Restoration of degraded agrosilvopastoral site in Central Tunisia using the forage legume "Sulla" (Hedysarum coronarium) (Mounir Louhaichi - Research Team Leader of Rangeland Ecology and Forages)

# Native Drought-Tolerant Forage Species for Enhanced Dryland Pasture Restoration (Tunisia)

## DESCRIPTION

**The technology utilizes a drought-tolerant native forage legume, Hedysarium coronarium, to restore degraded soils by covering the soil, fixing nitrogen, improving biodiversity and increasing water infiltration while fodder quality and availability is improved.**

In the semi-arid areas of Tunisia, drylands are prone to a harsh environment combining high temperatures and limited annual rainfall (350 - 600mm). Nevertheless, many marginal farmers depend on these drylands for income through grazing their livestock. However, due to worsening climatic conditions and mismanagement, the land is becoming seriously degraded. This results in a degradation cycle: overgrazing results in less land available to graze and therefore more rapid degradation on those areas. To break the cycle, an innovative approach is needed.

The International Centre of Agricultural Research in Dry Areas (ICARDA) recognized the problem and developed an approach, together with national parties Office de l'élevage et des pâturages (OEP), Office du Développement Sylvo- Pastoral du Nord -Ouest (ODESYPANO), and Direction Générale des forêts (DGF). They focused on native species which are adapted to the harsh environmental conditions. They selected leguminous species, because these enhance the soil's nutrient status through nitrogen fixation. Additionally, legumes improve the diet of livestock. The perennial Hedysarum coronarium or "Sulla" provides the soil with cover, reducing erosion and increasing water infiltration: rainfall is intercepted by the vegetation cover, resulting in less runoff. The cover also provides shade, which decreases evaporation. Then, the roots of the vegetation improve soil porosity, hence the infiltration capability of the soil. All these benefits improve biophysical and socio-economic resilience.

A degraded field was planted with Sulla in 2017. The land was ploughed before manual seeding. To prevent overgrazing, grazing was managed according to guidelines formulated by ICARDA and national parties. In the initial year, twenty-five smallstock (sheep/goats) graze one hectare for thirty to sixty days. In subsequent years, forty smallstock graze one hectare for thirty to sixty days, since the vegetation is then better rooted and developed. To maintain optimal production, a field needs reseeding after three years, hence the activities and related costs shown in this documentation are recurrent every three years.

This technology has had several positive impacts in the area. The productivity was increased from approximately 2310 kg (dry matter: DM) per hectare to approximately 5330 DM kg per hectare. The technology also increased water productivity from 9.5 DM kg per mm rainfall to 11.8 DM kg per mm rainfall. Hedysarum coronarium improved the quality of fodder, thus benefiting local land users. In addition, the soil was less prone to erosion and water better retained in the soil.

Land users also stated that they benefited from the improved fodder availability because this decreased the costs of feed import. Also, since Sulla is suited to the local climate, few inputs are required, reducing costs and work.

## LOCATION

**Location:** Zaghouan Governorate, Tunisia

**No. of Technology sites analysed:** single site

**Geo-reference of selected sites**
- 9.99224, 36.27779

**Spread of the Technology:** evenly spread over an area (approx. < 0.1 km2 (10 ha))

**In a permanently protected area?:** No

**Date of implementation:** 2017

**Type of introduction**
- [ ] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [x] during experiments/ research
- [x] through projects/ external interventions

"Sulla" or "French Honeysuckle", Hedysarum coronarium L. (Mounir Louhaichi)

Sampling Sulla (Mounir Louhaichi)

## CLASSIFICATION OF THE TECHNOLOGY

### Main purpose

- [x] improve production
- [x] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [x] reduce risk of disasters
- [x] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [ ] create beneficial social impact

### Land use

Land use mixed within the same land unit: No

### Water supply

- [x] rainfed
- [ ] mixed rainfed-irrigated
- [ ] full irrigation

### Purpose related to land degradation

- [ ] prevent land degradation
- [x] reduce land degradation
- [x] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

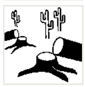
### Degradation addressed

**soil erosion by water** - Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying

**soil erosion by wind** - Et: loss of topsoil, Ed: deflation and deposition

**chemical soil deterioration** - Cn: fertility decline and reduced organic matter content (not caused by erosion), Cs: salinization/ alkalinization

**physical soil deterioration** - Pk: slaking and crusting, Pi: soil sealing

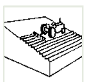


**biological degradation** - Bc: reduction of vegetation cover

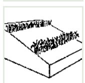
### SLM group

- pastoralism and grazing land management
- improved ground/ vegetation cover
- improved plant varieties/ animal breeds

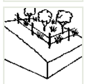
### SLM measures



**agronomic measures** - A1: Vegetation/ soil cover, A5: Seed management, improved varieties



**vegetative measures** - V2: Grasses and perennial herbaceous plants

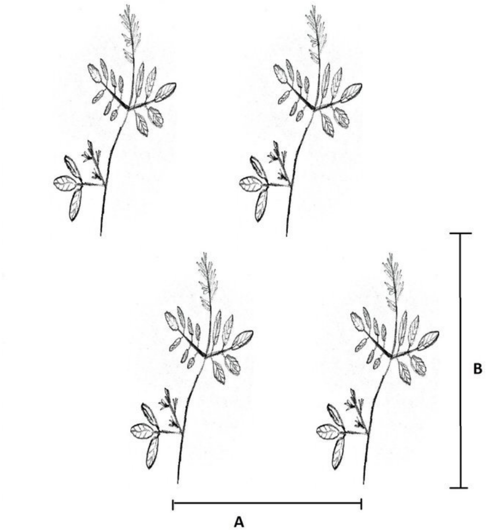


**management measures** - M2: Change of management/ intensity level

## TECHNICAL DRAWING

### Technical specifications

The average plant density is 120 per square metre. This relates to the following spacing:
Space within rows (A) = 9 centimeter
Space between rows (B) = 9 centimeter



Author: Joren Verbist

## ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

**Calculation of inputs and costs**
- Costs are calculated: per Technology area (size and area unit: **1 Hectare**)
- Currency used for cost calculation: **USD**
- Exchange rate (to USD): 1 USD = n.a
- Average wage cost of hired labour per day: 7

**Most important factors affecting the costs**
n.a.

**Establishment activities**
1. Land Preparation (Timing/ frequency: None)
2. Seeding (Timing/ frequency: None)

**Establishment inputs and costs (per 1 Hectare)**

| Specify input | Unit | Quantity | Costs per Unit (USD) | Total costs per input (USD) | % of costs borne by land users |
|---|---|---|---|---|---|
| **Labour** | | | | | |
| Manual Seeding | Person-Hours | 10.0 | 0.875 | 8.75 | 100.0 |
| **Equipment** | | | | | |
| Plough | Machine-Hours | 0.75 | 15.0 | 11.25 | 100.0 |
| **Plant material** | | | | | |
| Sulla Seed | Kilogram | 30.0 | 1.5 | 45.0 | |
| **Total costs for establishment of the Technology** | | | | **65.0** | |
| *Total costs for establishment of the Technology in USD* | | | | *65.0* | |

**Maintenance activities**
n.a.

## NATURAL ENVIRONMENT

**Average annual rainfall**
- < 250 mm
- ✓ 251-500 mm
- 501-750 mm
- 751-1,000 mm
- 1,001-1,500 mm
- 1,501-2,000 mm
- 2,001-3,000 mm
- 3,001-4,000 mm
- > 4,000 mm

**Agro-climatic zone**
- humid
- sub-humid
- ✓ semi-arid
- arid

**Specifications on climate**
n.a.

**Slope**
- flat (0-2%)
- gentle (3-5%)
- ✓ moderate (6-10%)
- ✓ rolling (11-15%)
- hilly (16-30%)
- steep (31-60%)
- very steep (>60%)

**Landforms**
- ✓ plateau/plains
- ridges
- mountain slopes
- ✓ hill slopes
- footslopes
- valley floors

**Altitude**
- 0-100 m a.s.l.
- ✓ 101-500 m a.s.l.
- 501-1,000 m a.s.l.
- 1,001-1,500 m a.s.l.
- 1,501-2,000 m a.s.l.
- 2,001-2,500 m a.s.l.
- 2,501-3,000 m a.s.l.
- 3,001-4,000 m a.s.l.

**Technology is applied in**
- convex situations
- concave situations
- ✓ not relevant

- [ ] > 4,000 m a.s.l.

**Soil depth**
- [ ] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [x] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

**Soil texture (topsoil)**
- [ ] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

**Soil texture (> 20 cm below surface)**
- [ ] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

**Topsoil organic matter content**
- [ ] high (>3%)
- [x] medium (1-3%)
- [ ] low (<1%)

**Groundwater table**
- [ ] on surface
- [ ] < 5 m
- [x] 5-50 m
- [ ] > 50 m

**Availability of surface water**
- [ ] excess
- [ ] good
- [ ] medium
- [x] poor/ none

**Water quality (untreated)**
- [ ] good drinking water
- [x] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

*Water quality refers to: ground water*

**Is salinity a problem?**
- [x] Yes
- [ ] No

**Occurrence of flooding**
- [ ] Yes
- [x] No

**Species diversity**
- [x] high
- [ ] medium
- [ ] low

**Habitat diversity**
- [ ] high
- [x] medium
- [ ] low

## CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

**Market orientation**
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

**Off-farm income**
- [ ] less than 10% of all income
- [x] 10-50% of all income
- [ ] > 50% of all income

**Relative level of wealth**
- [x] very poor
- [x] poor
- [ ] average
- [ ] rich
- [ ] very rich

**Level of mechanization**
- [x] manual work
- [ ] animal traction
- [x] mechanized/ motorized

**Sedentary or nomadic**
- [ ] Sedentary
- [x] Semi-nomadic
- [ ] Nomadic

**Individuals or groups**
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

**Gender**
- [ ] women
- [x] men

**Age**
- [ ] children
- [x] youth
- [x] middle-aged
- [x] elderly

**Area used per household**
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [x] 1-2 ha
- [x] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

**Scale**
- [x] small-scale
- [ ] medium-scale
- [ ] large-scale

**Land ownership**
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [x] individual, not titled
- [x] individual, titled

**Land use rights**
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

**Water use rights**
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [x] individual

**Access to services and infrastructure**

| | | | | | |
|---|---|---|---|---|---|
| health | poor | | ✓ | | good |
| education | poor | ✓ | | | good |
| technical assistance | poor | | ✓ | | good |
| employment (e.g. off-farm) | poor | | ✓ | | good |
| markets | poor | ✓ | | | good |
| energy | poor | | ✓ | | good |
| roads and transport | poor | ✓ | | | good |
| drinking water and sanitation | poor | | ✓ | | good |
| financial services | poor | ✓ | | | good |

## IMPACTS

**Socio-economic impacts**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| fodder production | decreased | | | | | | ✓ | | increased |
| fodder quality | decreased | | | | | ✓ | | | increased |
| risk of production failure | increased | | | | | | ✓ | | decreased |
| expenses on agricultural inputs | increased | | | | | | ✓ | | decreased |
| farm income | decreased | | | | | ✓ | | | increased |
| workload | increased | | | | | ✓ | | | decreased |

**Socio-cultural impacts**

**Ecological impacts**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| surface runoff | increased | | | | | | ✓ | | decreased |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| evaporation | increased | | | | | | ✓ | | decreased |
| soil moisture | decreased | | | | | | ✓ | | increased |
| soil cover | reduced | | | | | | ✓ | | improved |
| soil loss | increased | | | | | ✓ | | | decreased |
| soil accumulation | decreased | | | | | ✓ | | | increased |
| soil crusting/ sealing | increased | | | | | | ✓ | | reduced |
| nutrient cycling/ recharge | decreased | | | | | | ✓ | | increased |
| salinity | increased | | | | | ✓ | | | decreased |
| vegetation cover | decreased | | | | | | ✓ | | increased |
| biomass/ above ground C | decreased | | | | | | ✓ | | increased |
| plant diversity | decreased | | | | | ✓ | | | increased |
| drought impacts | increased | | | | | | ✓ | | decreased |
| micro-climate | worsened | | | | | | ✓ | | improved |

### Off-site impacts

## COST-BENEFIT ANALYSIS

### Benefits compared with establishment costs

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Short-term returns | very negative | | | | | | | ✓ | very positive |
| Long-term returns | very negative | | | | | | | ✓ | very positive |

### Benefits compared with maintenance costs

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Short-term returns | very negative | | | | | | | ✓ | very positive |
| Long-term returns | very negative | | | | | | | ✓ | very positive |

## CLIMATE CHANGE

### Gradual climate change

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| annual temperature increase | not well at all | | | | ✓ | | very well |

### Climate-related extremes (disasters)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| heatwave | not well at all | | | | ✓ | | very well |
| drought | not well at all | | | | ✓ | | very well |

## ADOPTION AND ADAPTATION

### Percentage of land users in the area who have adopted the Technology

- [x] single cases/ experimental
- [ ] 1-10%
- [ ] 11-50%
- [ ] > 50%

### Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [ ] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [ ] 91-100%

### Has the Technology been modified recently to adapt to changing conditions?

- [ ] Yes
- [x] No

### To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

## CONCLUSIONS AND LESSONS LEARNT

### Strengths: land user's view

- Decreased costs of feed import
- Better year-round availability of fodder
- Less risk of drought damage

### Strengths: compiler's or other key resource person's view

- Enhanced soil conditions such as improved soil moisture and fixed nitrogen
- Improved economic situation of local land users
- Restoration of degraded land

### Weaknesses/ disadvantages/ risks: land user's view → how to overcome

- Grazing management → Grazing management ensures sustainable fodder production hence it is a necessary sacrifice.

### Weaknesses/ disadvantages/ risks: compiler's or other key resource person's view → how to overcome

## REFERENCES

**Compiler**
Joren Verbist

**Reviewer**
william critchley
Rima Mekdaschi Studer

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**Resource persons**
Mounir Louhaichi - Research Team Leader of Rangeland Ecology and Forages
Slim Slim - Associate Professor

**Full description in the WOCAT database**
https://qcat.wocat.net/en/wocat/technologies/view/technologies_5919/

**Linked SLM data**
n.a.

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**Key references**


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