



Uptake of validated technologies and processes to enhance land use planning, management, governance and restoration practices in Mediterranean silvopastoral systems

MELIA STUDY

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List of Acronyms

BTS	Banque Tunisienne de Solidarité (Tunisian Solidarity Bank)
CBO	Community-Based Organization
COFO	Committee on Forestry (FAO)
CRDA	Regional Commissariat for Agricultural Development
CRDA	the Consultative Group on International Agricultural Research
DGF	Directorate General of Forests (Tunisia)
DM	Dry Matter
EOIO	End of Initiative Outcomes
FAO	Food and Agriculture Organization
GDA	Agricultural Development Group
GLF	Global Landscapes Forum
ha	Hectare
ICARDA	International Center for Agricultural Research in the Dry Areas
IGC	International Grassland Congress
IRC	International Rangeland Congress
MELIA	Monitoring, Evaluation, Learning, and Impact Assessment
MS	Master of Science
NGO	Non-Governmental Organization
PhD	Doctor of Philosophy
SPS	Silvopastoral System
TECA	Technologies and Practices for Small Agricultural Producers
t DM/ha	Tons of dry matter per hectare
TND	Tunisian Dinar
TransforMED	Transforming the Mediterranean region through agroforestry: large scale restoration of degraded lands by overcoming the socio-economic and sociocultural barriers for agroforestry adoption
WOCAT	World Overview of Conservation Approaches and Technologies

1. Context

1.1. Background Information

Rangelands in Tunisia cover approximately 5.5 million hectares, representing about a quarter of the country's overall land area. This large expanse includes 1.2 million hectares of forests, of which 90% are under state ownership and 10% are privately managed, along with 4 million hectares of rangelands and 450,000 hectares of esparto grass fields. Tunisia's forestry sector is significant for both ecological and economic purposes, directly supporting the livelihoods of nearly one million people who rely on the forests for various resources. The General Directorate of Forests (DGF) is responsible for overseeing the management of Tunisia's forested, silvopastoral lands, and some collective rangelands under the forest regime. These areas contribute roughly to 1.33% of the GDP and 14% of the agricultural GDP (World Bank, 2015). Forests and rangelands supply around 38% of the income for neighboring households, making them a crucial source of sustenance for many rural communities.

Silvopasture: land use practice integrating trees, pasture, and livestock grazing- plays a key in Tunisia's silvopastoral landscapes. This approach enhances soil health, promotes biodiversity, and provides shelter and shade for livestock, thus increasing their well-being and productivity. Additionally, the presence of trees in silvopasture systems contributes to carbon sequestration, helping to mitigate climate change impacts. Moreover, the diverse plant species found in these systems offer a more stable forage base, benefiting both livestock and the surrounding ecosystem. However, silvopastoral landscapes face numerous threats, including illegal logging, overgrazing, wildfires, and desertification. The DGF has worked extensively on reforestation and afforestation projects to address these issues. Yet, excluding livestock from rangelands over extended periods can have unintended consequences, such as soil degradation and a higher risk of wildfires due to the accumulation of undecomposed organic matter. Grazing animals are vital for nutrient cycling, breaking down plant material and enriching the soil with organic matter through their manure. Their movement also helps to aerate the soil and improve water infiltration. Without grazing, organic material accumulates without appropriate decomposition, leading to nutrient depletion, soil compaction, and higher erosion rates, which ultimately reduce rangeland productivity. Additionally, excluding grazing can result in a build-up of dry plant matter, elevating the risk of wildfires during extremely hot summer periods.

In response to these challenges, a collaborative initiative was established between the DGF, International Center for Agricultural Research in the Dry Areas (ICARDA), and national universities to develop sustainable land use strategies based on research and community input. As part of the One CGIAR initiative, Livestock and Climate (LC) and more recently the PRIMA project titled: "Transforming the Mediterranean region through agroforestry: large scale restoration of degraded lands by overcoming the socioeconomic and sociocultural barriers for agroforestry adoption" support land management by promoting validated tools and technologies that enhance planning, governance and restoration in silvopastoral systems. The key interventions include tools for assessing trade-offs and synergies in landscape management, conducting cost-benefit analyses, and valuing ecosystem services together, these efforts aim to foster an evidence based, community centered approach to managing Tunisia's silvopastoral resources sustainably, ensuring the balance between economic use and ecological health.

The Lighthouse: The silvopastoral lighthouse is located in central Tunisia, within the Zaghuan governorate, spanning an area of 5,000 hectares of state land, of which 100 hectares are under intensive restoration. The area supports 40 households, predominantly reliant on small ruminant farming and olive production. Given its vulnerability to climate change, the region faces significant challenges, including erratic rainfall patterns, with an annual average of less than 400 mm, exacerbating its susceptibility to land degradation. Through a participatory, multidisciplinary approach, we employed a participatory and multidisciplinary approach to enhance ecosystem services in this semi-arid region, developing sustainable land use practice that can serve as a model for similar areas across not only Tunisia but the Mediterranean region.

Interventions: To address environmental and economic challenges, the LC initiative implemented a suite of validated innovative tools and technologies from 2021 to 2024. This aimed at improving land use planning, governance and restoration in the mediterranean silvopastoral systems. These activities included reseeding with native species like Sulla (*Hedysarum coronarium*), optimizing grazing capacity, conducting comprehensive ecosystem evaluations, and implementing water-harvesting methods. Additionally, the program emphasized training and capacity-building initiatives for both community members and national staff with sustainable land management skills. This was to create a model that could be replicated and scaled across Tunisia.

A significant success of the program was building trust between local communities and stakeholders by allowing community members to sustainably utilize state land. This empowerment instilled a sense of ownership within the community, strengthening the initiative's long-term sustainability. Grazing management practices rooted in scientific methods—including determining optimal stocking rates and appropriate grazing durations—ensured that the vegetation cover was used without degradation, contributing to the program's overall success.

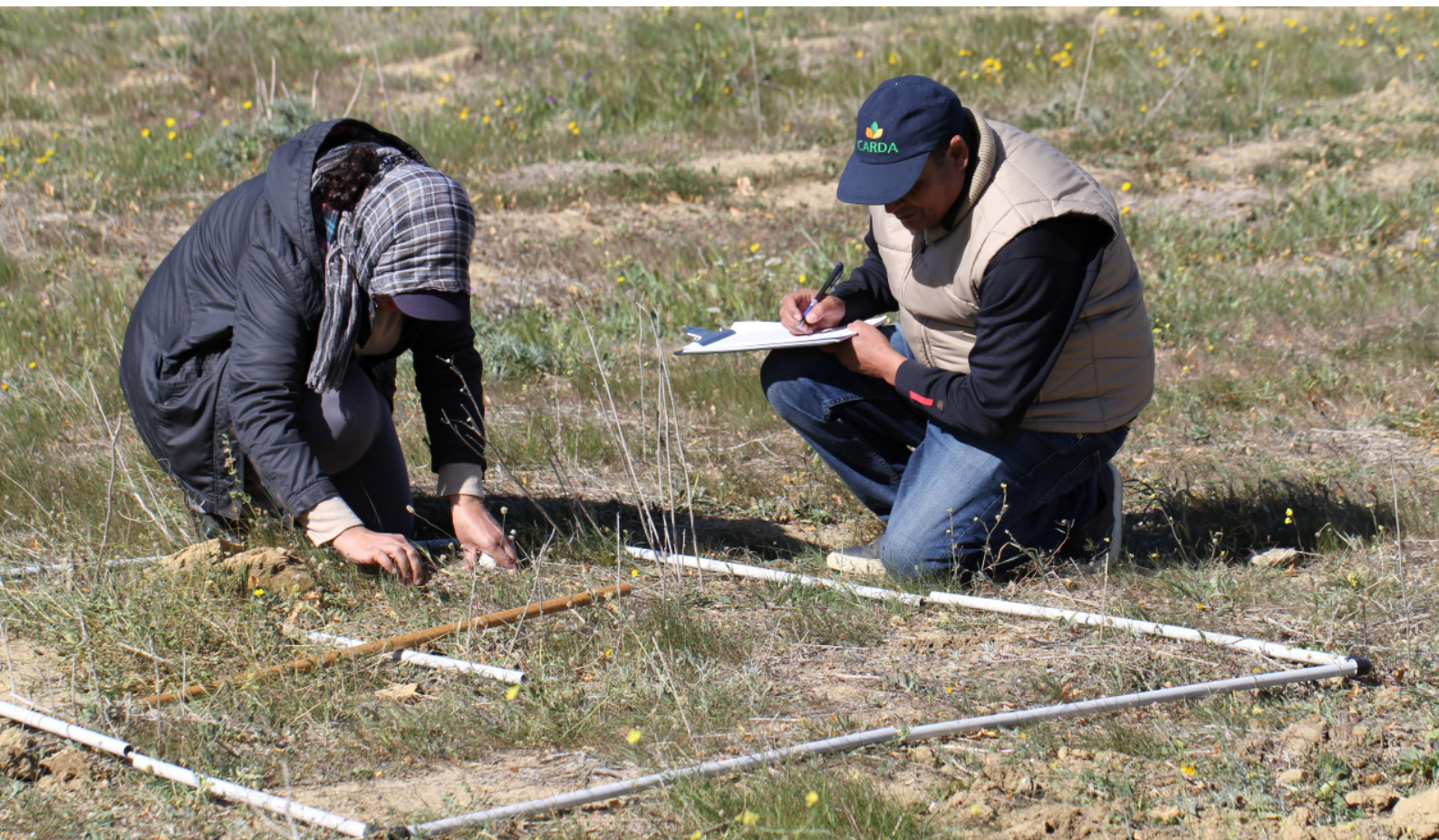


Photo credit: Mounir Louhaichi

1.2. Objective of this Study

This study focused on assessing the uptake of innovative tools and technologies aimed at improving land use planning, governance and restoration in the Mediterranean silvopastoral systems. The study evaluated how these validated practices contribute to sustainable livestock production, improved ecosystem management, and enhanced governance frameworks in these regions. Specifically:

- Evaluate the effectiveness of promoting native forage legume species in restoring soil health and vegetation cover in degraded Mediterranean silvopastoral systems.
- Assess the changes on productivity among pastoral farmers as a result of the use of validated tools technologies to improve land use and management ration practices.
- Analyze the socioeconomic benefits and sustainability of using restoration practices applied by pastoralist in the silvopasture improving livestock productivity and supporting ecosystem services in Mediterranean silvopastoral systems.
- Evaluate gender and community participation in decision making process and how that influences the success of land management practices.

1.3. Methodology

This study utilized a mixed methods approach, combining evidence synthesis with qualitative insights to provide a comprehensive evaluation of the Livestock and Climate initiative progress in Tunisia under Work package 3 and the TransforMED project Work package 4. Data was collected from multiple sources, including project reports, assessments and findings from Focus Group Discussions (FGDs) to aggregate evidence on the end of initiative outcome.

The (FGD) among diverse group of participants from ICARDA, DGF, and the local community—including women, youth, and farmers was conducted in 2024. This discussion provided valuable insights into the experiences and perspective of local farmers regarding the adoption of improved governance, management and restoration practices within Tunisia’ silvopastoral system.

The evidence synthesis approach on the other hand enabled the study to systematically gather and analyze data from diverse sources, highlighting how pastoralists and farmers have adopted improved governance, management, and restoration practices. This approach not only reflects the initiative progress towards the end of initiative outcome of sustainable managing 400,000 hectares but also emphasizes the target of ensuring that at least 30% of women actively participate in decision making.

Inclusion and exclusion criteria of articles:

A variety of reports, including journal articles, proceedings papers, technical reports, and blogs, were produced during the implementation of L&C Work Package 3. However, not all were included in this analysis. Articles that did not specifically address silvopastoral systems were excluded, along with some blogs and presentations. Additionally, papers published before Month 2021 were omitted. Included in this study were publications and reports span from 2021 to 2024, closely aligning with the project’s implementation phase (Annex 1).

These reports were developed to share key findings on restoring silvopastoral systems using native forage legumes. This multi-format approach was designed to reach diverse audiences, including researchers, policymakers, and the general public—promoting both visibility and practical relevance of the study’s outcomes. The publications serve multiple purposes: they establish academic credibility, disseminate field research findings, offer practical recommendations for policymakers, and engage broader audiences. Each report captures different stages of the project’s implementation, from initial experimental insights to comprehensive evaluations of the interventions’ impact on silvopastoral restoration. This diverse format strategy ensures that the project’s findings are broadly accessible, supporting the restoration of degraded silvopastoral systems.



Photo credit: Mounir Louhaichi

2. Results

2.1. Improved Livestock Performance

The silvopastoral interventions in the silvopastoral lighthouse site, Tunisia, were strategically designed to address the acute degradation of natural resources and improve livestock productivity in semi-arid areas through a holistic, community-driven approach. The initiative collaborated with key partners, including the Tunisian DGF, the Regional Commissariat of Agricultural Development (CRDA) of Zaghouan, local universities, and community organizations in delivery of key interventions. Central interventions focused on the establishment of a community-based organization (CBO) to enhance the local community's capacity to sustainably manage and improve state land. This was achieved through the strengthening of the (GDA) of Sbaihia.

With respect to the restoration activities several best practices were implemented on the ground including:

1. soil and water conservation techniques such as establishment of stone gabions and bench terraces.
2. reseeded degraded pasture with the native forage legume *sulla*.
3. regenerative grazing based on scientific assessments of carrying capacity.

Results from the assessment conducted by the project team (Focus group discussion report: <https://hdl.handle.net/10568/168864>) indicate a significant improvement in livestock performance due to enhanced pasture health. The results highlight a significant positive impact on livestock performance as a result of improved pasture health. Key findings show:

- About three-fold increase in forage production, contributing to better feeding conditions.
- 5% to 10% increase in the live weight of lambs and kids.
- 15% to 25% rise in cow milk production.
- Three-fold improvement in vegetation cover, signaling enhanced pasture quality.
- Three-fold increase in grazing duration, leading to reduced dependency on supplement feed.
- Reseeding pastures with *Sulla* in direct grazing systems resulted in over a 16-fold increase in revenue per hectare compared to control (degraded) pasture.

These findings highlight the effectiveness of the initiatives interventions in pasture restoration in improving livestock productivity and economic benefits to farmers. The increased grazing duration and vegetative cover imply more sustainable land use and reduced pressure on external resources. The rise in milk and livestock weight further translates to higher incomes for farmers, reduced feed cost and enhanced food availability. This result underscores the importance of ongoing investments in sustainable pasture management and its role in improving the resilience of livestock systems.

2.1.1. Impact of Improved Pasture on Meat Production

The introduction of *Sulla* reseeded and protection from continuous grazing had a significant impact on the growth and weight of livestock, particularly lambs and goats. Farmers observed that grazing on *Sulla*-reseeded pasture results in a 5-10% increase in the live weight of lambs and kids compared to those grazing on degraded pasture (control). This weight gain is primarily due to the higher nutritional value of *Sulla*, which provides a more balanced and nutrient-rich diet. The improved forage quality not only accelerates growth rates but also enhances the overall health and productivity of the livestock. This increase in live weight translates into higher market value for young animals, especially during Eid, when there is a high demand for young sheep, resulting in an additional 50 TND per sheep. Evidence: (Focus group discussion report: <https://hdl.handle.net/10568/168864>)

2.1.2. Cost-Benefit Analysis of Improved Silvopastures on Milk Production per Cow

The cost benefit analysis of improved silvopastures on milk production reveals that improving silvopasture significantly enhances milk production and profitability. Cows grazing on improved pasture generated nearly double the revenue (1,620 TND) compared to those on degraded silvopasture (720 TND). The improved silvopasture extended the milking season by 30 days (90 days vs 60 days), which means a longer period of milk production and revenue generation. Additionally, after accounting for expenses, cows on improved pasture yielded a net revenue 1,270 TND per cow compared to 690 TND per cow on degraded pasture. This indicates that, despite the increased costs of improving pasture, the financial returns are significantly greater, emphasizing the cost-effectiveness pasture improvements. Furthermore, the ability to generate more revenue from improved pasture reduces farmers' dependency on purchasing feed or other supplements, as the improved vegetation increases natural grazing options leading to sustainable livestock management practices. Lastly by improving the health of silvopasture, farmers enhance the resilience of their livestock system. This not only benefits individual households but also contributes to broader food security and economic stability in the community. Overall, the findings on the cost benefit analysis highlight the need to advocate for scaling up investments in silvopasture restoration to enhance livestock productivity, profitability and resilience in pastoral community.

Evidence: (Focus group discussion report: <https://hdl.handle.net/10568/168864>).



Photo credit: Mounir Louhaichi

2.1.3. Reduction in Feeding Expenses

The evaluation of feeding cost reduction focused on two key factors. The first factor was the reduction achieved through community livestock grazing on a 70-hectare state pasture over a defined period. The site featured two types of interventions: reseeded and protected areas where grazing was restricted solely for conservation purposes. The productivity of these improved state pastures was assessed by measuring the output from Sulla-reseeded pastures and evaluating the productivity of the protected pasture. This assessment followed standardized scientific methods, with data collected by the ICARDA research team in collaboration with the DGF and the CRDA. To ensure long-term sustainability, it was recommended that only 60% of the site's forage production be utilized, with 40% reserved to maintain ecosystem health. The duration of grazing was determined based on forage availability and the size of the community's livestock herd, which included sheep, goats, and cows (with one cow equivalent to five sheep). This grazing management was overseen by the DGF and CRDA, with support from ICARDA and in close coordination with the local community.

The second factor focused on the gains local communities achieved in terms of cost savings from seeding Sulla on their farms (private land), an intervention supported through the distribution of Sulla seeds by the project. Traditionally, these lands were continuously grazed, but the introduction of Sulla enabled farmers to reseed their land, producing high-quality forage. The Sulla forage was utilized in two ways: through direct grazing and by cutting and storing it as bales for future use. An additional benefit observed was that farmers who planted Sulla did not need to apply ammonia fertilizer (which typically costs 150 TND) to their pasture, as Sulla naturally fixes nitrogen in the soil.

The following results and data are based on discussions held in FGDs, which included both male and female farmers from the local community. The outcomes of these discussions are presented below:

2.1.3.1. Cost-Benefit Analysis of Forage Utilization

2.1.3.1.1. State land

2.1.3.1.1.1. Cost-Benefit Analysis of Improved Pasture for Grazing

On the state land, the productivity and financial returns of improved pastures (Sulla reseeded and protected pastures), and control pasture were evaluated. For the improved pasture, 60% of the available forage was utilized, allowing 10 sheep per hectare to graze for 45 days. The revenue generated was 2 Tunisian Dinars (TND) per sheep per day, resulting in total revenue of 900 TND per hectare. Expenses for grazing on improved pasture included land rental (150 TND) and miscellaneous costs (30 TND), totaling 180 TND per hectare. Therefore, the net revenue from the improved pasture was 720 TND per hectare.

In contrast, on control pasture where 100% of the available forage was consumed by the same number of sheep for 15 days, the revenue was 150 TND per hectare. With no land rental costs, the expenses amounted to 30 TND, leading to a net revenue of just 120 TND per hectare. Thus, improved pasture generated significantly higher returns (720 TND) compared to control pasture (120 TND).

2.1.3.1.2. Private land

2.1.3.1.2.1. Cost-Benefit Analysis of Improved Pasture for Baling

On the private land, Sulla pasture significantly outperformed control pasture in terms of hay yield. Sulla produced 7,000 kg of hay per hectare, resulting in 140 bales (50 kg each) per hectare, which were sold at 16 TND per bale, generating a total revenue of 2,240 TND per hectare. Expenses for Sulla baling included land rental (150 TND), land preparation (150 TND), cutting and collection (150 TND), and baling costs (350 TND), for a total of 800 TND per hectare. Miscellaneous costs added 140 TND, bringing total expenses to 940 TND. The net revenue from Sulla baling was therefore 1,300 TND per hectare.

In contrast, control pasture produced only 2,500 kg of hay, yielding 50 bales per hectare which were sold at 15 TD per bale, generating a revenue of 700 TND per hectare. Expenses for the control pasture totaled 300 TND (land rental, baling and miscellaneous expenses: 150+70+30 TND), resulting in a net revenue of 400 TND. Thus, one hectare of reseeded pasture with Sulla generated much higher net revenue (1,300 TND) compared to the same area of control pasture (400 TND).

2.1.3.1.2.2. Cost-Benefit Analysis of Improved Pasture for Direct Grazing

For direct grazing on Sulla, the estimation gave a ratio of 10 sheep grazing for 120 days at a cost of 2 TND per sheep per day, generating a total revenue of 2,400 TND per hectare. Expenses for Sulla grazing included land preparation (150 TND), land rental (150 TND), and miscellaneous costs (100 TND), for a total of 400 TND per hectare. Therefore, the net revenue from Sulla grazing was 2,150 TND per hectare.

For the control pasture, 10 sheep could graze for 15 days, generating 300 TD per hectare. With expenses totaling 180 TND, the net revenue was just 120 TND per hectare. Consequently, reseeding pasture with Sulla yielded significantly higher returns (2,000 TND) compared to the control pasture (120 TND).

Summary of results on reduction in feeding expenses: The results demonstrate a substantial reduction in feeding expenses and highlight the positive impact of improved pastures on the resilience of livestock production systems. On state land, the introduction of improved pastures yielded 720 TND per hectare, compared to 120 TND from control, which is enough to feed 250 sheep for one day (as 2 TND is required to feed one sheep per day). This represents a sixfold decrease in feed expenses. On farmers' lands, the "cut and carry" method from Sulla pasture generated 1,300 TND per hectare, significantly higher than the 400 TND from control pasture (more than 3 folds), demonstrating the economic benefits of improved forage. The greatest gains were observed in direct grazing systems, where reseeding pastures with Sulla produced 2,000 TND per hectare, compared to only 120 TND from control pasture (>16 folds).

These improvements in pasture productivity not only reduce feeding costs but also enhance the resilience of livestock production systems by ensuring a more reliable and abundant source of forage, particularly in semi-arid regions. This resilience is critical for withstanding environmental stresses such as drought, as it lessens dependency on external feed sources and allows for more sustainable livestock management. Increased feed availability also supports better livestock health and productivity, contributing to greater food security and economic stability for farmers and pastoralists. By improving the efficiency of resource use and lowering operational costs, these interventions offer a sustainable pathway to bolster the resilience of livestock production systems in vulnerable regions.

2.2. Additional Income

The project interventions have provided farmers with multiple avenues for additional income and cost savings, as derived from the FGDs. One key area of savings is fertilizer costs, where farmers are able to save approximately 150 TND per hectare on ammonium and phosphate fertilizer for the subsequent crop, as the nitrogen-fixing properties of Sulla eliminate the need for additional fertilizers. In terms of livestock products, farmers have seen a notable increase in milk production, resulting in a net gain of 348 TND. Additionally, pasture improvement with Sulla has contributed to a 5-10% increase in meat production, particularly in young sheep. This translated to an added value of around 50 TND per sheep, further enhancing farmers' income during peak demand periods, such as Eid. Overall, these interventions have increased farmers' profitability through both higher sales of livestock products and significant cost reductions.



Photo credit: Mounir Louhachi

2.3. Enhanced Silvopastoral Ecosystem Services

2.3.1. Enhancing Ecological Health

2.3.1.1. Increased Productivity (biomass)

The implementation of silvopastoral systems significantly influenced the overall productivity of the land, particularly through the incorporation of *Sulla* as a forage legume. Given the project's relatively short duration, it is essential to note that it typically takes three to five years for fodder shrubs and trees to mature and become available for livestock feeding. Consequently, our assessment primarily focused on the impacts of *Sulla*.

Data from the reseeded pastures reveal remarkable results: biomass production was approximately four times greater in these areas compared to the protected pasture, and more than ten times higher than the control pasture. Specifically, the biomass yield from *Sulla*-planted areas reached an impressive 5.3 tons of dry matter (DM) per hectare, whereas control pastures only produced about 1.2 tons of DM per hectare (Figure 1). These findings underscore the potential of *Sulla* to enhance forage availability and quality, ultimately contributing to improved livestock productivity and supporting a more sustainable agricultural system.

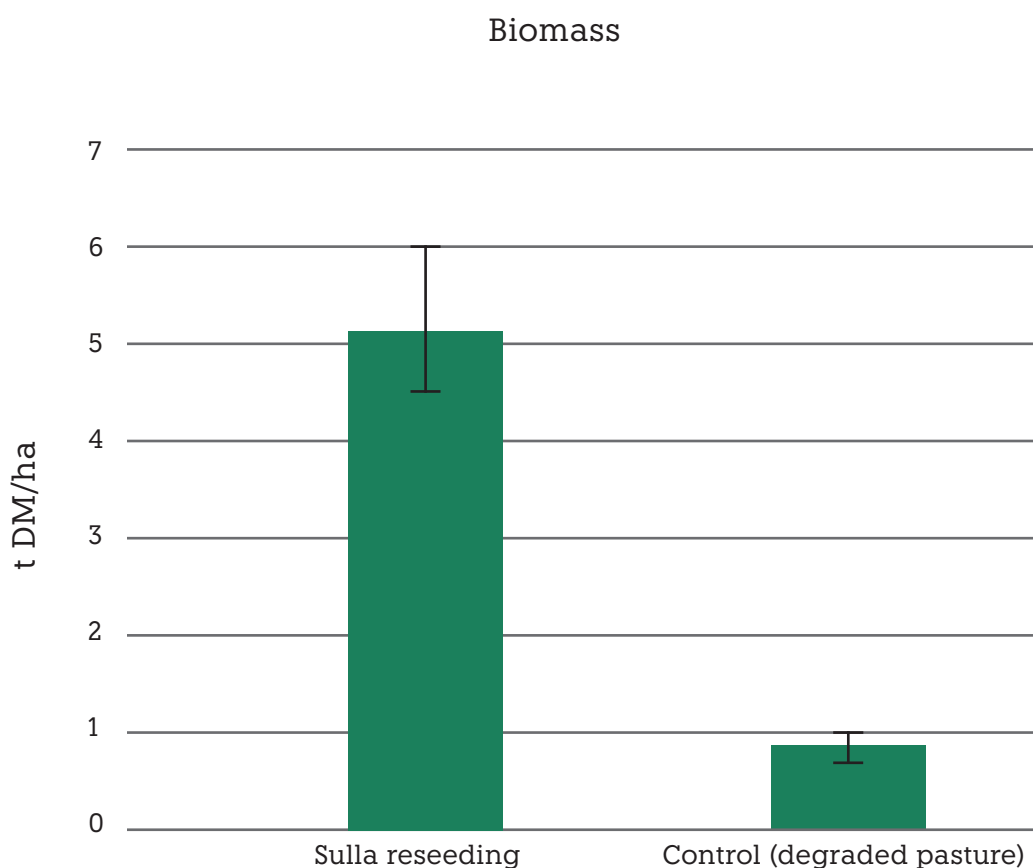


Figure 1. Biomass Production of *Sulla* Reseeding Pasture Compared to Control Pasture.

Evidences:

Louhaichi et al. 2023. Cultivating Sulla for Silvopastoral Restoration of the Mediterranean Basin. https://hdl.handle.net/10568/134772	TECA - Technologies and Practices for Small Agricultural Producers published by FAO.
Louhaichi et al. 2023. Silvopastoral restoration to enhance ecosystem services and increase farmers' income. IGC, Kentucky – USA. https://hdl.handle.net/10568/140524	Proceedings paper published by International Grassland Congress.
Louhaichi M. 2022. How can extensive grazing be beneficial for the restoration of dryland ecosystems. Presentation. FAO-GLF Digital Forum. https://hdl.handle.net/10568/126874 https://hdl.handle.net/10568/126635	Video Presentation at the digital forum jointly hosted by the Global Landscapes Forum (GLF) and the FAO.
https://qcat.wocat.net/en/wocat/technologies/view/technologies_5919/	WOCAT: Native Drought-Tolerant Forage Species for Enhanced Dryland Pasture Restoration.

2.3.1.2. Enhanced Vegetation Cover and Density

The adoption of silvopastoral practices has led to significant improvements in both vegetation cover and density when compared to traditional pasturelands. ICARDA has employed a new innovation, VegMeasure, to accurately estimate plant cover, which has provided valuable insights into the effectiveness of silvopastoral practices (Figure 2).

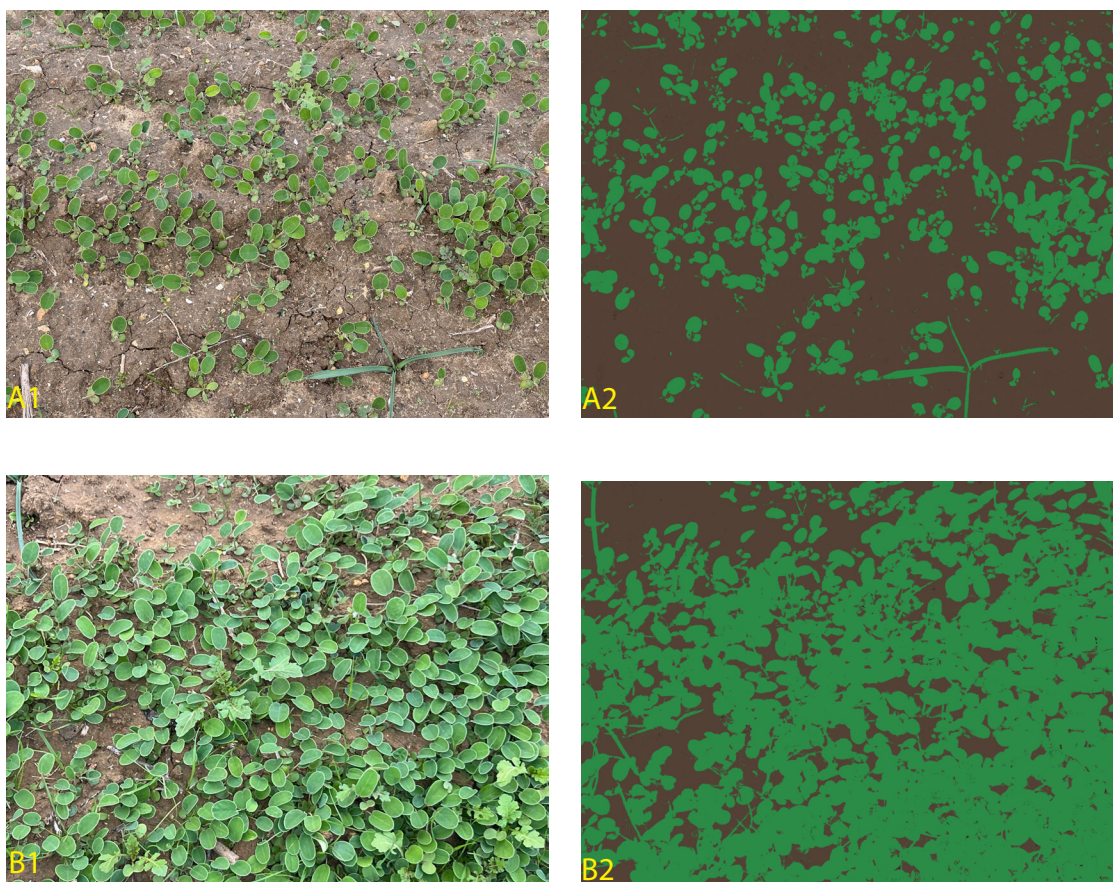


Figure 2. Plant Cover Estimation Using VegMeasure Software. Images A1 (January 2024) and B1 (early February 2024) show the original photographs, while A2 and B2 display the processed images. Analysis indicated a vegetation cover of 26% and soil cover of 73% in image A, while image B showed 70% vegetation cover and 30% soil cover.

The adoption of these practices has led to substantial improvements in both vegetation cover and density compared to traditional pasturelands. Specifically, pastures that were reseeded with *Sulla* and designated as protected achieved an impressive 100% plant cover. In contrast, control pastures, which did not benefit from reseeded or protection, showed less than 30% cover. This clear difference highlights the success of silvopastoral restoration techniques in enhancing vegetation growth and overall ecosystem health. The increased plant cover in protected and reseeded areas not only reflects better land management but also contributes to improved soil stability, moisture retention, and biodiversity (Figure 3).

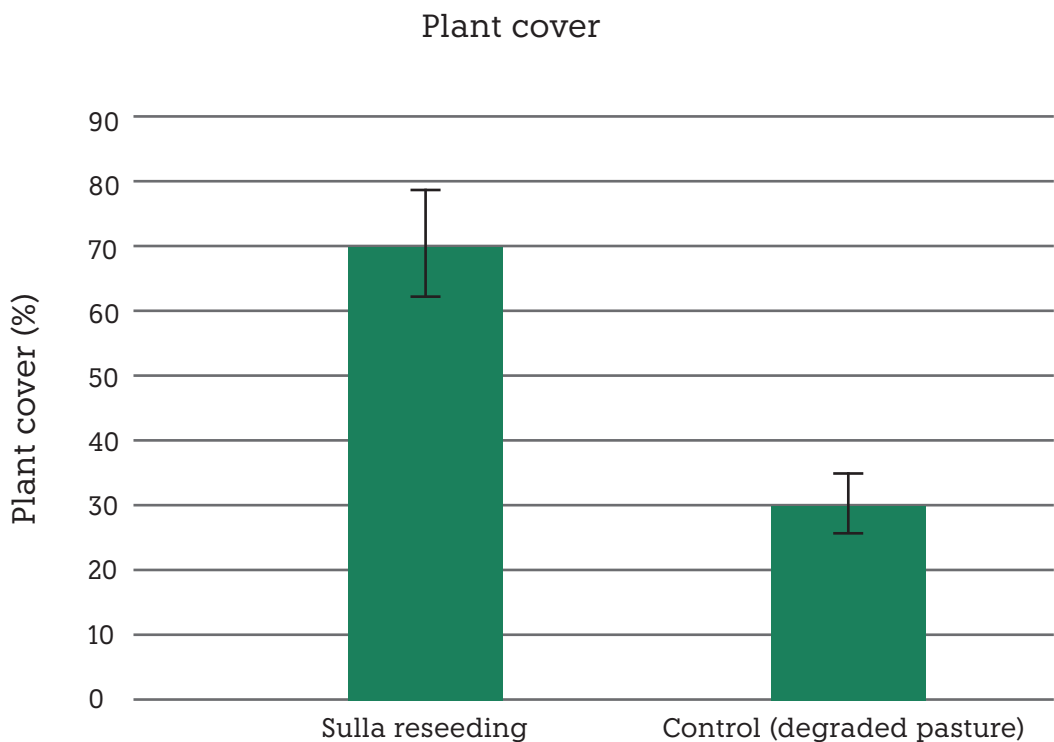


Figure 3. Plant cover (%) of *Sulla* Reseeding Pasture Compared to Control Pasture.

In terms of plant density, the highest values were observed in the reseeded pasture, with an impressive 163.2 plants per square meter, followed by protected pasture at 30.6 plants per square meter and the control pasture which had the lowest density at 29.8 plants per square meter. These findings, as reported by Louhaichi et al. (2022), clearly demonstrate the effectiveness of silvopastoral systems in enhancing vegetation cover and density, contributing to improved ecological health and forage availability in semi-arid agrosilvopastoral systems. (Evidence: Louhaichi et al. 2022. Improving Forage Production Quantity and Quality Using Native Legume Species in Semi-arid Agrosilvopastoral System. <https://hdl.handle.net/10568/125783>)

2.3.1.3. Enhanced Biodiversity (species composition)

The implementation of silvopastoral practices has resulted in significant improvements in plant biodiversity, particularly in species composition across the *Sulla*, protected, and control pastures. Based on the data, the reseeded *Sulla* pasture contained a total of 24 species, while the protected pasture had 19 species, and the control pasture had 18 species. Notably, the *Sulla* site showed the highest richness of species, supporting a greater number of palatable species compared to the other areas. For example, highly palatable species such as *sulla* (Palatability index: 5) and *Hordeum vulgare* (Palatability index: 5) were prevalent in the *Sulla* area but absent in the control site (Unpublished report).

The correlation between palatability and species richness further highlights that 12 species (50%) in the Sulla pasture were classified as palatable, while 8 species (42%) in the protected pasture and 6 species (33%) in the control pasture were palatable. This indicates that the Sulla reseeding not only boosted overall biodiversity but also favored the growth of desirable, forage-rich species. In contrast, less palatable species like *Anagallis arvensis* (Palatability index: 1) and *Diploaxis harra* (Palatability index: 2) were more common in the control and protected pastures. Although the low species richness in the control is probably due to grazing since palatable annuals will disappear first, these findings suggest that silvopastoral systems are effective in enhancing both biodiversity and forage quality, making them a sustainable option for rangeland restoration (Table 1).

Sulla	Protected	Control	Palatability index
<i>Acacia saligna</i>	-	-	2
<i>Allium roseum</i>	-	-	2
<i>Anacyclis clavatus</i>	-	-	4
-	<i>Anagallis arvensis</i>	-	1
<i>Anemone coronaria</i>	-	-	4
-	-	<i>Astragalus cruciatis</i>	4
<i>Atractylis proliferata</i>	-	-	2
<i>Bromus madritensis</i>	-	<i>Bromus madritensis</i>	4
-	-	<i>Calycotome villosa</i>	3
<i>Centaurea dimorpha</i>	-	-	1
-	<i>Centaurea napifolia</i>	<i>Centaurea napifolia</i>	1
<i>Chrysanthemum sp.</i>	<i>Chrysanthemum sp.</i>	-	4
-	<i>Cynodon dactylon</i>	-	2
<i>Daucus carotta</i>	<i>Daucus carotta</i>	<i>Daucus carotta</i>	3
-	-	<i>Dipcadi erythraeum</i>	0
<i>Diploaxis harra</i>	<i>Diploaxis harra</i>	<i>Diploaxis harra</i>	2
-	<i>Echinops spinosus</i>	<i>Echinops spinosus</i>	1
<i>Ephedra sp</i>	-	-	1
-	-	<i>Globularia alypum</i>	3
<i>Hedysarum coronarium</i>	<i>Hedysarum coronarium</i>	-	5
-	<i>Hedysarum spinosissimum</i>	<i>Hedysarum spinosissimum</i>	5
-	-	<i>Helianthemum lippii</i>	5
<i>Hordeum vulgare</i>	<i>Hordeum vulgare</i>	-	5
<i>Launaea resedifolia</i>	<i>Launaea resedifolia</i>	<i>Launaea resedifolia</i>	4
-	-	-	3
<i>Olea europaea</i>	<i>Lycium arabicum</i>	-	5
-	<i>Oryzopsis miliaceae</i>	-	4
<i>Plantago ovata</i>	<i>Plantago ovata</i>	-	5
<i>Rapistrum sp.</i>	<i>Rapistrum sp.</i>	-	1
-	-	<i>Reseda alba</i>	4
-	-	-	1
-	-	-	2
-	-	<i>Scorzonera undulata</i>	4
<i>Stipa capensis</i>	-	-	1
-	-	<i>Tetraclinis articulata</i>	1
-	<i>Urginea maritima</i>	-	0

Table 1: Species Richness and Palatability Index of Species Observed in Sulla, Protected, and Control Pastures.

2.3.2. Impact on Soil

2.3.2.1. Reduced Soil Erosion Risks

In areas under silvopastoral management, soil erosion risks have significantly decreased compared to conventional grazing systems. The integration of biological and mechanical treatments has played a crucial role in this reduction. The Sulla intervention has notably increased plant cover, enhanced soil carbon levels, and improved overall soil quality. Evidence: Slim et al. 2021 (<https://hdl.handle.net/10568/168701>).

Key Interventions:

- **Gabion Structures:** Four stone gabions were constructed in critical eroded areas to trap soil and water flow. These structures have proven effective in mitigating erosion by significantly reducing runoff. The analysis indicated that these gabions preserved at least 4,800 tons of soil per hectare per year. Their design helps to dissipate energy from flowing water, thereby decreasing the potential for soil displacement.
- **Manual Benches:** Manual benches serve to further enhance soil and water conservation. They are capable of storing approximately 280 cubic meters of water, which can be utilized for irrigation of planted shrub species. Additionally, the manual benches have reduced soil erosion by around 186 tons per hectare per year.
- **Water Retention Improvements:** The implementation of these techniques has resulted in a substantial reduction in water loss by runoff. In bare pasture, the estimated volume of water lost due to runoff was calculated to be 7,700 cubic meters, which decreased to 4,900 cubic meters after the interventions. This reduction of 800 cubic meters per hectare indicates a significant improvement in water retention and availability for vegetation.

Evidence: FAO-ICARDA Silvopastoral project final report (<https://hdl.handle.net/20.500.11766/10220>)



Photo credit: Mounir Louhaichi

2.3.2.2. Soil Organic Matter, Total Carbon and Total Nitrogen Levels

In the state lands, soil analysis indicated that protected pastures contained approximately 6% more nitrogen mineral content compared to control pastures, although the total nitrogen content remained similar between the two pastures. The organic matter percentage in protected pastures was 5% higher than in control pastures, reflecting enhanced soil fertility and potential for better plant growth in the protected pastures (The data originates from a paper currently being prepared for submission).

On private lands, farmers reported positive effects from growing *Sulla*, citing noticeable improvements in soil quality. They observed enhanced soil structure and fertility, attributing these benefits to *Sulla*'s ability to enrich the soil through its nitrogen-fixing properties and organic matter contributions. This has led to increased productivity and sustainability on their lands (Focus group discussion report).

2.4. Establishment and Empowerment of Local Silvopastoral Communities:

Progress toward the empowerment of local silvopastoral communities, such as GDAs, while also encouraging youth participation in business ventures within the silvopastoral sector.

2.4.1. GDA Empowerment

The restoration and other technical improvement activities of the lighthouse site for silvopastoral systems are not enough and sustainable in the absence of very good governance. This is based on our experience during the last few years about the management of the silvopastoral site and more specifically the opening of the site for grazing by the community herds, many challenges ICARDA and national institutions including the DGF and CRDA of Zaghuan have faced mainly in term of community commitment in respecting the carrying capacity either in terms of the number of animals or in terms of duration of grazing. To this effect, to promote community engagement, ensure legal compliance, emphasize participatory governance, minimize conflicts of interest, and above all reconcile individual with collective interests, ICARDA and its national partners in collaboration with the community have created the GDA of Sbaihia.

The general tasks of the GDA are in line with the law N° 99-43 du 10 May 1999 and are very broad:

1. Conservation and rationalization of the use of natural resources.
2. Protection and survey of the plantations and crops.
3. Contribution to the consolidation of land tenure and agrarian situations.
4. Increasing the productivity of agricultural farms.
5. The development of rangeland and livestock systems.
6. The accomplishment of any mission aimed at strengthening the collective interest and its members.

ICARDA, DGF, and CRDA of Zaghuan are continuously supporting the GDA and providing technical backstopping. A number of practical training sessions for members of the GDA on the methods and tools for implementing the participatory and integrated silvopastoral system development and management plan.

The success of technical restoration and management actions, whatever their nature, has already

been ensured by the presence of the GDA as the representative structure of the different users of the silvopastoral system, dynamic, honest, and equipped with the means of work. This fact has significantly minimized the conflict of interest and reconciled individual interests with collective interests within the community. Indeed, the community having confidence in the GDA willingly contributes to the success of the proposed actions by:

- a- declaring the real size of their herds.
- b- respecting the rules for grazing.
- c- applying technical recommendations for good herd management.
- d- falling within the various self-financing processes of common property management structures.

The GDA is pivotal in guiding land-use policies, fostering community participation, and ensuring sustainable practices. Furthermore, it will facilitate the role of the governmental institutions to invest and approach other national and international donors to finance other livelihood-improving projects. The government's financial commitment can only be decided based on the agreement and commitment of the GDA for the implementation of this silvopastoral system management plan and based on a good demonstration of their ability to manage the resulting system improvements. The mobilization of resources to carry out restoration and management must consider users' contributions and commitments to respect the disciplines of opening grazing periods and carrying capacity.

2.4.2. Youth and Gender Participation

Rural women in Tunisia constitute half of the rural population and represent 32% of all Tunisian women—around 1.8 million individuals, according to the Tunisian Ministry of Agriculture. Contrary to common assumptions, these women are deeply involved in livestock grazing and rearing, contributing substantially to pastoral systems. Research suggests that empowering women to sustain and enhance pastoral practices could play a critical role in restoring Tunisia's degraded ecosystems, capitalizing on their knowledge and involvement in sustainable land management.

In 2021, Tunisia's national unemployment rate reached 18.4%, reflecting a decade of economic challenges post-revolution. Many young people, disillusioned by limited economic prospects, continue to call for meaningful opportunities. Unemployment remains particularly high among university graduates, women, and youth, with 28.5% of young people classified as Not in Education, Employment, or Training (NEETs), limiting their career development and potential. This situation underscores the importance of involving local communities—especially women and youth—in decision-making processes related to sustainable pastoral and silvopastoral management.

Through various capacity-building efforts aimed at enhancing governance for sustainable silvopastoral restoration and improved livelihoods, local communities have agreed to establish a Specialized GDA focused on silvopastoral systems in Shada, with 40% representation from the local community. The GDA's responsibilities include:

- Supporting capacity development for young entrepreneurs.
- Assisting in preparing financing files and conducting market studies.
- Facilitating the creation of microprojects targeting rural women and youth through bank credit programs (e.g., BTS: Tunisian Solidarity Bank).

Key income-generating activities supported by the GDA include livestock products, honey production, and aromatic and medicinal plant cultivation.

During capacity-building events, including field days and workshops focused on Sulla and other practices, over 200 youth and 70 women benefited directly, contributing to the initiative's evidence-based success (source: capacity development reports).

Regarding the aspects linked to marketing, the sale of local products (honey, aromatic and medicinal plants under different forms: essential oils, dry parts, liquid, etc...) can be done through organic shops, owned by the GDA, to promote cultural tourism in the Governorate of Zaghouan.

2.4.3. Economic Benefits for GDAs

Creating the GDA of Sbaihia stimulates good silvopastoral governance at environmental, institutional, and economic levels, under local constraints like land tenure systems. The GDA as a governance structure of the silvopastoral system regardless of the land tenure (private, collective, and state-owned) plays a key role in valorizing the system resources and services, fostering community participation, and ensuring sustainable practices.

These services (fodder, medicinal and aromatic plants, honey production, etc...) are important for the well-being of the Sbaihia community which mostly depends on these resources to treat human and livestock ailments and diseases. Additionally, they are a potential source of income for resource-poor people, especially women, who are involved in most of the fieldwork. Preservation of these species and knowledge of their uses will require specific intervention to ensure that this knowledge and these plants are not lost through environmental degradation, agricultural expansion, and over-exploitation. The GDA supports the conservation, management, and sustainable utilization of all these services, through conservation, cultivation, and propagation as opposed to collection from the wild. It also contributes to the development of effective in-situ protection of threatened habitats and ecosystems.

In terms of silvopastoral system governance, to ensure the sustainability of the developed innovative silvopastoral governance approach and extend its impact to larger spaces and other silvopastoral sites, the use of improved sites should not be free of charge. The community, through the GDA, must agree on grazing fees to be paid per head of animal and grazing day or period, then on the allocation of revenues and the terms of their management. For example, the GDA could be responsible for collecting these fees and using them to acquire livestock feed and allow the community to rest other sites, pay guards, common infrastructure, etc.

So far, the few farmer producers are not able to commercialize easily their products (milk, meat, honey, essential oils, etc...), the GDA can play an important role in linking the community products to markets.



Photo credit: Mounir Louhaichi

2.4.4. Capacity Building

The initiative has implemented a comprehensive capacity-building program, reaching over 2,500 individuals (of whom approximately 75% were women, with a significant majority being youth) through a diverse range of tailored events designed to enhance the skills and knowledge of stakeholders critical to its operations. This effort included structured training courses that provided specialized instruction on sustainable rangeland and silvopastoral management practices, complemented by on-the-job training to ensure participants could apply their knowledge in real-world scenarios. Advanced educational pathways were also supported, with several participants pursuing master's and PhD research, further contributing to the technical expertise and academic foundation of the project's objectives. Beyond formal training, interactive field days and in-person meetings enabled hands-on learning and knowledge-sharing among participants, while webinars provided an accessible platform for remote engagement, expanding the initiative's impact. Notably, approximately 75% of attendees were women, with a majority being youth, underscoring a deliberate focus on empowering women and young people as leaders in sustainable land management.

In addition, these capacity-building efforts emphasized empowering local community members, especially youth and members of the GDA, to take active roles in sustainable rangeland governance. Through workshops and training sessions, participants gained essential insights into the legal and procedural steps required to establish a GDA specifically focused on silvopastoral management, promoting long-term stewardship. This holistic approach to capacity development has not only strengthened technical competencies and fostered a sense of ownership but has also significantly increased awareness within the community about the importance of organized, sustainable management practices.

The collaborative framework established through these workshops has fostered strong partnerships among various stakeholders, including government entities, local communities, and NGOs. This approach not only enhances knowledge transfer but also promotes a sense of ownership among participants, encouraging them to contribute to sustainable practices. The workshops have outlined a clear roadmap for the establishment of the GDA, which is critical for the success of silvopastoral systems, enabling community members to navigate the formation process effectively and ensuring that their voices are heard in decision-making.

Moreover, the emphasis on specialized training opportunities, such as courses focused on optimal pasture utilization and support for local silvopastoral species, equips community members with practical skills that enhance their livelihoods and promote sustainable land management. The initiatives also underscore the importance of evidence-based decision-making and scientific research, encouraging participants to adopt informed practices in addressing challenges within silvopastoral management.

Evidence: Report (<https://hdl.handle.net/10568/137311>).

3. Sustainability and Scalability

The lighthouse site for silvopastoral systems exemplifies sustainability through its integrated approach to agrosilvopastoral management. By combining crop production, livestock grazing, and forestry, the project enhances biodiversity, improves soil health, and increases water retention, all of which contributes to long-term ecological resilience. The use of Sulla, a nitrogen-fixing legume, not only reduces the need for synthetic fertilizers but also enriches the soil, making it more productive for future cropping cycles. Additionally, the emphasis on sustainable grazing management prevents overgrazing, allowing pasture to regenerate and maintain their ecological balance.

Scalability is evidenced by the DGF's commitment to replicating this model across similar landscapes in Tunisia, alongside the FAO's recognition of the case as one of the successful examples in "Twelve Success Stories of Sustainable Livestock Transformation." The positive outcomes observed at the lighthouse site—including increased biomass production, reduced feeding costs, and enhanced farmer livelihoods—serve as a template for other regions facing similar challenges. By adapting the practices demonstrated in this case, such as efficient water management and the introduction of high-value forage species, other sites can achieve comparable benefits. The focus on community involvement and knowledge sharing further ensures that this model can be tailored to local conditions, making it both practical and adaptable for broader application in Tunisia and beyond.

Proofs: FAO selected stories (<https://hdl.handle.net/10568/155126>)



Photo credit: Mounir Louhaichi

4. Conclusion

A significant progress toward achieving sustainable land use and improved ecosystem services was noted. This was mainly as a result of the uptake of validated tools and technologies in silvopastoral planning and governance, making strides in managing nearly 400,000 hectares. This includes tools for assessing landscape trade-offs, cost-benefit analysis, and ecosystem valuation, which are being actively adopted by communities with the support of GDAs. Interventions, such as native forage reseeding, soil and water conservation, and structural improvements, have led to notable increases in vegetation cover, forage availability, and livestock productivity. For example, the reseeding of nitrogen-fixing *Sulla* tripled forage production and improved milk and meat yields, delivering substantial economic returns and reducing fertilizer costs by 150 TD per hectare. These results underscore the initiative's impact on enhancing productivity and resilience in pastoral systems, promoting sustainable resource use.

Community empowerment through the establishment of GDAs, especially with a focus on active participation from women and youth, fostered governance structures that prioritize inclusive decision-making, aligning well with the initiative's target of 30% women representation in leadership roles. Capacity-building programs reaching over 2,500 individuals bolstered community engagement in sustainable practices and strengthened the GDAs' role in guiding land use policy and fostering economic opportunities, such as market access for honey and medicinal plant products. By bridging individual and collective interests, the GDAs enable a more resilient, community-driven approach to land management, mitigating conflicts and securing community buy-in for regulated grazing and resource management. This holistic model not only demonstrates tangible progress toward sustainable ecosystem services but also sets a foundation for scaling these practices across other silvopastoral landscapes.

The SPS approach adopted in the lighthouse consisted of an integrated technological package that included technical, environmental, social, economic, and institutional options. This package has improved soil fertility, reduced soil erosion, increased water availability, improved forage availability, and therefore animal production, diversification of income generative activities, gender empowerment, and community engagement through the creation of the GDA, a community-based organization.

All the presented indicators certify the silvopastoral improvement accomplished in the region of Sbaihia. The suggested approach relies heavily on a robust participatory process, ensuring full cooperation from the local community, who actively contributed to key decisions implemented on-site. These decisions included selecting appropriate plant species, managing the site post-planting, and determining strategies to enhance ecosystem service performance within the silvopastoral site. The participation of women and young people in this initiative is considered the main pillar to harness innovative capacities and create long-term mitigation effects of climate change while increasing production. The creation of the GDA as a community representative has and will be a guarantee in fostering community participation and ensuring sustainable practices and of the silvopastoral resources.

Sulla, a drought-resistant native forage legume, enhances quality and availability of fodder, improves soil quality by providing soil cover, nitrogen fixation, biodiversity enhancement, and improved water infiltration. Furthermore, the vegetation cover intercepts rainfall, reducing runoff, while the shade it provides reduces evaporation. Additionally, the plant's roots improve soil porosity, enhancing soil infiltration capacity.

Diversification of the silvopastoral systems using *sulla*, a forage legume-pollinator, is strongly recommended for strengthening of SPS and improving livelihood of the Mediterranean silvopastoral communities.

5. Recommendations

The uptake of validated technologies and processes to improve land use planning, management, governance, and restoration practices in Mediterranean silvopastoral livestock systems can significantly benefit semiarid regions. For example, reseeded well-adapted native forage species has great potential to boost productivity, reduce feeding costs, and enhance the income of silvopastoral communities.

1. The demonstration, training, and communication of good practices and optimal solutions towards all stakeholders from the decision-makers and governmental institutions to the future users from the silvopastoral communities and their representatives and can be therefore considered as a lighthouse.
2. Sulla legume species showed high adaptive and productive performances and is considered the main component of the developed and implemented silvopastoral technical package as an important source of protein for livestock in addition to the other benefits. However, to produce more balanced feed resources on the site, planting perennial grass forage species (such as buffel grass, hairy crabgrass, orchard grass, fescue, ray-grass, etc.) as a source of energy will be a necessity and more beneficial for the community to reduce the costs of imported concentrates.
3. In silvopastoral systems, it is essential to enhance the complementarity between the tree and shrub layers and the herbaceous understory. Replacing the exotic and invasive *Acacia saligna* with more adaptive native species, such as the Carob tree (*Ceratonia siliqua*) and *Periploca angustifolia*, can serve as a standing fodder bank to buffer seasonal fluctuations and dry years. This approach is crucial for maintaining livestock productivity, particularly in the absence of herbaceous species like Sulla.
4. The silvopastoral system approach developed in the lighthouse is an integrated environmental, social, economic, and institutional package of good practices successfully tested and implemented. This SPS can therefore be outscaled and practiced in similar socio-agroecological contexts.
5. Promote the use of landscape assessment and cost-benefit tools to guide community and government land-use decisions. Building the capacity of development agencies, community leaders, and GDA members to use these tools will help support sustainable ecosystem management while balancing economic growth and environmental resilience.

Annexes

Annex 1: Publications

Publication type and title	Research question(s) Objective(s)	Methodology	Key message(s) / key findings	Citation CG/MEL Link
1. Journal Article (ISI) Assessment of soil surface scarification and reseeding with sulla (Hedysarum coronarium L.) of degraded Mediterranean semi-arid rangelands.	To investigate the effects of soil surface scarification and reseeding rangelands with sulla on biomass production and pastoral value of rangelands in the semi-arid zone of Tunisia.	The experimental design consisted of a randomized complete block design with six replications. The treatments were: (i) soil surface scarification; (ii) reseeding sulla following soil scarification; and (iii) control.	The highest aboveground net primary production (2 307 and 5 330 kg dry matter ha ⁻¹), water productivity (9.5 and 11.8 kg DM mm ⁻¹), and pastoral value (2 099 and 4 853 forage units ha ⁻¹) values were recorded in the rangelands reseeded with sulla. combined soil scarification and reseeding well-adapted native forage species has a great potential to improve productivity of semi-arid rangelands.	Slim et al. 2021 Assessment of soil surface scarification and reseeding with sulla (Hedysarum coronarium L.) of degraded Mediterranean semi-arid rangelands. African Journal of Range and Forage Science. https://hdl.handle.net/10568/168701
2. Proceedings paper IRC 2022 Improving Forage Production Quantity and Quality Using Native Legume Species in Semi-arid Agrosilvopastoral System.	To evaluate the impact of Hedysarum coronarium L. (sulla) reseeding on pasture productivity, plant cover and plant density in semi-arid silvopastoral systems.	The experimental design consisted of a randomized complete block design having 3 treatments including reseeding sulla; protection from grazing and control (free grazing) with three replications per treatment.	Reseeding well-adapted native forage species has a great potential to improve productivity of semi-arid silvopastoral systems, which would contribute towards reducing the feeding cost and, therefore, enhancing the income of the agrosilvopastoral communities.	Louhaichi et al. 2022. Improving Forage Production Quantity and Quality Using Native Legume Species in Semi-arid Agrosilvopastoral System. Kenya. https://hdl.handle.net/10568/125783

<p>3. Proceedings paper IGC 2023 Silvopastoral restoration to enhance ecosystem services and increase farmers' income.</p>	<p>Develop a sustainable silvopastoral system in Central Tunisia to enhance ecosystem services and increase farmers' income.</p>	<p>This study evaluated sustainable silvopastoral systems (SPS) in Central Tunisia to mitigate the effects of climate change. The approach involved integrating Native legume species to enhance soil quality, promote carbon sequestration, diversify income, and conserve biodiversity.</p>	<p>Diversification of the silvopastoral systems using sulla, a forage legume-pollinator is strongly recommended for strengthening SPS and improving livelihood of the Mediterranean silvopastoral communities.</p>	<p>Louhaichi et al. 2023. Silvopastoral restoration to enhance ecosystem services and increase farmers' income. https://hdl.handle.net/10568/140524</p>
<p>4. FAO technical report 2022 Grazing with trees: A silvopastoral approach to managing and restoring drylands.</p>	<p>Improve the productivity and resilience of silvopastoral system.</p>	<p>The report demonstrates the outcomes of interventions at a silvopastoral site in Tunisia aimed at restoring degraded SVP. By integrating tree species with grazing systems, the project improved soil quality, boosted vegetation cover, enhanced carbon sequestration, and promoted biodiversity. Native shrubs, legumes, and trees were used to increase ecosystem resilience.</p>	<p>Increase in the silvopastoral production of forage and livestock through halting land degradation and erosion using silvopastoral tools, with clear outcomes in conserving the natural resource base (flora, fauna, soil and water), while improving the livelihoods and resilience of agrosilvopastoral communities, in the target area.</p>	<p>Louhaichi et al. 2022. Sustainable silvopastoral restoration to promote ecosystem services in Tunisia. https://hdl.handle.net/10568/125780</p>

<p>5. Blog on Preserving Dryland Forests and Agrosilvopastoral Systems: Sustainable Rangeland Management at the Committee on Forestry (COFO).</p>	<p>Preserving Dryland Forests and Agrosilvopastoral Systems.</p>	<p>The blog outlines a sustainable restoration approach for dryland forests and agrosilvopastoral systems by integrating ecological, social, and economic factors. It emphasizes community engagement, biodiversity conservation, and land management using the Sustainable Rangeland Management Toolkit. Key methods include a participatory multi-stakeholder approach, regenerative practices like opportunistic grazing, and the use of innovative agricultural technologies such as seed banks and science-based innovations. These methods were showcased during the COFO 2023 session, focusing on strengthening resilience in dryland ecosystems.</p>		<p>Madison Spinelli & Mounir Louhaichi. 2023. Preserving Dryland Forests and Agrosilvopastoral Systems: Sustainable Rangeland Management at the Committee on Forestry (COFO). URL: https://www.cgiar.org/news-events/news/preserving-dryland-forests-and-agrosilvopastoral-systems-sustainable-rangeland-management-at-the-committee-on-forestry-cofo/</p>
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Annex 2: Capacity building

Training event	Key areas covered / Objectives	Total # participants	Number of Female	CG/MEL Links
Travelling workshop (2022): Silvopastoral System Restoration under changing climate and land use: improving sustainability and efficiency	Increase awareness of farmers about sustainable silvopastoral restoration under changing climate and land use. Specific objectives include 1) demonstrate best practices for introducing forage legume species (sulla), multi-purposes shrub/tree and grazing management and 2) distribute sulla seeds to interested farmers.	124	33	https://hdl.handle.net/10568/126878
Group training course: Seed Collection & Conservation and Nursery Management of Indigenous Silvopastoral Species	Empower participants to adequately handle indigenous collect, store and plant seeds to produce healthy seedlings.	33	9	https://hdl.handle.net/10568/134774
Webinar: Challenges and opportunities for promoting use of native species for the rehabilitation of degraded silvopastoral systems in Tunisia	Promote the use of native species for restoring degraded silvopastoral systems.	34	9	https://hdl.handle.net/10568/134774
Field day: The importance of the Sidr tree (Ziziphus spina-christi) and its preservation	Increase awareness about the vital role of Ziziphus species in Tunisian silvopastoral systems, emphasizing their ecological, economic, and cultural significance.	37	20	https://hdl.handle.net/10568/137310
Workshop (2023): Strengthening governance for sustainable silvopastoral restoration and enhanced livelihood	Raise awareness among the local silvopastoral community about the legal steps involved in formulating a silvopastoral CBO (GDA).	26	7	https://hdl.handle.net/10568/137311

Field day: Strengthening the resilience of silvopastoralists through proven climate smart practices in the semi-arid region of Tunisia	Demonstrate sustainable silvopastoral restoration practices, with farmers receiving Sulla seeds, marking a transformative step toward sustainable agriculture and improved economic well-being.	40	12	https://hdl.handle.net/10568/137307
Training of Trainers: Rangeland Monitoring & Assessment: Integrating Land PKS, VegMeasure, and Traditional Methods	to enhance trainers' capacity in rangeland monitoring, assessment, and data collection, enabling effective knowledge transfer and strengthening institutional capacity.	6	1	https://hdl.handle.net/10568/134768
Group training course: Techniques of Survey of Vegetation Cover and Determination of Carrying Capacity	Estimate carrying capacity for an improved silvopastoral site using two techniques. Generate land use map using waypoint collected by handheld GPS and digitizing on screen in Google Earth. Acquire proficiency in using VegMeasure computerized vegetation-management program.	17	4	https://hdl.handle.net/20.500.11766/69416
Long-term training: 1 PHD student	Evaluate the effects of natural additives on the production of genetically stable in vitro plants: Application to Aloe (<i>Aloe vera</i> L.)	1	1	https://hdl.handle.net/10568/137250
Long-term training: 2 MS Students	Characterization and evaluation of the implementation of best silvopastoral practices in the rural community of Sbaihia, Zaghouan region	2	2	Thesis
Long-term training: 1 undergraduate student	Mapping silvopastoral systems using geoinformatics	1	1	Thesis

E-learning course to tackle complex challenges of managing dry-land forests and agrosilvopastoral systems.	This course aims to: 1) bridge the knowledge gap and build capacity in dryland management practices. 2) equip individuals with the necessary skills and knowledge to tackle the complex challenges faced by these ecosystems. 3) foster positive change and promote sustainable practices for the benefit of both communities and the environment	800	375	https://hdl.handle.net/10568/134657 URL: https://www.cgiar.org/news-events/news/new-e-learning-course-to-tackle-complex-challenges-of-managing-dry-land-forests-and-agrosilvopastoral-systems/
Field days: Empwoer women women's GDA	Strengthen governance, better access to markets & loans, social protection, and other services for women-based cooperatives	1500	1500	List of participants
Total		2621	1974	

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How to cite:

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