. Indicators were organized in five categories and twelve components and assigned with weights. SPSS (Statistical Spatial Package for the Social Sciences) was used for analyzing data and clustering farms typologies, and composite function, with three equations that are hierarchically and sequentially arranged, was used for the calculation of Agricultural Resilience level.

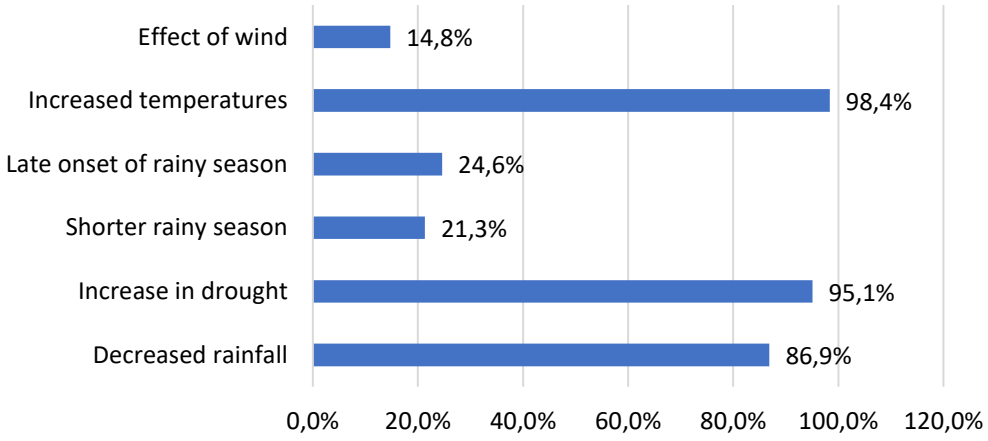
Indicators for assessing oasis agroecosystem resilience

Categories weighting	Components weighting	Indicators	Proposed weighting
Biophysical factors (0,474)	**Soils (0,5)**	Land degradation	0,135
		Soil drainage	0,350
		Types of soil	0,112
		Fertility	0,199
		Land use	0,092
		Soil conservation/management practices	0,113
	Water (0,5)	Availability of water for irrigation	0,555
		Irrigation water quality	0,229
		Water conservation practices	0,215
Sociocultural (0,161)	**Capacities (0,38)**	Disturbance	0,722
		Capacity for Action	0,278
	Public services and social security (0,25)	Access to basic services	0,25
	Land structure (0,15)	Land ownership	0,536
		Farm size	0,254
		Infrastructure	0,210
	Competencies (0,22)	Training Offer	0,491
		Level of schooling	0,368
		Participation in organizations	0,141
Technological (0,138)	**Practices and innovation (0,42)**	Adaptation practices	0,482
		Sustainable postharvest practices	0,293
		Fertilizer use	0,125
		Weed Management practices	0,046
		Pesticide use	0,054
	Technical Assistance (0,40)	Type of technical assistance	0,404
	Information management (0,18)	Management of climatic information	0,785
		Administration Record	0,215
Economic Factors (0,128)	**Financial capacity (0,73)**	Savings Capacity	0,190
		Productivity of water	0,326
		Revenue (level of Income)	0,398
		Availability and access to credit	0,085
	Market Access (0,27)	Destination of Production	0,330
		Market prices/costs (1kg of date)	0,670
Agro-ecological factors (0,099)	**Agroecological diversity**	Crop diversity	0,562
		Origin of species used (Date)	0,119
		Origin of seed sources (Other crops)	0,081
		Livestock	0,238

A structured survey was used to collect data on farmers perceptions on main challenges for agricultural activities and on indicators for measuring resilience. The survey was carried out among a sample of 61 farmers from the local GDA, with the support of the Regional Research Center for Oasis agriculture of Deguache, in addition, several privileged stakeholders were interviewed, including the director of the CTV (CRDA) office in Deguache responsible for "Agricultural Engineering, Water Resources, Irrigation Perimeters, Soil, Statistics and Plant Production," and the chairpersons of some GDAs.

What were the main findings?

The research has confirmed that smallholder farmers feel many uncertainties that are influencing their agricultural production. They have a clear feeling that climate change is impacting on their agricultural activities, in particular increasing temperature and droughts and reducing rainfalls. This perception is confirmed by some farmers' statements: "The seasons are different now than they were 20 years ago" or "For me, the environment has changed".



Perception of climate change

Farmers agreed that climate change has significantly impacted their production and harvests. The vast majority relate it to water scarcity and soil salinity, followed by the loss of fertility and organic matter content. They listed additional factors that are influencing agricultural activities that included:

- increased effect of wind on soil erosion and loss of agricultural land;
- low financial capacity and poor access to credit;
- lack of qualified labor;
- poor water management in terms of water turn and quantities;
- water salinity, problem of hot water, lowering of the water table;
- soil salinization and acidification;
- high expenditure on agricultural inputs.

The survey confirmed the importance of date palm for the farmers, the base of their incomes. It revealed a tendence and interest of farms to diversify their production, investing on other fruit trees as second cultivation layer in date palm trees; an interest to cultivate date palms in organic to save inputs costs and get higher final products price; to adopt sustainable agricultural technologies and practices to face with water scarcity and land degradation problems. These include the introduction of bubbler irrigation system or drip irrigation, in substitution of field submersion, to save water; the regular use of organic manure and terracing, and the introduction of minimum tillage, for improving soil fertility.

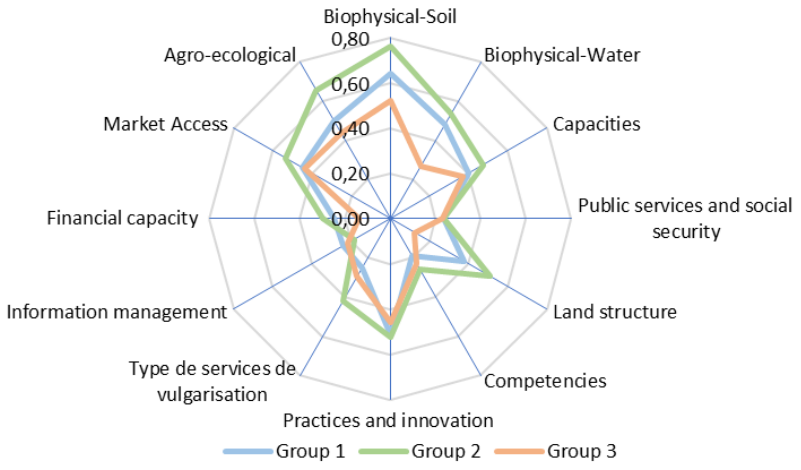
Through the analysis of the 36 selected indicators, it was possible to cluster the interviewed farmers in three main groups/typologies.

Farmers' groups in relation to indicators analysis

	Group 1	Group 2	Group 3
Land degradation	High degradation (several degradation drivers observed)	Moderately severe degradation (not numerous degradation drivers)	High degradation (several degradation drivers observed)
Soil drainage	75% of farmers have access to existing drainage systems	95% of farmers have access to existing drainage systems	50% of farmers have access to existing drainage systems
Types of soil	Mostly one type of soil which is sandy	Mostly one type of soil which is sandy	Existence of more than one type of soil, i.e. sandy-stony or sandy-clay
Fertility	Very low organic matter application	Control and regular supply of organic matter	Very low organic matter application
Land use	Coexistence of date palm groves and farms in transition	The majority of farms are in transition to a diversified cropping pattern	Dominant date palm monoculture
Soil conservation /management practices	Regular	Optimal	Regular
Availability of water for irrigation	Availability of various water sources for irrigation	Availability of various water sources for irrigation	Reduced number of irrigation water sources
Irrigation water quality	Poor to medium quality of irrigation water	Moderate quality of irrigation water	Very low quality of irrigation water
Water conservation practices	Practiced by a very limited number of farmers	Practiced by a very limited number of farmers	No water conservation practices adopted
Capacity for Action/innovation capacities	Very low capacity to cope with external shocks	Medium (Willingness and commitment with restrictions)	Very low capacity to cope with external shocks
Land ownership	Owner	Possessor	Lessee
Farm size	<=1 ha	>=1 ha	1 ha
Infrastructure (state of the drainage and irrigation systems)	Moderate	Slightly enhanced	Weak
Level of schooling	Primary	Vocational, technical, or professional	Secondary

Adaptation practices	Agriculture in transition to sustainability	Agriculture based on the principles of environmental sustainability	Agriculture based on maximizing production
Sustainable postharvest practices	May or may not exist	Yes	None
Weed Management practices	In transition management	Mixed	In transition management
Availability of extension services	Some	Yes	Some
Administration Record	None	some	None
Productivity of water	0,36	0,34	0,19
Revenue (level of revenue)	6541,15TND	10628,81 TND	4349,04 TND
Availability and access to credit	Occasional	Occasional	None
Destination of Production	Local	Local, regional	Local
Species diversity	Medium	High	Medium
Livestock	1 species	2 to 3 species	1 species
Impact of climate change	High	Moderate	High
Other type of disturbance	Low	Medium	High
Origin of seed sources	Moderate seed source diversification	Diversified seed sourcing	Low seed source diversification
Market prices/costs (1kg of date)	1,82	1,89	1,65

The calculation of the Agricultural resilience level identified farmers of group 2 as the more resilient, while the one of group 3 as the less resilient, with group 1 in the middle. The resilience levels among the groups depended mainly on the bio-physical, agroecological, land structure variables, while all groups suffer for the lack of financial capacities, of information, competencies, extension and public services in general.



Agricultural resilience Levels

In conclusion the study showed that in the oasis under study smallholders feel unsecure for a number of factors that are challenging their agricultural activities and climate change and water scarcity are recognized as the major factors; many of them are adapting their agricultural activities through the adoption of new irrigation technologies, or reduction of inputs use, or diversification of crops, to ensure secure incomes. The calculation of resilience index highlighted the possibility to categorize farmers in different groups in terms of available assets, knowledge, resources. Each category corresponds to a different level of resilience, based on ways they are reacting to changes

and stress, environmental or economic. Thus, the calculation of the resilience index could be a tool to inform decision makers and drive policy making, in a way to target specific social categories. The complexity of the exercise, however, requires additional research to confirm the validity of the model.

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Stakeholders' identification to manage aquifer recharge in Médenine territory – South of Tunisia

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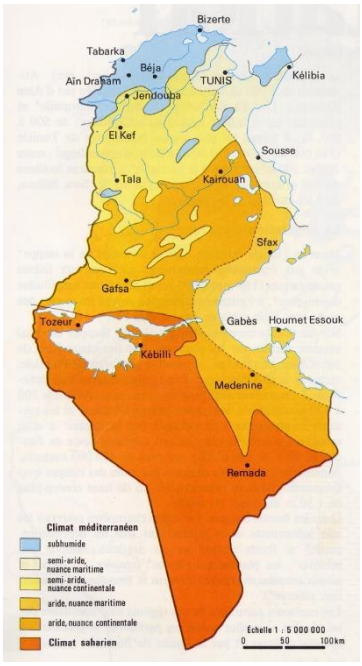
What were the research background and objective?

Water scarcity in agriculture is a main challenge in Tunisia, particularly in semi-arid areas of the south. In these territories rainfall is very scarce, limited and concentrated, in the last years even erratic and irregular. The temperature increasing is inflating the problem, with the recurrence of more intensive droughts and with farmers struggling for watering their crops and animals. Data indicate that there will be an increase in the frequency and intensity of extreme phenomena, like storms and floods, and of drought periods.

Aquifers in these territories are a main resource that compensate the lack of rain and surface water. These have good quality water (salinity lower than 1.5 g/l) and must serve the needs of farmers but also of an increasing urban community. However, their overexploitation frequently led to water deficit and increasing of water salinity.

This situation highlights the importance to develop new forms and ways of management of aquifers, designed to feed specific community needs, without affecting water availability and quality, and incurring in overexploitation. Nature Based Solutions can drive this shift. These are solutions to concrete challenges inspired and supported by nature, but designed by humans, cost-effective, and providing environmental, social, and economic benefits.



Study area Zeus-Koutine (Jeffara)

Managed Aquifer Recharge (MAR) in particular, is an approach for aquifer management classifiable as a Nature Based Solution that have already a range of application in different contexts. It is defined as "engineered system where surface water, generated by rain and floods, is conveyed in the ground for infiltration to aquifers to increase groundwater resource availability", and is properly managed to avoid overexploitation. It is not only an effective way of harvesting and storing water, but also an approach that enables better governance of underground water. It is included in a whole package of measures to control the recharge, abstraction, and the restoration of the aquifer balance. The approach can be adapted and improved with innovative techniques in all phases of MAR process starting from the water capture and harvesting, recharging the aquifer, recovery until the discharge and use. Governance framework is essential to ensure that MAR is sustainable and generates benefits for all members of groundwater-dependent community. Also, it should provide a common ground and attempt to define and establish a 'best compromise' between the varying demands and interests and between different actors from different sectors included in the water management sector. Thus, this can sometimes be competing or even conflicting. Therefore,

involving stakeholders in MAR is a decisive step to study, test and implement the technology, facilitating stakeholders' participation and learning, thus supporting a sustainable management of the aquifers.

MAR is an approach under development in the south of Tunisia, in Médenine territory, a semi-arid area with a growing demand of water and strongly relying on aquifer exploitation. Research institutions are working on aquifer recharge technologies and infiltration wells have been already installed to promote the aquifer recharge through floodwater collection.

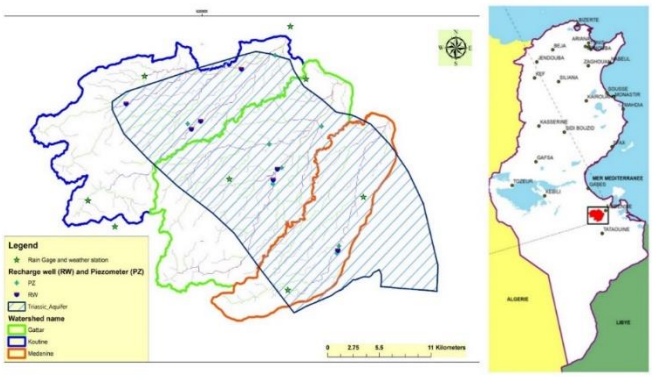
Recharge wells installed in the study area behind a gabion check dam injecting floodwater after a rainstorm

The EU project SALAM-MED (https://www.salam-med.org/), whose focus is on NBSs development in the Mediterranean area, has set up a case study in Médenine aimed at the establishment of a Living Lab (LL) on MAR. The main objective is to mobilize and engage on MAR approach a range of key stakeholders at the local level, including public institutions, research experts, farmers, and privates. The final scope is to have an active network of local actors concerned on MAR that, with different roles and expectations, finds and implements concrete solutions for the aquifer management problem, through a process based on multi-stakeholders' participation and learning.

Accordingly, the present research aimed at answering the following question: who are the key actors who must be involved in a LL for developing a local approach for MAR? Specifically, it aimed to identify:

- the main actors concerned with aquifer exploitation in Médenine area;
- their motivations and reasons for being included in a Living Lab;
- a prioritized list of stakeholders.

How was the research implemented?



Study area Zeus-Koutine (Jeffara) watershed with the location of Rain gage, weather station, piezometer (PZ) and recharge well (RW)

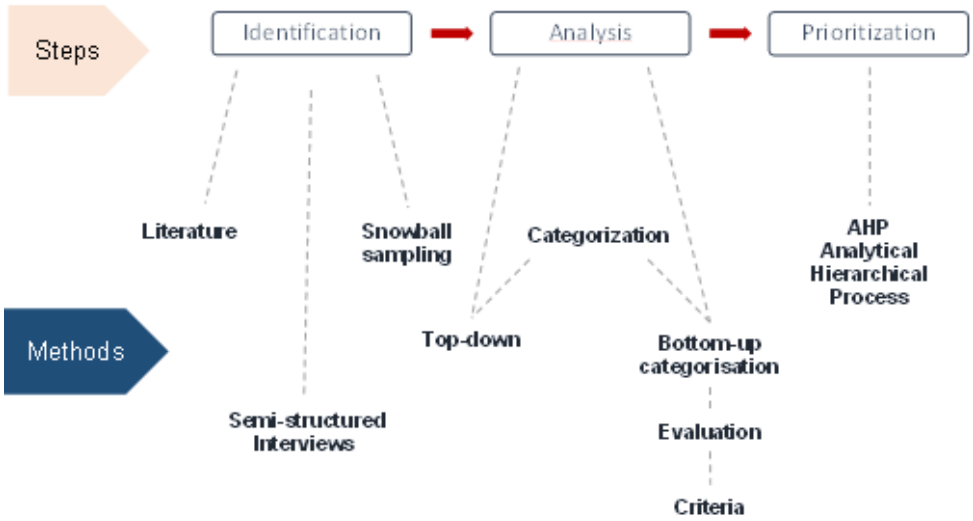
The research was implemented in Médenine territory, specifically in Jeffara plain, where infiltration wells have been installed.

The site covers an area of 650 km², drained by "Wadi Koutine", "Gattar" and "Hjar", which starts from the mountain range of "Béni Khedache" and reaches the cities of "Koutine", "Metameur" and "Médenine". The highest elevation of the study area is about 650 m that corresponds to the peak of the mountain "Jbel Moggar". The plain is relatively

extensive with an almost perfect flatness of its surface that is rarely disturbed by the presence of a few hills. The region is characterized by an aggressive aridity with rainfall that varies between 100 to 200 mm per year and with trends that prospect an increasing of temperature and decreasing of rainfall. Olive groves are the most dominant irrigated crop. The recourse to intensification of the groundwater use in the plain has increased the tension between farmers who need to irrigate their fields, with increasing areas under irrigation, causing competition and conflicts. Aquifers exploitation is however mainly oriented to match with the needs to have drinking water for domestic, tourist and urban uses (over 90% of water use).

For identifying the actors that must be part of the LL on MAR in Médenine areas, it was implemented the methodology proposed by SALAM-MED project. It relied on actors' analysis and mapping through three steps:

- Identification: listing the potential stakeholders.
- Analysis: categorizing and evaluating the potential stakeholders.
- Prioritizing: ranking the potential stakeholders.

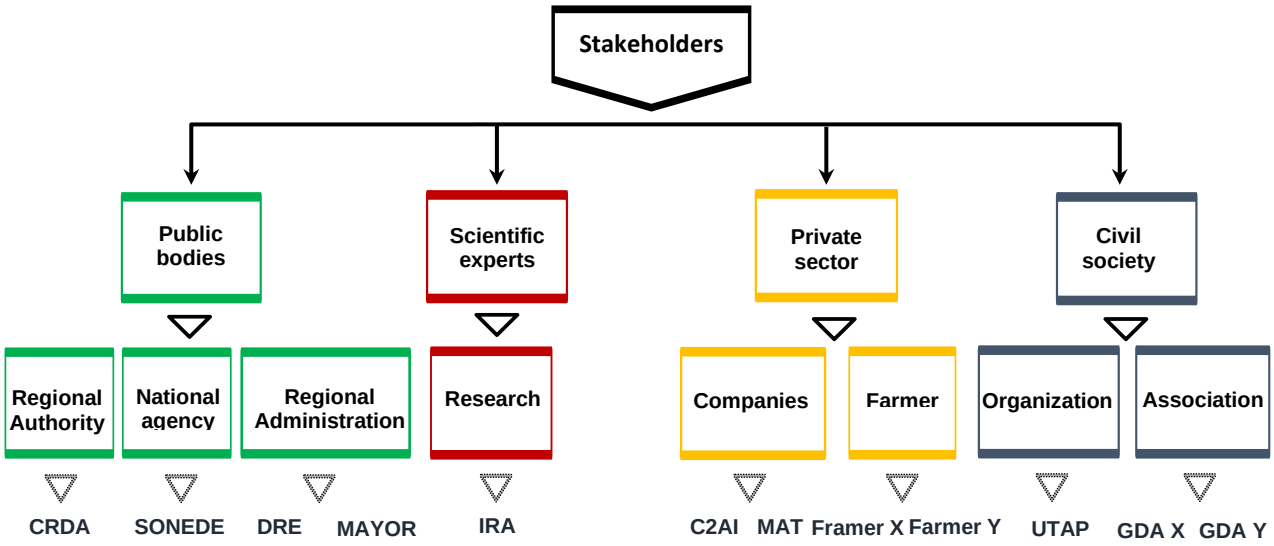


Schematic representation of the different steps of the stakeholders mapping methodology adapted to the case study context

The identification of stakeholders started with a literature review. Then, the selected actors were interviewed (semi-structured interviews). The interviews were carried out to know about the existent hierarchical distribution of water sector stakeholders, their roles, positions, and ways of management and allowed to understand about actors' opinions, expertise, motivations, attitudes toward the project idea. Analyses were made to explore about their synergies, interactions, alliances, influence to prioritize their roles in the governance, evaluate and prioritize them according to criteria of willingness, influence, capacity, and of necessity for being part of a LL on MAR.

Which were the main findings?

The study allowed to select 9 key stakeholders that must be part of the starting LL on MAR, since they deal in Medénine on aquifer exploitation with different ways and concern. The actors cover the 4 domains that must be represented in a Living Lab: public bodies, private sectors, scientific experts, civil society.



Schematic representation of the stakeholders' classification according to the Quadruple Helix Model

Description of the institutions identified in the water sector

Institution	Description
Ministry of Agriculture, Water Resources and Fisheries - MARHP	National authority responsible for expanding the agricultural, fisheries and forestry sector, preparing plans and programs and implementing laws and policies in the government and the sustain of natural resources for longer-term production.
Arid regions institute of Médenine - IRA	Regional research center which aims to carry out the research necessary for the development of the agricultural sector, the protection and conservation of natural resources and adaptation towards desertification in arid and desert regions.
Regional agricultural development commission - CRDA	They are in charge of implementing regional government agricultural policy, including water resource management and water supply, they oversee water and soil conservation, they manage hydraulic equipment, and they oversee distribution of agricultural water to farmers and exercises authority over institutions involved in carrying out the fixed missions
Regional environmental directorate - DRE	Directorates of the Ministry of the Environment and Sustainable Development at the regional level who are responsible for observing, monitoring, and controlling the general environmental situation of the region.
National Water Supply and Distribution Company - SONEDE	Public establishment of an industrial and commercial nature (EPIC) responsible for water production, treatment, distribution (management and maintenance of the drinking water network and equipment and management of customers) and development (studies, works).

Agricultural development group - GDA	Development association in the agriculture and fisheries sector in rural areas, that is responsible for managing water supply systems installed by the Directorate of Rural Engineering within the Ministry of Agriculture in areas where the SONEDE-managed networks are not available. They have a management contract with the government.
Tunisian union of agriculture and fisheries - UTAP	National, independent, democratic, and unionized organization for development and services, which aims to take care of farmers and fishermen. To represent them, defend their interests and protect their rights. It is divided in regional URAP in each governorate.
C2AI Technologies	A private company specialized in products, solutions and services for environmental technologies and innovations in terms of equipment for the control and management of fluids and environmental measurements.
Médenine Agro Tech - MAT	A private company specialized in the creation and management of technological services for the benefit of farmers.

The results showed that the Regional Commission of Agriculture Development (CRDA) has the higher necessity for inclusion. Indeed, they have almost the entire responsibility of the water sector in the region; they are in charge to supervise the activities of operators (National agency, regional associations, etc.), they have allies and influence with all the institutions (Research, private, civil society...) and they have the expertise in the technical as well as organizational and institutional aspects. CRDA has the authority over institutions that are involved in the water distribution and management. For instance, it rules the establishment of private well, assigning permission to build shallow (< 50 meters) and deep (> 50 meters) wells.

Agricultural development groups (GDA) have been selected since the role in the management of public wells. They are divided in between those managing collective irrigation schemes and those managing rural drinking water supply mostly in rural areas, while some, are managing both. Similarly, the National Water Supply and Distribution Company (SONEDE) manages mainly urban zones with some rural zones, and it is responsible for water production, treatment, distribution (management and maintenance of the drinking water network and equipment and management of customers).

The presence of UTAP is also important. They have good interactions with farmers and defend their rights, help them to solve problems and play the role of a bridge between farmers and other actors.

Also, MARHP have been selected as a key actor for the LL. It is represented at the regional level through the general directorate of water resources, a key department in the managed aquifer recharge. It has responsible for the general supervision of water resources (surface and groundwater) and their management, granting authorizations for water use and abstraction, besides, monitoring of the resources through observation points (water quality measuring stations, rainfall, piezometric levels).

In conclusion the study highlighted the importance to undertake an accurate stakeholder analysis that might mobilize a multistakeholder platform, a living lab, on the development of MAR approach. The promotion of participation, including actors from different sectors, from decision makers to farmers, from public to private sector, is important. The stakeholder's platform must be aware of the groundwater situation in the area and represent the local context and the current state of

governance. For the purpose, the analysis of stakeholders according to the criteria of willingness, influence, capacity, and necessity, was a key process to select actors who have interest and motivations toward the idea, could eliminate gaps through roles, provide expertise and knowledge.

The process of characterizing, evaluating and prioritizing actors, has shown the necessity to involve technical experts that have knowledge and have created innovations and stability in water management. Besides, the results have showed the necessity to identify facilitators in a way to ensure multi-stakeholders' participation, synergies and complementarities.

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