Sustainable Silvopastoral Restoration to Promote Ecosystem Services in Tunisia

Quarterly Progress Report
01 April – 30 Jun 2018

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ABBREVIATION

CBO: Community Based Organization,

CRDA: Commissariat Régional de Development Agricole

DGF: Direction Générale des Forets

DMY: Dry Matter Yield

ESAM: Ecole Supérieur d'Agriculture de Mateur

FAO: Food and Agriculture Organization of the UN

ICARDA: International Center for Agricultural Research in the Dry Areas

INRGREF: National Institute for Research in Rural Engineering, Water and Forests

OEP: Office de l'Elevage et des Pâturages

OM: Organic Matter

PDIE: Protein Digestible in the Intestine allowed by Energy

PDIN: Protein Digestible in the Intestine allowed by Nitrogen

PV: Pastoral Value

TD: Tunisian Dinar

USD: United States Dollar

WUE: Water Use Efficiency

1. EXECUTIVE SUMMARY

From an environmental and productive point of view, one of the main advantages of silvopastoral systems is to fulfil multipurpose land use objectives through increasing resource use efficiency at spatial and temporal scales, the reduction of hazards and risks, the enhancement of system stability and the promotion of the social and recreational use of these natural landscapes. Therefore, there is both a need and an opportunity to improve use and management of these degraded ecosystems. This is because successful establishment and management of silvopastoral systems will yield sustainable production of multiple outputs (meat, milk and timber) alongside the generation of environmental services such as increased ecological diversity and carbon sequestration. This report provides an evaluation of adopting a participatory/multidisciplinary approach toward sustainable restoration of a silvopastoral production system to promote the delivery of ecosystem services located in Sbaihia, Zaghouan, Tunisia.

Methods of analysis include monitoring and assessing the impact of the sustainable silvopastoral practices. With respect to perennial shrubs and trees (e.g. oldman salt bush, tree medic and cactus pear), it is too early to evaluate their impact. Three months after their transplantation, their survival rate was estimated which amount to over 85%. of reseeding rangelands with a native biannual forage legume species (sulla) on ecosystem services such as grazing biomass for livestock, soil and water conservation. Biomass production was significantly higher ($p<0.05$) in improved areas (2.3 t DM/ha) compared to control areas (1.2 t DM/ha), whereas rain use efficiency (0.8 in planted sites compared to 0.5 kg DM ha^{-1} m^{-3} in non-planted sites) Despite the arid conditions encountered in 2018 at the Sbaihia site (only 60% of the long term annual average precipitation was received during the study period of January to May 2018), the results confirm that the restoration of the silvopastoral pilot site improves the pastoral value of the natural rangelands through increasing the provision of ecosystem services (e.g. enhanced forage productivity made available, livestock productivity, increased soil cover reducing erosion, etc.). Furthermore, improved rangelands (sulla reseeding), dropped cost of livestock feeding to 0.75 TD per day per head (equal to 0.28 USD). Under this scenario, livestock keepers were able to save almost 2 TD/day/head (equal to 0.76 USD) compared to when they have to purchase feed.
At least eight capacity development events were executed, where a total of 200 participants targeting local farmers, extension staff, local authority and students have been equipped with skills and information concerning sustainably managing silvopastoral systems. From this total, 25 technical workers (including 6 females) were trained on participatory approaches towards sustainably managing silvopastoral systems and 16 (5 females) community members on the role of soil and water conservation in improving the pastoral potential of rangelands on soil and water conservation strategies. A further 19 community members were educated about the importance of sustainably grazing rangelands. In addition, a new initiative aimed at increasing the awareness about conservation of our natural resource base and best practices targeted 40 primary school pupils.

Over time, the benefits of diversifying well adapted forage species will be fully integrated to the feeding programs of livestock, yielding more benefits from the silvopastoral approach. Also, planting forage legume species, such as sulla, will be beneficial in enhancing soil fertility. The successful collaboration, at the national and regional level, between the Directorate General of Forests (DGF) of the Ministry of Agriculture, the Regional Commissariat of Agricultural Development (CRDA) of Zaghouan (represented by the forest service and the water and soils conservation service), the Higher School of Agriculture of Mateur (ESAM), the National Institute for Research in Rural Engineering, Water and Forests (INRGREF), the Community Based Organization (CBO) and the communities and farmers will be beneficial for the sustainability of the work undertaken within the framework of this project.

2. INTRODUCTION

The combined effects of climate change (recurrent droughts) and overgrazing on rangeland environments are detrimental: altering plant community composition, impairing ecological processes, and facilitating colonization by invasive species (Ouled Belgacem and Louhaichi, 2013; Thornton et al., 2009). Techniques which have been developed and adopted to face the challenges in degraded rangeland areas, include controlled grazing, planting well adapted trees and shrubs, and reseeding herbaceous forage species behind water harvesting structures. Well managed silvopastoral production systems are likely to enhance soil carbon (C) storage in lower soil layers due to the presence of deep tree roots, thus enhancing soil processes, supply of forage for livestock and provision of a habitat for flora and fauna (Haile et al., 2010). When a silvopastoral system is established by integrating trees/shrubs into pasture systems, above and belowground productivity, rooting depth and distribution, and the quantity and quality of organic matter inputs to soil will change (Howlett et al., 2011). Tree/shrub-based land-use systems are expected to have better soil C sequestration potential than most row crop agricultural systems based on the premise that the tree components in agroforestry systems can be significant sinks of atmospheric C due to their high and long-term biomass stock and extensive root systems (Montagnini and Nair, 2004). Therefore, the aim of this pilot initiative is to adopt a participatory/ multidisciplinary approach toward sustainable restoration of a silvopastoral production system to promote the delivery of ecosystem services in Sbaihia community, Zaghouan governorate, Tunisia (Figure 1).

Figure 1. Geographical location of the Sbaihia pilot site within the governorate of Zaghouan, Northern Tunisia.

2.1 Overall goal and specific objectives

The overall goal of this pilot initiative is to sustainably manage a silvopastoral production system and improve the livelihood of the local communities. The specific objectives include:

- Increase the forage and livestock production
- Alleviate land degradation and reduce effects of soil and water erosion
- Conserve natural resource base (flora, fauna, soil and water)
- Develop the linkages between seasonal fodder/forage production and livestock husbandry
- Increase community resilience, income and capacity of the local population
- Improve the livelihood of agro-silvopastoral communities

2.2 Planned activities for the second quarter of 2018

Based on the agreement, ICARDA (service provider) has been carrying out the following activities during the second quarter of 2018:

- Continue engaging communal farmers for a participatory approach in managing the silvopastoral pilot site
- Continue rangeland rehabilitation activities
- Initiate rational grazing management for herbaceous strata
- Conduct rangeland inventory and monitoring
- Continue implementation and maintenance of water harvesting interventions
- Continue capacity development of all stakeholders through meetings, field days, group training events and supervision of students.

2.3 Climate condition for 2017/18

Most of MENA region in general is experiencing harsh arid or semi-arid climates with low and unpredictable precipitation and wide temperature fluctuations. The target site is no exception as during the 2017/18 agriculture calendar the rainfall recorded represented only 60% of the long term average (Figure 2). The drought condition was really disappointing as it negatively impacted the germination, establishment and growth of the planted species.

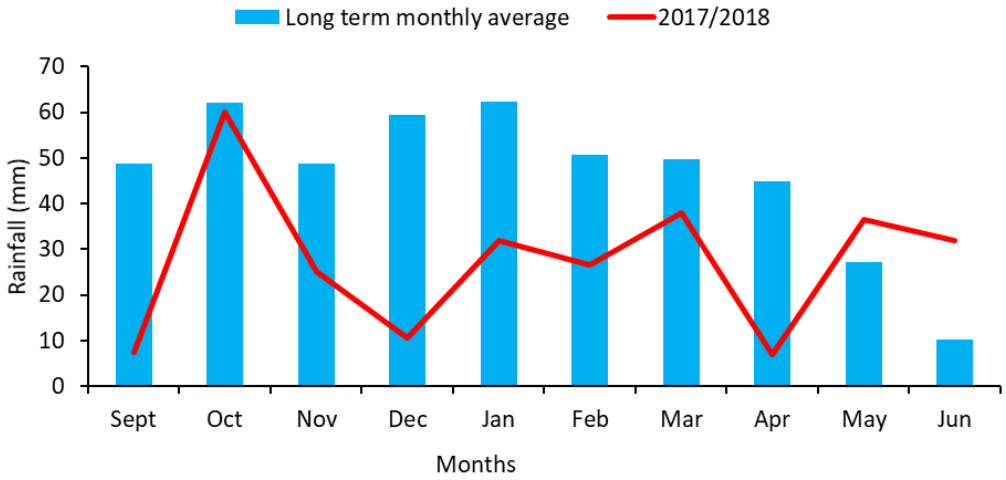

Figure 2. Long term monthly average rainfall (20-year) and the rainfall received during the data collection period (January- May 2018).

2.4. Land tenure

In Tunisia, rangelands cover approximately 5,566,180 ha, including 2,500,000 ha of collective land, 1,285,000 ha of private land, 970,000 ha of forest rangelands, 743,300 ha of *Stipa tenacissima* based rangelands and 67,880 ha of state-owned land. Under the collective land, over 2 M Ha (36% of the total rangeland area in the country) are under the supervision of the forestry department (DGF). The target site of Sbaihia fits this category and presents an opportunity to demonstrate both approach (working with local community and institutions) and an integrated technical package for wider dissemination to these large areas. Therefore, a memorandum of agreement (MOA) was signed between the department of forestry (Direction General des Forets "DGF" and ICARDA with detailed a working plan. The DGF is responsible for managing the silvopastoral site.

3. PROJECT INITIAL IMPACTS

As indicated in the FAO-ICARDA agreement this pilot initiative was recently launched (end November of 2017). This late fall start of the project was not ideal to guaranty success of project field activities as we missed early rain which usually starts in September/October in Tunisia. Nevertheless, the field activities are being implemented since then and continue to be enhanced and maintained for at least 2 years or until the perennial species (shrubs and trees) are well

established. These two facts in combination with the state of degradation of the target site, the drought condition of 2017/18 and time needed to gain full trust of the community, make it difficult and too early to assess the impact of the project interventions either on the environment (soil, vegetation, etc.) or at the community level (household). Nevertheless, at the request of the FAO counterpart, we tried somehow to make an initial assessment of the impact.

3.1 Cactus and shrub transplantations

In order to control the spread of rangeland degradation and reduce its adverse influence on forage production and natural resource degradation, planting of trees/shrubs is particularly necessary. Such a practice provides a large amount of fodder for livestock, combats desertification, and plays a key role in natural resource conservation.

Furthermore, trees and shrubs have a facilitative effect on the establishment of understory seedlings in environments that are characterized by harsh environmental conditions. They also reduce solar radiation and soil temperature, conserve moisture, and enrich the soil nutrient content.

The selection and choice of species to plant in the pilot site was made in consultation with all concerned stakeholders and this continued discussion started during meetings and field days where questions about the needs of the region were discussed. The outcome of these consultations in narrowing down choices to focus on drought tolerant species, such as cactus pear (*Opuntia ficus-indica*), old man saltbush (*Atriplex nummularia*), carob tree (*Ceratonia siliqua*) and tree medick (*Medicago arborea*). These species are very promising to survive under harsh conditions due to their morphological and genetic characteristics permitting them to withstand prolonged droughts, interrupted by irregular occurrence of often light rainfall.

3.1.1 Materials and methods

- **Cactus pads transplantation**

Cactus pads, which were over a year old and sourced from the Office of Livestock and Pasture (OEP), were harvested from the mother plants in March 2018. The pads were air-dried by placing them under a shade for a period of 10 days. Drying was meant to heal the areas where the pads were cut off from the mother plant, and the drying avoided wilting the pads.
Parts of the target site are too rough (steepness) to plant shrubs that require irrigation during establishment phase. Therefore, the decision was taken to populate these areas with cactus since it has low input. During the spring season (March - April) of 2018, cactus pads were planted in these rough areas to limit soil and water erosion (Figure 3). The spacing between the cladodes was 1.5 m apart in rows and the rows were at least 3 to 3.5 m apart, and the spacing varied according to the condition of the field. A total of 1,800 double cladodes were planted in the rangelands of Sbaihia. Keeping in mind that cactus plantation will not be grazed directly (cut and

carry) especially these rough areas are avoided by sheep and the risk of direct grazing is minimum.

Figure 3. Landscape areas (rough terrain and steep slope) where cactus pads have been planted.

- **Seedling (shrubs/trees) transplantation**

Seedlings, sourced from the Forest Service public nurseries, of selected fodder trees and shrubs have so far been planted on the sides of the slopes to reduce soil erosion and to consolidate the water harvesting structure. The species include *C. siliqua* (300 seedlings), *M. arborea* (200 seedlings), and *A. nummularia* (300 seedlings). To get maximum profit from the runoff, seedlings were transplanted in constructed micro-catchments, with a spacing of least 1.5 m apart (Figure 4). Due to the steepness of the slopes, spacing between rows varied between 2 to 3 m. The micro-catchments were established using tools that are readily available and can be implemented on land slopes with variable soil depth. Seedlings were irrigated immediately after transplanting.

Figure 4. Seedlings transplanted in the micro-catchments where water can be easily harvested after a rainfall event.

- **Distribution of cactus cladodes and shrub seedlings to local farmers**

An additional quantity of 3,200 cladodes of spineless cactus, 300, 200 and 300 seedlings respectively of carob tree, tree medic and Atriplex, were distributed free of charge to the local community for them to transplant in their private rangeland areas (Figure 5).

- **Selection criteria of farmers**

Community members were selected based on the following criteria:

- Private property should be surrounding the pilot site,
- Willingness of farmers to take care of the seedlings through irrigation and prevention of browsing,
- Willingness to apply technical backstopping provided by the multidisciplinary team.

Farmers who met these conditions were then offered plant material free of charge as follows:

- Farmers owning a flock of sheep, goats and cattle with more than 20 heads received between 50-60 seedlings of each shrub species and at least 500 cactus cladodes (Figure 5).
- Households with smaller herd size received a lower allocation of seedlings (between 20-50 seedlings of each species) and cactus cladodes (between 300-400 cladodes).

Figure 5. Seedlings offered to farmers to plant in their farms.

3.1.2 Expected impacts

Cactus and shrub species are planted in the pilot site because (a) they act as standing fodder bank to buffer seasonal fluctuations that occur in this dry area, (b) an important source of energy and water (cactus) in the dry season when forage production is very low in the rangelands, (c) are a protein supplement (mainly the legumes tree medick and Carob tree) for livestock on poor native rangelands or consuming low quality roughages, (d) are a means of soil erosion control, and (e) are a fuel source for low income farmers.

While preliminary establishment rates of the transplanted seedlings and cactus pads, recorded after 4 weeks at the pilot site, are relatively high varying from 73% for (the carob tree) to 100% for (the cactus) in Sbaihia (Figure 6), it is still early to ascertain their final establishment and survival before summer drought and the amount of biomass these shrubs will produce to potentially cover the feed gap during the dry seasons. The overall seedling survival rate is estimated at > 85%.

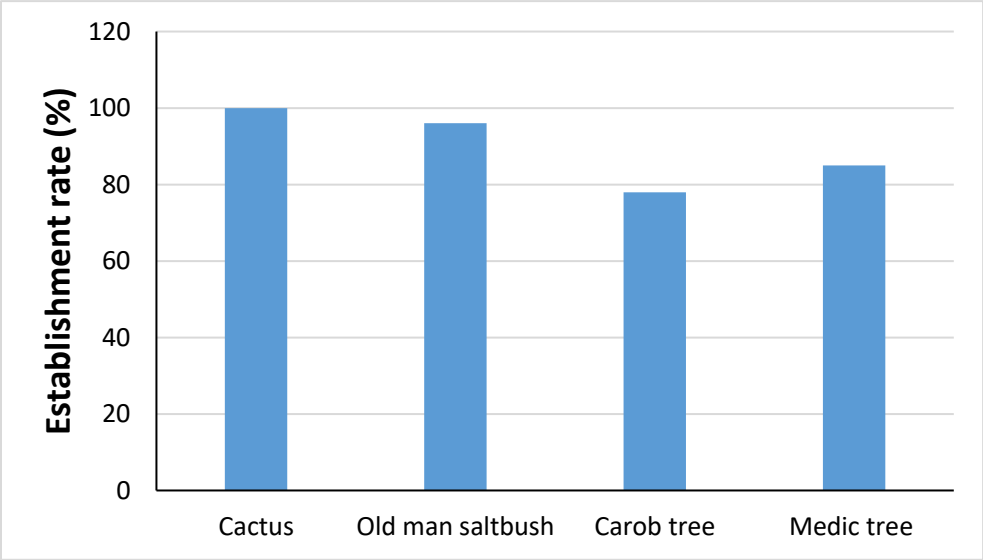

Figure 6. Preliminary establishment rates of the transplanted seedlings at the pilot site

3.2 Reseeding of sulla (forage legume species)

Sulla (*Hedysarum coronarium* L.) is a short-lived, biannual, herbaceous legume originating from the Mediterranean region where it is used widely for hay, silage, and green feed (Stienezen et al., 1996). It has a deep branching root system, prostrate to erect reddish stems, and grows to 150 cm tall with bright red flowers produced over much of the growing season. Sulla is mainly used for its benefits towards soil conservation, especially in view of its ability to grow on a wide range of soil types, and its tolerance of dry conditions (Douglas, 1984). Sulla is well known by its fast growth permitting to produce a large herbage biomass (up to 16 t dry matter (DM)/ha per

rainy season), suggesting that this species is a very useful source of protein for livestock, and contributes towards the feed gap in environments which experience extended periods of droughts, such as Sbaihia. The objective of this study was to determine the effects of scarification and sulla plantation on soil properties.

3.2.1 Materials and methods

Experimental design

The trial consisted of three treatments: i) sulla reseeding following soil scarification, ii) soil scarification and iii) control (no scarification neither sulla reseeding). The trial was laid out as a randomized block design with six replicates. The experiment was established in December 2017 at the Sbaihia site located at Zaghouan governorate (26°27'34" S, 10°13'50" E). Sulla seeds were purchased from the Office of Livestock and Pasture farm in Fritissa with the following characteristics: 69% germination capacity, 89% specific purity and 10.94 ± 0.31 g of 1,000 grain weight. Seeds were manually sown on December 13th, 2017, at 40 kg/ha seeding rate (Figure 7).

Figure 7. Sulla at germination and flowering stage at Sbaihia site, Zaghouan, Tunisia

Data collection

Measurement of vegetation characteristics were carried out monthly from January to May. The following parameters were calculated: dry matter yield (DMY), water use efficiency (WUE), pastoral value (PV). Contents of PDIN, PDIE in sulla leaves were calculated according to (Jarrige, 1988; Colin-Schoellen et al., 2000). To this effect, for each treatment and within each plot, 10 quadrats of 1 m x 1 m area each, were randomly placed. Within each, standing plants were clipped at ground level and weighed before oven-drying at 85^{o}C for 24 h, to estimate dry-matter yield (DMY). The average dry matter was calculated in tons' dry matter yield, the biodiversity index (H') was determined according to the method of Cavallero and Roggero (2002). The pastoral value was determined according to Pittarello et al. (2018) formula, while rain use efficiency was determined according to Howell (2001). Ten surface soil (i.e., 0–15 cm depth) samples were randomly taken from each treatment plot before initiation of the trial in December 2017 and after the growing season of Sulla in May 2018. On each sampling date, the soil samples

were bulked by treatment, air-dried and sieved for laboratory analyses. The soil samples were analyzed for organic matter (OM) according to Nelson and Sommers (1996).

3.2.2 Expected impacts

The main results obtained show that despite the low rainfall amount recorded during the 2017/18 calendar year (only 224 mm) in the pilot site, technical interventions (soil surface scarification and sulla reseeding) generated higher yields than the control treatment.

The percentage of vegetation cover and bare ground differed between the scarified and control plots ($p<0.001$) (Figure 8). The scarification treatment increased the total plant cover by 64% compared to the control treatment. This can be explained by the fact that in arid and semi-arid regions where moisture availability is the critical limiting factor, the soil surface scarification can help break the soil surface crusted layer, which improves rainfall infiltration and facilitate soil seed bank germination.

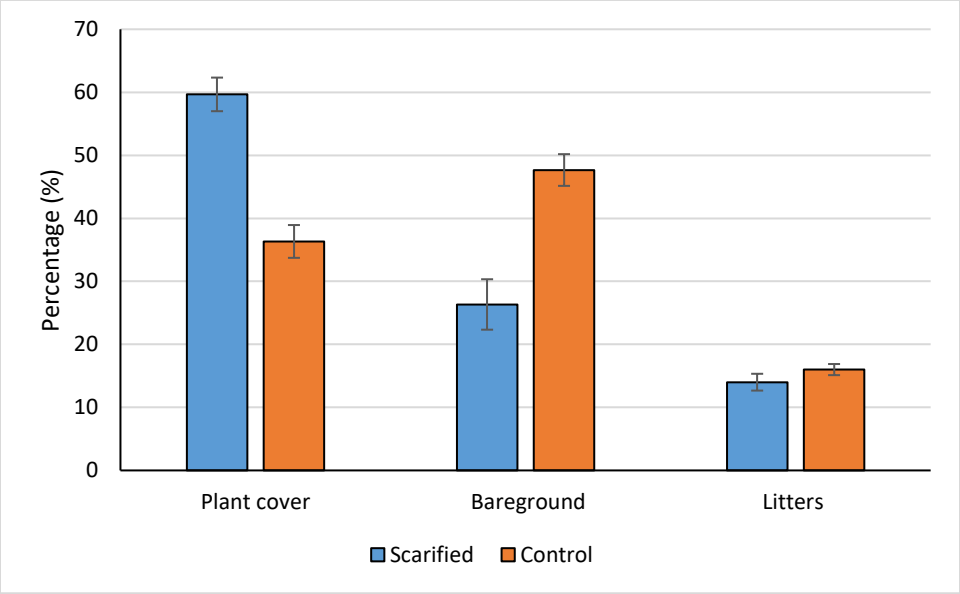

Figure 8. Percent cover (%) of plant cover, bare ground and litter in both scarified and control plots in Sbaihia, Tunisia.

For all scored parameters, the highest values were recorded in the Sulla reseeded plots. The dry matter yield ($p<0.05$) of the Sulla reseeded plots was with 2.3 t DM/ha higher than the dry matter in both scarified and control plots (Figure 9).

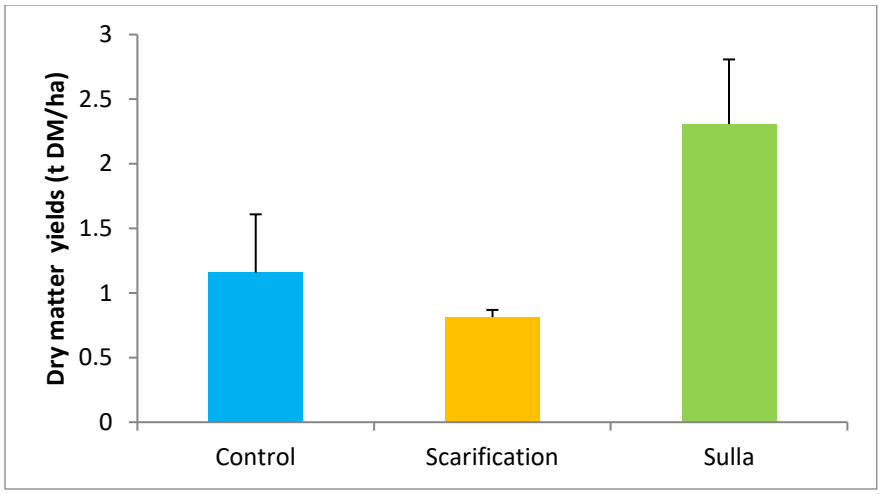

Figure 9. Estimate of productivity (t DM/ha) per treatment in Sbaihia, Tunisia.

The rain use efficiency followed the same trend and recorded the highest value in sulla reseeding plots followed by scarification treatments (Figure 10). These results indicate the importance of the pant cover role as a mean to increase the water infiltration and to reduce the water erosion.

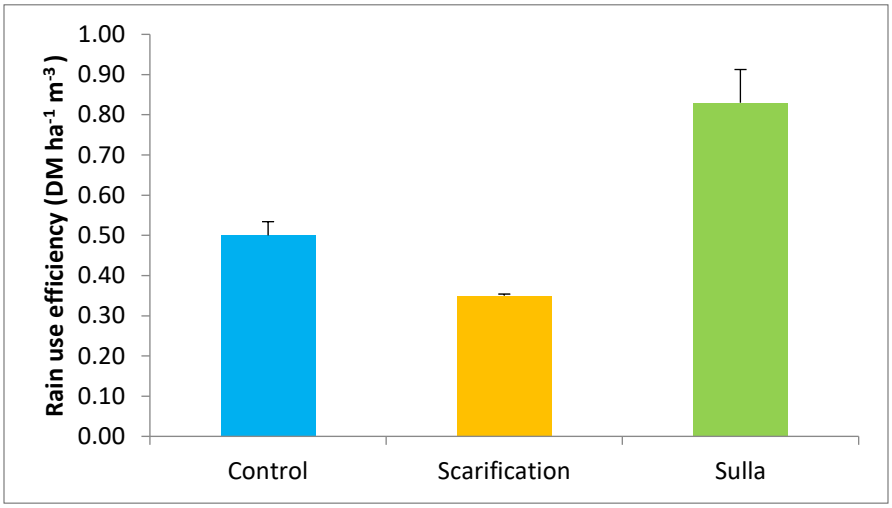

Figure 10. Estimate of rain use efficiency in the vegetation samples per treatment in Sbaihia, Tunisia.

The protein digestible in the intestine allowed by nitrogen (PDIN) 90 g/kg DM and protein digestible in the intestine allowed by energy (PDIE) 92g / kg DM in sulla reseeded sites compared to the control and scarified sites (Figure 11a and b).

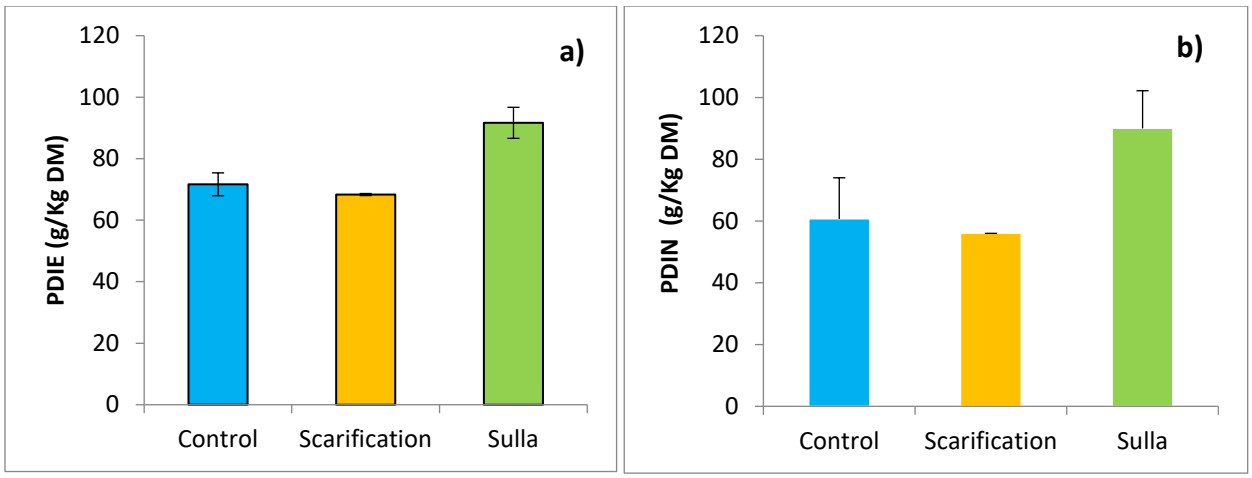

Figure 11. Variation of a) the protein digestible in the intestine by nitrogen (PDIN) and b) protein digestible in the intestine by energy (PDIE) per treatment in Sbaihia, Tunisia.

The pastoral value is an index that summarizes forage yield, quality, and palatability for livestock. It was calculated according to the following formula:

$$PV = 0.2 \sum SIi \times SCi$$

Where: SC_i is the Species contribution to total plant cover (Argenti and Lombardi 2012), and SI_i is the specific index, ranging from 0 to 5, which summarizes the forage value of each species in the pasture (Bagella et al. 2013).

The pastoral value was also higher in sulla reseeded sites (42.5%) compared to the scarified and control sites (Figure 12).

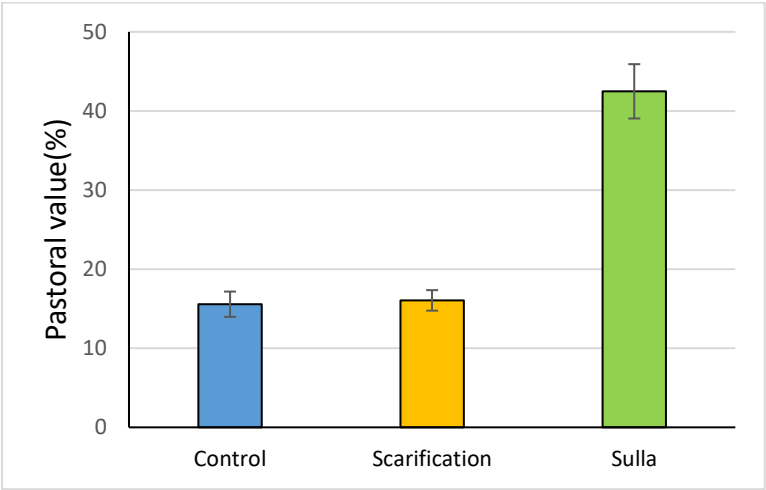

Figure 12. Variation of pastoral values per treatment in Sbaihia, Tunisia.

Despite the relatively low amount of rainfall recorded during the first experimental growing season, the results certify that reseeding of sulla has significantly improved the production and nutritive value of the natural rangelands. Even the low soil organic matter recorded in sulla sites could be explained by the fact that the period of sulla growth has not been long enough for it to develop a root system to induce any change in soil properties, compared to the control sites which had been undisturbed for a longer period of time. With time, the expectation is that the growing sulla will deposit vegetation residues which will positively influence soil chemical and physical properties, mainly through the nitrogen fixation process.

3.3 Grazing management of the rehabilitated area

Grazers are important regulators of ecosystem processes in grazing ecosystems as they increase forage concentration, grazing efficiency, forage nutrient concentration and above-ground plant production (Teague et al., 2011).

Sulla should be moderately grazed to ensure root development and plant ideal plant population for seed production in the second year (Neal et al., 2009). After browsing, at least 40% of biomass should remain to avoid delay in regrowth. The browsed sulla plant will have several advantages when compared with the grazed herbaceous plant, because woody plants have stem cambia with almost unlimited sources of new growing points that are completely protected from damage by browsing (Rutherford, 1979). The objective of this study is to estimate feeding cost reduction between improved rangeland compared to natural degraded rangeland (control).

3.3.1 Materials and methods

After several meetings among the various stakeholders involved, joint decision was made to open the site to grazing. The decision to open the site for grazing was requested by community itself due to the great need of feed resources in the region resulted from three years of drought affecting the country. Figure 13 shows the project intervention and Table 1 shows the total areas where sulla was reseeded.

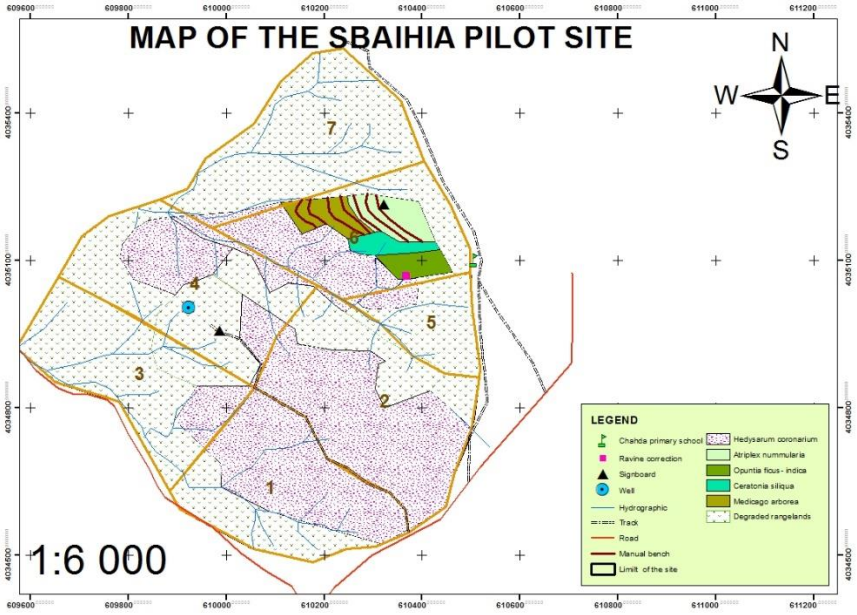

Figure 13. The location of the grazed plots located in Sbaihia, Tunisia.

Table 1. The total areas (ha) of sulla reseeding intervention in Sbaihia rangelands.

	Plot Number				Total
Utilization	**1**	**2**	**3**	**4**	
Sulla	6.3	7.8	1.3	2.3	17.7
Rangelands	3.2	3.8	7.4	8	22.4
Total	9.5	11.6	8.7	10.3	40.1

The number of livestock and the duration of grazing were calculated based on the current year's production. The CBO Sbaihia actively participated in the control and selection of farmers involved in the grazing operation. In this regard, the site was divided into 7 plots. Grazing was allowed in plots 5, 6 and 7 and restricted for plots 1, 2, 3, and 4. The grazing lasted one month at a stocking rate of 10 heads per ha. The animals belong to about 120 members of the community. Grazing started at the flowering stage of Sulla plants (Figure 14).

Figure 14. Livestock grazing in the rehabilitated rangelands of Sbaihia, Tunisia.

3.3.2 Expected impacts

Despite the current state of rangeland degradation and the current drought improved rangeland was able to contribute to animal feeding.

During dry season when there is nothing to graze the cost of feeding is estimated at 2.7 Tunisian Dinar (TD) per day per head (>1 USD/ sheep) to cover the cost of purchased hay and concentrates. When livestock keepers let their animal graze on natural rangeland vegetation, they have to supplement their animal with hay and concentrates which is estimated at about 1.17 TD/day/head (equal to 0.44 USD).

For the improved rangelands (sulla reseeding) of Sbaihia pilot site, the cost of livestock feeding dropped to 0.75 TD per day per head (equal to 0.28 USD). Under this scenario, livestock keepers were able to save almost 2 TD/day/head compared to when they have to purchase feed. This is one of the main reasons behind the high adoption rate for sulla reseeding intervention by the community in Sbaihia as it was profitable in terms of feed cost reduction.

The first year grazing trial, showed that proper understanding among the various stakeholders including local communities of the grazing management is crucial to ensure sustainability of the restoration. Therefore, more awareness of the local community to the importance of the stocking rate and grazing duration should be raised to avoid any misuse. Future grazing will follow the regulation in place put forward by the DGF which include paying a fee per head per day.

3.4 Soil and water conservation measures

Soil erosion not only reduces soil fertility, crop production, and biodiversity but also alters water quality and increases risks of global climate change and food insecurity (Blanco-Canqui and Lal, 2010). Therefore, soil conservation contributes towards increasing crop yields, reducing water pollution, and mitigating concentration of greenhouse gases in the atmosphere (Reij et al., 2013). The experimental site in Chahda in the region of Oued Sbaihia is strongly threatened by water and soil erosion as a result of the steepness of the slopes and lack of adequate soil cover.

3.4.1 Materials and methods

- **Gabion technique:**

In light of this, stone gabions were constructed in some sections of the eroded areas at the project site. The gabions were constructed to trap soil and water flowing downstream and to also reduce the effects of runoff on the soil. So far, two gabions were constructed and it is anticipated that the number will increase (Figure 15).

Figure 15. Stone gabion constructed within the pilot site.

- **Manual benches technique**

In addition to the gabion technique to reduce soil degradation, ten manual land benches were implemented to further increase soil and water conservation (Figure 16).

Figure 16. Benches constructed manually at the pilot site.

3.4.2 Expected impacts

- **Gabion technique:**

With a depth around 3.5 m for the 1st gabion and 5 m for the 2nd gabion, and an average width of 4 m and 7 m and with a dissipation basin of 4 m^2 and 6 m^2respectively for the 1st and the 2nd gabion, the land loss will be calculated based on the FAO formula:

$$(Es\ (t / ha / year) = Fm * C1 * C2 * C3$$

With C1 = 1.1, the soil is a loamy type, C2 = 0.8 Coef Depth of SBV Slope C3 = 0.6 it is a course. With an average rainfall of 400mm / year, the two gabions are expected to preserve at least 2400T / ha / year from degradation.

The constructed gabions are expected to significantly reduce the runoff as well as to trap the soil carried downslope by runoff. As this activity was only initiated in May 2018, tangible results are expected during the following rainy season.

- **Manual benches technique**

With a total distance of 700 m and a water retention capacity of 0.4m^2/m, a total estimated water harvesting is expected to be 280 m^3/year. This water quantity is sufficient for irrigating all planted trees and shrubs in border of the manual land benches installed in this site.

4. MEETINGS AND CAPACITY DEVELOPMENT BUILDING

Organizing field days and workshops in communities is important in bringing new ideas, resources and opportunities towards attaining community empowerment (Mathie and Cunningham, 2003). Such events, create new ties among the members of a community, leading to new norms of trust and cooperation, as well as new activities and collective action that could be beneficial for the community as a whole (Haines 2009). Hosting field days and workshops is also critical as this fosters collaborative relations between and amongst residents, as well as institutions involved in project implementation and establishment (Mathie and Cunningham 2005). Capacity development of communities results in community members to be well represented in critical decision making processes, thus enforcing community-based and –controlled initiatives, which have the potential to devolve responsibility of resource management to local levels, as well as mobilizing institutional resources such as local government, formal community based organizations and private enterprises (Gittell and Vidal 1998).

The capacity development activities carried out up to the end of June are presented in Table 2, and explained in detail in the text. A total of eight events were conducted so far covering various themes linked to the sustainable development of silvopastoral production systems in the dry areas. The emphasis was on the pilot site of Sbaihia (Zaghouan, Tunisia). The target participants were mainly from the local community, but we included the local authority, extension specialists and university students. In addition, a new initiative aimed at increasing the awareness about conservation of the natural resource base and best practices and targeting elementary school pupils.

Table 2. Meetings and capacity development events carried out since the beginning of the pilot study.

Event name & location	Date	Theme	Number of participants
Inception workshop (Zaghouan)	21-Nov-17	Develop and action plan for the project	35
Meeting at CBO (Sbaihia)	13-Dec-17	Awareness about project and involvement of farmers in the project activities	8
Field day on sulla cultivation (Sbaihia)	20-Dec-17	Introduce farmers to the cultivation and exploitation of sulla	35
Field day on importance of multipurpose shrubs and trees (Sbaihia)	28-Mar-18	Train community members on the cultivation, use and management of multipurpose shrubs and trees	15
Seedling transplanting field day for primary school pupils (Chahda Primary School, Sbaihia)	15-Apr-18	Educate and inform pupils in the school about the importance of trees towards sustaining human livelihoods	40
Field day on rational grazing management (Sbaihia)	1-May-18	Inform the Sbaihia community about the importance of sustainably grazing rangelands	19
Official visit of the FAO Forestry Officer (Sbaihia)	3-May-18	Update and evaluate project progress	23
Workshop on participatory approach and local development (coupled with field exercise at the pilot site) (Hammamet and Sbaihia)	7-12-May-18	Train participants on participatory approach and local development	25

4.1 Importance of multipurpose trees field day

A field day with 15 participants was held on the 28th of March 2018 at the CBO of Oued Sbaihia. Dr. Slim Slim (Assistant Professor and Consultant) welcomed the participants and stated that the aim of the field day was to train community members on the cultivation, use and management of multipurpose trees (Figure 17). Dr. Slim brought specimen of three multipurpose shrubs/trees of economic and ecological importance; the carob tree (*Ceratonia siliqua*), old man saltbush (*Atriplex nummularia*) and tree medic (*Medicago arborea*). Dr. Slim highlighted the important role played by these shrubs/trees for rehabilitating degraded rangelands through reducing soil erosion and improving the nutrient status of the soil, as well as being an important source of browse for livestock in rangelands. Dr. Slim also informed the participants that once planted, the trees/shrubs need a minimum 2 year-period for establishment before browsing can be initiated (Figure 17).

Figure 17. Participants during the multipurpose field day in Sbaihia, Zaghouan in March 2018.

4.2 Awareness creation through a restoration field day

A field day to illustrate restoration techniques and develop community environmental awareness was organized on the 15th of April 2018 at Chahda Primary School in Sbaihia, Zaghouan. This particular field day targeted at least 40 pupils and was facilitated by Mr. Jamel Kailene (DGF). Mr. Kailene welcomed the pupils and introduced the main aim of the field day to educate and inform them about the importance of restoration in general with emphasis on afforestation using native trees towards sustaining human livelihoods and on the role of trees in our ecosystem (Figure 18). Mr Kailene mentioned that the field day also included practical demonstrations and participation of school pupils in the planting of seedlings in the rangeland surrounding their communities. After introduction and a detailed presentation about the role of trees and shrubs for ecosystem service provision and their role in rehabilitating degraded ecosystems, we distributed seedlings and booklets to the pupils with information describing how humans should sustainably use trees for a better tomorrow (Figure 18).

These booklets were describing trees and their benefit in simple terms, understandable to primary school pupils. The process of transplanting seedlings was then described to the pupils who then participated in the seedling transplanting in nearby rangelands (Figure 18). After transplanting, students watered the seedlings to boost their survival. In total, the pupils transplanted 120 shrub seedlings. With the cooperation of the primary school teacher during the field day, it was agreed that pupils would maintain the seedlings, mainly through watering during certain periods after school. In order to motivate pupils, incentives (booklet/flier, lunch box, etc.) were offered to them so that they fully participated while also committing to taking care of the seedlings.

Figure 18. Participation of pupils in the Chahda Primary School field day, held in Sbaihia, Tunisia in April 2018.

4.3 Official visit of the FAO Forestry Officer

On the 3rd of May 2018 the FAO Forestry Officer, Mr. AbdelHamied Hamid, visited the Sbaihia site. His visit was organized in a way to evaluate the progress made during the first four months of the project and discuss the future workplan. During his visit he also met with the local authority representing the Ministry of Agriculture in Zaghouan. The community members were able to discuss the various challenges they face regarding the status of the rangelands surrounding their communities. During the discussion, community members also expressed enthusiasm and hope that the pilot site/initiative in Sbaihia will also yield more initiatives similar to the current one for their benefit, because their livelihoods depend on the healthy status of the rangelands. Mr. Abdelhamid was then taken on a tour to the pilot site, where he was shown the progress made in the project (Figure 19). The visit by Mr. Abdelhamid was beneficial for the pilot operation team, because Mr. Abdelhamid was able to give his opinion and valuable feedback on where the site operation team could improve their activities in order to improve the overall impact of the project.

Figure 19. Visit of Mr Abdelhamid (FAO Representative) to the pilot site

4.4 Grazing field day

A grazing field day was held in Sbaihia Site (Zaghouan) on the 3rd May 2018, attended by 19 participants. Dr. Slim and Mr. Kailene highlighted that the objectives of the field day were to inform the Sbaihia community about the importance of sustainably grazing rangelands as well as the ecological relationships within grazing systems. Dr. Slim and Mr. Kailene further mentioned the need to integrate livestock in the management of rangelands, because they play a pivotal role in seed dispersal and nutrient deposits though their urine and faeces (Bauer and Hoye, 2014). In the pilot site in Sbaihia, the role of adopting a participatory approach involving the local community as well as the research organizations (e.g. ICARDA and the FAO) was also discussed as a critical strategy towards ensuring the community involvement in managing the rangelands.

Such a process of engaging the local community to identify and select potential rangeland management approach, based on their indigenous knowledge, also provides an opportunity for community empowerment and reduces the risk of the pilot site in Sbaihia being viewed as irrelevant by the local community.

The community members welcomed this idea and felt that it was necessary to incorporate their opinion in managing developmental initiatives in their region as they need empowerment in order to sustain their livelihoods. During the discussion, Dr. Slim also proposed that animals in the site should not exceed 400 animals, while grazing/browsing in the pilot site should not exceed a period of 30-days. This was suggested to ensure that vegetation is given enough time to recover from the herbivory. The importance of formulating a rotational grazing scheme in order to improve the management of communal rangelands was also discussed. The community members were encouraged to avoid letting the livestock graze in the protected planted area as well as the experimental plot, because vegetation in these areas was still not well developed. After the discussion, the participants were then taken on a tour to the planted area and experimental site (Figure 20).

Figure 20. The participants in the grazing field day at the pilot site in Sbaihia, Tunisia.

4.5 Training workshop on participatory approach, local development and basic organizations

From 7-12 May 2018, a field exercise on project activities in Sbaihia, Tunisia was held which also involved local farmers. This training module was carried out to focus on appropriation and application of a participatory approach and to also ensure local capacity development of farmers in Sbaihia. Thus, a training session targeted 25 technicians and executives (including 6 females) of the General Directorate of Forestry (DGF) in addition to representatives of the Office of Grazing and Livestock (OEP), the Research Institute in Rural Engineering, Water and Forests (INGREF) and the Integrated Landscape Management Project Management Unit (UGO) as key technical partners (Figure 21). In order to be effective in carrying out the training, a field visit was organized

on Thursday, May 10, in Oued Sabayhia, whose community benefits from the pilot operation for sustainable silvopastoral restoration to promote ecosystem services in Tunisia.

On 10th May a field visit was organized to the Ouled Sbaihia site. It consisted of a practical exercise where participants were asked to practice group moderation (data collection and analysis of the functioning of the CBO with discussions of development perspectives). The program consisted of two sessions:

1- The first session involved explaining to the participants the role of the project in the Sbaihia community and the potential future benefits of the project towards improving the livelihoods of the local community. This exercise was moderated by Dr. Slim, who also answered questions regarding the expectations of the community members regarding improving their livelihoods or sustaining themselves.
2- A second exercise was carried out with the CBO and consisted of one of the participants facilitating a discussion with the CBO members in order to clarify the functioning of CBO and its role in the development and management of the project site as well as its participation to improve the income of the adherent population.

Figure 21. Participants in the field exercise on participatory approach, local development and basic organizations in Sbaihia, Tunisia.

The program included a one-day field visit to the pilot site. The visit enabled us to conduct an exercise aimed at collecting suggestions and recommendations from participants to fully understand the difficulties and advantages of applying the participatory process and especially the role of the facilitator in conducting the discussions/negotiation with the community members. The discussions initiated during the course of this field exercise allowed participants to compare their experiences through the application of the participatory approach, and to identify the shortcomings of the project. Some practical recommendations have even been suggested to remedy the current situation and to make the future work in the project in Sbaihia more effective:

- Working with local communities is not an easy task and requires a good mastery of the group facilitation / moderation process.

- Participants were offered a brief introduction to the use of GPS and accompanied software (Access and Map info) needed for mapping the site
- The indigenous knowledge of community members needs to be integrated with the scientific research towards managing the rangelands of Sbaihia. This will ensure that community members feel as being part of the ongoing project.

5. SOCIO ECONOMIC SURVEY

Silvopastoral production systems are often undervalued and their socio-economic importance is largely unknown. To improve management of Sbaihia silvopasture site, it is essential to provide guidance that is realistic within the socio-economic context surrounding target site. To understand this further the project team intend to conduct household surveys for the silvopastoral community that live near the pilot site of Sbaihia. The collected information will provide guidance and management that is tailored appropriately. Sustainable silvopastoral management has to address underlying socio-economic variables that include who makes the decisions in the community, the past and present land management, indigenous knowledge, and educational levels. External drivers of fodder prices and income sources can at times undermining project efforts if not understood.

The main objective of the survey is to obtain in-depth insights on the past management and current silvopastoral land use (see questionnaire in appendix A). In particular, the following aspects will be elucidated:

Land-use decision making:

- Who (men/women/wealthier/poorer farmer) takes the decision?
- Who has access to the rangeland/forest area?
- Past involvement in any silvopastoral restoration projects.

Changes in the management of the silvopastoral production systems:

- Impact of climate change.
- An understanding of the management practices for the last 10 years.
- Indigenous knowledge of silvopastoral production system.
- Crop productivity of the main crops (wheat and barley).
- Fodder prices (market value).

Economic possibilities and demographic profile of the community surrounding pilot site:

- Sources of income.
- Household education levels.
- Available subsidies.

A draft questionnaire is being circulated to all partners to consolidate all inputs before data collection (Appendix A). The survey will be conducted in September 2018 (3rd quarter.

6. REFERENCES

Argenti, G. and Lombardi, G. 2012. The pasture-type approach for mountain pasture description and management. *Italian Journal of Agronomy* 7: 293-299

Bagella, S., Salis, L., Marrosu, G. M., Rossetti, I., Fanni, S., Caria, M, C., Roggero, P.P. 2013. Effects of long-term management practices on grassland plant assemblages in Mediterranean cork oak silvo-pastoral systems. *Plant Ecology* 214: 621-631.

Bauer, S. and Hoye, B.J., 2014. Migratory animals couple biodiversity and ecosystem functioning worldwide. *Science*, 344(6179):1242552. DOI:10.1126/science.1242552

Blanco-Canqui, H. and Lal, R., 2010. Soil and water conservation. In *Principles of soil conservation and management* (pp. 1-19). Springer, Dordrecht.

Douglas, G. B. 1984. Seed production of sulla—a plant for soil conservation. Proceedings of the New Zealand Grassland Association (45): 239-242.

Colin-Schoellen, O., Jorjanz, S. and Laurent, F. 2000. Metabolizable protein supply (PDIE) and restricted level of ruminally degradable nitrogen (PDIN) in total mixed rations: Effect on milk production and composition and on nitrogen utilization by dairy cows. Livestock Production Science 67(1): 41-53.

Gittell, R. and Vidal, A., 1998. *Community organizing: Building social capital as a development strategy*. Sage publications.

Haile, S.G., Nair, V.D. and Nair, P.R., 2010. Contribution of trees to carbon storage in soils of silvopastoral systems in Florida, USA. *Global change biology*, *16*(1): 427-438.

Haines, A., 2009. Asset-based community development. *An introduction to community development*, *38*, p.48.

Howell, T.A., 2001. Enhancing water use efficiency in irrigated agriculture. *Agronomy journal*, *93*(2): 281-289.

Howlett, D.S., Mosquera-Losada, M.R., Nair, P.K., Nair, V.D. and Rigueiro-Rodríguez, A., 2011. Soil carbon storage in silvopastoral systems and a treeless pasture in northwestern Spain. *Journal of environmental quality*, *40*(3): 825-832.

Jarrige, R. 1988. Alimentation des bovins, ovins et caprins, INRA, Paris. 303 pp.

Mathie, A. and Cunningham, G., 2003. From clients to citizens: Asset-based community development as a strategy for community-driven development. *Development in practice*, *13*(5): 474-486.

Mathie, A. and Cunningham, G., 2005. Who is driving development? Reflections on the transformative potential of asset-based community development. *Canadian Journal of Development Studies/Revue canadienne d'études du développement*, *26*(1): 175-186.

Montagnini, F. and Nair, P.K.R., 2004. Carbon sequestration: an underexploited environmental benefit of agroforestry systems. In *New vistas in agroforestry* (pp. 281-295). Springer, Dordrecht.

Neal, J.S., Fulkerson, W.J., Lawrie, R. and Barchia, I.M., 2009. Difference in yield and persistence among perennial forages used by the dairy industry under optimum and deficit irrigation. *Crop and Pasture Science*, *60*(11): 1071-1087.

Nelson, D.W. and Sommers, L.E., 1996. Total carbon, organic carbon, and organic matter. *Methods of soil analysis part 3—chemical methods*, (methodsofsoilan3), pp.961-1010.

Pittarello, M., Lonati, M., Gorlier, A., Perotti, E., Probo, M. and Lombardi, G., 2018. Plant diversity and pastoral value in alpine pastures are maximized at different nutrient indicator values. *Ecological Indicators*, *85:* 518-524.

Reij, C., Scoones, I. and Toulmin, C., 2013. *Sustaining the soil: indigenous soil and water conservation in Africa*. Routledge.

Rutherford, M.C., 1979. Plant-based techniques for determining available browse and browse utilization: a review. *The Botanical Review*, *45*(2): 203-228.

Stienezen, M., Waghorn G.C. and Douglas G.B., 1996. Digestibility and effects of condensed tannins on digestion of sulla (*Hedysarum coronarium*) when fed to sheep. New Zealand Journal of Agricultural Research, 39(2): 215-221.

Teague, W.R., Dowhower, S.L., Baker, S.A., Haile, N., DeLaune, P.B. and Conover, D.M., 2011. Grazing management impacts on vegetation, soil biota and soil chemical, physical and hydrological properties in tall grass prairie. *Agriculture, Ecosystems & Environment*, 141(3-4): 310-322.

Thornton, P.K., van de Steeg, J., Notenbaert, A. and Herrero, M., 2009. The impacts of climate change on livestock and livestock systems in developing countries: A review of what we know and what we need to know. *Agricultural Systems*, *101*(3): 113-127.

Ouled Belgacem, A., and Louhaichi, M. (2013). The vulnerability of native rangeland
482 plant species to global climate change in the West Asia and North African
483 regions. *Climatic Change* 119: 451-463.

7. APPENDIX A: Socio economic survey

Household Socio-Economic Survey (draft copy)

Pilot Initiative on Sustainable Silvopastoral Restoration to promote ecosystem services
Sbaihia Site, Zaghouan - Tunisia

Date : ……

Region : ……

Delegation : ……

Imada : ……

Douar : ……

Presentation of Household Head

1	**First and Last name**										
2	**Phone Number**										
3	**Age**										
4	**Level of education**										
0. Illiterate		**1.Koteb**		**2.Primary**		**3.Secondary**		**4.Superior**			
5	**Main Occupation**										

I. **Presentation of Household and main activity** *(reference period: the last 12 months)*

1	2	3	4	5	6	7	8	9	10
Name	Sex M=1 F=2	Relationship with the HH **Code A**	Age	Education level **Code B**	Occupation **Code C**	Income	Contribution in agriculture **Code D**	Type of activity **Code E**	Experience in agriculture

Code A: 1 = Head of Household, 2 = Spouse, 3 = Son / Daughter, 4 = Father / Mother
Code B: 1 = illiterate, 2 = Koteb, 3 = primary, 4 = high school, 5 = middle school, 6 = university
Code C: 1 = none, 2 = Farming (crops + livestock), 3 = Casual labor on-other farm, 4 = student, 5 = Casual labor off-farm, 6 = Salaried employment, 7 = other (specify ....)
Code D: 1 = part-time, 2 = full-time, 3 = depending on the season (olive harvest, harvest ... etc.)
Code E : 1 = Breeding, 2 = Cultivation, 3 = Harvesting / Olive Harvesting, 4 = Livestock Sale / Purchase, 5 = Crop Sale / Purchase

I. **Breeding** *(reference period: the last 12 months)*

1. Livestock Production

	Type of livestock	Number	Race	Type of breeding	By-product		
					Production	Destination Code A	Price/unit
1	Cattle						
2	Sheep						
3	Goats						
4	Beekeeping						
5	Aviculture						
6	Other ……						
Code A: 1 = Consumption, 2 = Storage, 3 = Sale, 4 = Other (.....)							

2. 2. **Fodder Calendar/Schedule Foraging** *(reference period: the last 12 months)*

	Item	Total amount used	Amount purchased	Price / unit (TND)	Quantity Distribution / season			
					Spring	Summer	Autumn	Winter
1	Private Rangeland (ha)							
2	Communal Rangeland (ha)							
3	Forest areas (ha)							
4	Grazed barley (ha)							
5	Barley grain (T)							
6	Bran (T)							
7	Sulla (T)							
8	Straws (balls)							
9	Hay (balls)							
10	Fodder Shrubs * (T)							
11	Pellets (T)							
12	Concentrate feed (T)							
13	Feed Blocks (T)							
14	Cactus (T or ha)							
15	Other (……)							
* Specify the forage species used								

3. Distribution/Division of tasks related to livestock

		Decision Making (%) ?		Execution (%) ?	
		1. Men	**2. Women**	**1. Men**	**2. Women**
1	Grazing				
2	Feeding				
3	Maintenance / Cleaning the barn				
4	Providing water				
5	Buying food				
6	Purchase / Sale of livestock				
7	Slaughtering				
8	Shearing				
9	Insemination (natural / artificial)				
10	Other (.....)				

4. What are the problems usually encountered related to animals feeding?

	Problems	**Period**
	1. Low amount of produced livestock feed (hay, straw, barley, grain ...)	
	2. High price of purchased foods	
	3. Unavailability of subsidized foods (Bran, Barley)	
	4. Lack of livestock feed from suppliers	
	5. Poor quality of purchased foods	
	6. Other problems:	

5. What are the main rangelands problems encountered?

	1. Distance from the grazing areas / rangeland
	2. Rangeland status Explain: ....
	3. Conflict between operators
	4. Right of access to Rangeland
	5. Other problems: ....

II. Rangeland management

- Rangeland Management

6. What is your opinion about current rangeland management?

.....

7. What is your opinion about the access to rangeland?

.....

8. What is your opinion about the improvement work/activities done by the project and related to the rangeland?

.....

9. What is your opinion about the choice of species planted in the rangeland? Do you have another proposal?

.....

.....

10. What is your opinion about the decision-making approach about rangeland?

.....

- Institutional aspects

Legal level:

11. Are you aware that there is a pastoral code? □ Yes, □ No

12. If there is a proposal for a law / pastoral code, what do you think is obvious / important to put in this law / code?

.....

13. What is the appropriate approach for the preparation and implementation of this law / code?

.....

Rangeland management:

14. Do you have any suggestions for improving rangeland management?

.....

15. Do you think that the improvement of rangeland allows the increase of breeders' income? □ Yes, □ No

1. If no, why? .....
2. If yes how? .....

16. Are you ready to pay fee to benefit from the rangeland?
1. If no, why? .....
2. If yes, how much? .....

III. Forest Land

17. Use of forest

		Period	Executed by	
			Men	Women
1	Grazing			
2	Firewood			
3	Collection of aromatic and medicinal plant			
4	Beekeeping			
5	Other uses …….			

18. How do you judge the access to the forest?
.....
19. What are the problems encountered?
.....

20. How do you judge the degree of degradation of the area (erosion)?
....
21. What CES work has already been done in the region?
....
22. How do you judge / what do you think about these interventions?
....
23. Do you have any other suggestions for improvement?
.....

IV. Rangeland

24. How did you benefit from this pastoral activity? What was the area?

.....

25. How can you estimate the distance to the site of this pastoral activity?

.....

26. In your household, who made the decision for adoption and how?

....

27. Regarding fodder plantations, do you prefer other species? Yes □, No □

1. If no, why? ....

2. If yes, which ones? .....

28. Are you satisfied with the arrangements proposed by pastoral activity? Yes □, No □

1. If no, why? .....

2. If yes, how? .....

29. What is your opinion about the methodology for implementing pastoral activity?

.....

30. What are your expectations regarding this pastoral activity?

.....

31. What is your vision for improving this pastoral activity?

.....

32. Do you want to have capacity building? Yes □, no □
If yes:

What are the 3 main themes	
Period of the year	
Duration	
Place	
Beneficiary (for whom?)	
Trainer sex (m / f) why?	

33. What are the expenses for the implementation of this pastoral activity?

Variety plant	Plant price	Area planted (ha)	Labor **Code A**	Labor cost	Machinery cost
Code A: 1 = Family Member (Female), 2 = Family Member (Male), 3 = Hired					

34. In your opinion, could this project improve your income? Yes □, No □

*If not why?.....

*If yes, how?.....

- **Perception of work for students**

35. What is your perception / level of understanding of this operation?

....

36. How do you evaluate your contribution to the success of the operation?

.....