



A Farmer inspecting his cactus (Slim Sim)

## Cactus Cultivation (Tunisia)

### DESCRIPTION

This technology is based on the natural advantages and the multi-purpose usage of spineless cactus pear (*Opuntia ficus-indica*), to cultivate marginal lands in central Tunisia, generating environmental and socio-economic benefits.

The central areas of Tunisia are semi-arid and receive less than 500 millimeters of annual rainfall. Most of these lands are considered marginal as result of land degradation. Marginal lands are often used as (unproductive) grazing land for livestock. To revitalize these areas and to benefit the local population, the International Centre of Agricultural Research in Dry Areas (ICARDA) and its national partners have investigated the potential of cactus as a crop (e.g. *Opuntia ficus-indica*).

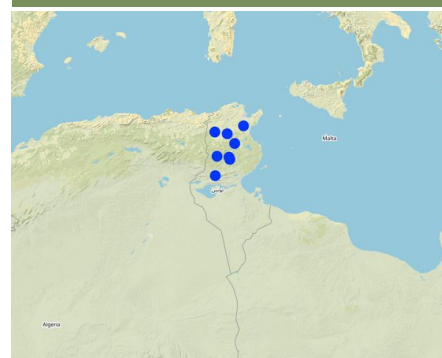
Spineless cactus was already introduced in Tunisia during the sixteenth and seventeenth centuries, but beginning in 1920-1930 cultivation for fodder production has gradually evolved. *Opuntia* is known for its invasive character, but the particular species being promoted - *Opuntia ficus-indica* - is non-invasive. The crop is well suited for the Tunisian context because the cacti can cope with high temperatures and grow well in (semi)-arid areas with limited rainfall. Additionally, the plant is very resilient as it can withstand a long dry season due to its high water-content and water-use efficiency, which are a result of its morphology (waxy cuticle, no actual leaves) and its Crassulacean Acid Metabolism (CAM). In a CAM plant, stomata in the leaves remain shut during the day to reduce evapotranspiration, but open at night to collect and fix carbon dioxide (CO<sub>2</sub>). In general, cacti have multiple products that benefit local livelihoods. These are, for example, stable production of fodder for livestock and fruits for human consumption. Also, cactus can grow and produce requiring few inputs such as fertilizers, therefore marginal lands are well suited for cultivation. The main current risk for cactus cultivation is the risk of cochineal, an insect pest.

To establish a cactus plantation, the surface is ploughed to loosen up the often crusted soil. Then furrows are constructed in which the cacti pads are planted. Simultaneously, the furrows are partly filled with manure. The depth and widths of the furrows are 30 centimetres. The spacing between plants within the row is 50 centimeters and the distance between rows is 5 meters.

A cactus plantation needs weeding. Weeding is mechanically done by a plough in March to May. Harvesting of fruit is manually done by fruit-pickers in August to September. Cacti can also be harvested for their pads, which can be fed to livestock or used for outplanting. It is excellent fodder as it has a high nutritional value and high water-content. On average, a farmer following these agronomic practices generates an income of 800 USD per hectare.

To conclude, this documentation shows that the implementation of cacti is socio-economically and environmentally appropriate to cultivate marginal lands as cacti uses water and nutrients highly efficient while reducing land degradation. Therefore, the out-scaling of cacti is very valuable and a practical option to fight land degradation and enhance smallholder's income.

### LOCATION



**Location:** Kairouan, Zaghouan, Siliana, Kef, Sidi Bouzid, Kasserine and Gafsa, Central Tunisia, Tunisia

**No. of Technology sites analysed:** 100-1000 sites

#### Geo-reference of selected sites

- 9.42697, 35.14238
- 9.71637, 35.69609
- 10.15496, 36.41371
- 9.35297, 36.09566
- 8.72947, 36.15951
- 9.47131, 35.04746
- 8.83297, 35.18552
- 8.75169, 34.38844

**Spread of the Technology:** evenly spread over an area (approx. 1-10 km<sup>2</sup>)

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

**Date of implementation:** 10-50 years ago

#### Type of introduction

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



Household Survey (Mounir Louhaichi)



Tasting delicious cactus pear fruits in Tunis (Mounir Louhaichi)

## CLASSIFICATION OF THE TECHNOLOGY

### Main purpose

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

### Land use

Land use mixed within the same land unit: No



#### Cropland

- Tree and shrub cropping: cactus, cactus-like (e.g. opuntia)

Number of growing seasons per year: 1

Is intercropping practiced? No

Is crop rotation practiced? No



#### Grazing land

- Cut-and-carry/ zero grazing

Animal type: goats, sheep

### Water supply

- rainfed
- mixed rainfed-irrigated
- full irrigation

### Purpose related to land degradation

- prevent land degradation
- reduce land degradation
- 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/ gullyng



soil erosion by wind - Et: loss of topsoil



physical soil deterioration - Pk: slaking and crusting

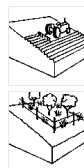


biological degradation - Bc: reduction of vegetation cover

### SLM group

- improved ground/ vegetation cover
- improved plant varieties/ animal breeds

### SLM measures



agronomic measures - A1: Vegetation/ soil cover, A3: Soil surface treatment



management measures - M1: Change of land use type

## TECHNICAL DRAWING

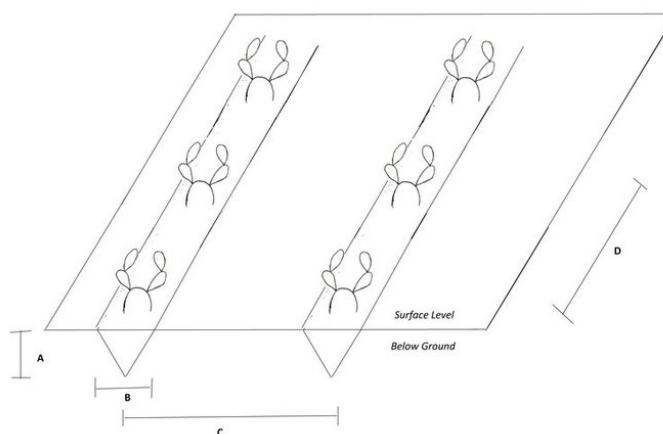
### Technical specifications

A = Depth Furrow = 30 centimeter

B = Width Furrow = 30 centimeter

C = Spacing between rows = 5 meter

D = Spacing between plants = 0.5 meter



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: n.a

### Most important factors affecting the costs

n.a.

### Establishment activities

1. Surface Soil Ploughing (Timing/ frequency: Prior to Furrow Digging)
2. Digging Furrows (Timing/ frequency: Prior to Planting)
3. Planting the Cacti (Timing/ frequency: Spring to Autumn (During Planting))
4. Fertilizer Application (Timing/ frequency: Spring to Autumn (During Planting))

### 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
<b>Labour</b>					
Planting & Fertilizer Application	Person-Hours	91.5	0.875	80.06	100.0
<b>Equipment</b>					
Furrow Digging	Machine-Hours	1.0	10.0	10.0	100.0
Surface Soil Ploughing	Machine-Hours	2.0	10.0	20.0	100.0
<b>Plant material</b>					
Cactus Pads	Pads	4000.0	0.045	180.0	100.0
<b>Fertilizers and biocides</b>					
Fertilizer	Ton	1.0	110.0	110.0	100.0
<b>Total costs for establishment of the Technology</b>				<b>400.06</b>	
<i>Total costs for establishment of the Technology in USD</i>				<i>400.06</i>	

### Maintenance activities

1. Mechanical Weeding (Timing/ frequency: March-May)
2. Harvesting (Timing/ frequency: August-September)

### Maintenance 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
<b>Labour</b>					
Harvesting	Person-Hours	40.0	0.875	35.0	100.0
<b>Equipment</b>					
Weeding	Machine-Hours	1.0	10.0	10.0	100.0
<b>Total costs for maintenance of the Technology</b>				<b>45.0</b>	
<i>Total costs for maintenance of the Technology in USD</i>				<i>45.0</i>	

## NATURAL ENVIRONMENT

Average annual rainfall

Agro-climatic zone

Specifications on climate

<input checked="" type="checkbox"/> < 250 mm	<input type="checkbox"/> humid	n.a.
<input checked="" type="checkbox"/> 251-500 mm	<input type="checkbox"/> sub-humid	
<input type="checkbox"/> 501-750 mm	<input checked="" type="checkbox"/> semi-arid	
<input type="checkbox"/> 751-1,000 mm	<input checked="" type="checkbox"/> arid	
<input type="checkbox"/> 1,001-1,500 mm		
<input type="checkbox"/> 1,501-2,000 mm		
<input type="checkbox"/> 2,001-3,000 mm		
<input type="checkbox"/> 3,001-4,000 mm		
<input type="checkbox"/> > 4,000 mm		

<b>Slope</b>	<b>Landforms</b>	<b>Altitude</b>	<b>Technology is applied in</b>
<input checked="" type="checkbox"/> flat (0-2%)	<input checked="" type="checkbox"/> plateau/plains	<input type="checkbox"/> 0-100 m a.s.l.	<input type="checkbox"/> convex situations
<input checked="" type="checkbox"/> gentle (3-5%)	<input checked="" type="checkbox"/> ridges	<input checked="" type="checkbox"/> 101-500 m a.s.l.	<input type="checkbox"/> concave situations
<input type="checkbox"/> moderate (6-10%)	<input type="checkbox"/> mountain slopes	<input type="checkbox"/> 501-1,000 m a.s.l.	<input checked="" type="checkbox"/> not relevant
<input type="checkbox"/> rolling (11-15%)	<input type="checkbox"/> hill slopes	<input type="checkbox"/> 1,001-1,500 m a.s.l.	
<input type="checkbox"/> hilly (16-30%)	<input type="checkbox"/> footslopes	<input type="checkbox"/> 1,501-2,000 m a.s.l.	
<input type="checkbox"/> steep (31-60%)	<input type="checkbox"/> valley floors	<input type="checkbox"/> 2,001-2,500 m a.s.l.	
<input type="checkbox"/> very steep (>60%)		<input type="checkbox"/> 2,501-3,000 m a.s.l.	
		<input type="checkbox"/> 3,001-4,000 m a.s.l.	
		<input type="checkbox"/> > 4,000 m a.s.l.	

<b>Soil depth</b>	<b>Soil texture (topsoil)</b>	<b>Soil texture (&gt; 20 cm below surface)</b>	<b>Topsoil organic matter content</b>
<input type="checkbox"/> very shallow (0-20 cm)	<input checked="" type="checkbox"/> coarse/ light (sandy)	<input checked="" type="checkbox"/> coarse/ light (sandy)	<input type="checkbox"/> high (>3%)
<input checked="" type="checkbox"/> shallow (21-50 cm)	<input type="checkbox"/> medium (loamy, silty)	<input type="checkbox"/> medium (loamy, silty)	<input checked="" type="checkbox"/> medium (1-3%)
<input checked="" type="checkbox"/> moderately deep (51-80 cm)	<input type="checkbox"/> fine/ heavy (clay)	<input type="checkbox"/> fine/ heavy (clay)	<input checked="" type="checkbox"/> low (<1%)
<input type="checkbox"/> deep (81-120 cm)			
<input type="checkbox"/> very deep (> 120 cm)			

<b>Groundwater table</b>	<b>Availability of surface water</b>	<b>Water quality (untreated)</b>	<b>Is salinity a problem?</b>
<input type="checkbox"/> on surface	<input type="checkbox"/> excess	<input type="checkbox"/> good drinking water	<input checked="" type="checkbox"/> Yes
<input type="checkbox"/> < 5 m	<input type="checkbox"/> good	<input type="checkbox"/> poor drinking water (treatment required)	<input type="checkbox"/> No
<input checked="" type="checkbox"/> 5-50 m	<input type="checkbox"/> medium	<input checked="" type="checkbox"/> for agricultural use only (irrigation)	
<input type="checkbox"/> > 50 m	<input checked="" type="checkbox"/> poor/ none	<input type="checkbox"/> unusable	<b>Occurrence of flooding</b>
		<i>Water quality refers to: ground water</i>	<input type="checkbox"/> Yes
			<input checked="" type="checkbox"/> No

<b>Species diversity</b>	<b>Habitat diversity</b>
<input type="checkbox"/> high	<input type="checkbox"/> high
<input type="checkbox"/> medium	<input type="checkbox"/> medium
<input checked="" type="checkbox"/> low	<input checked="" type="checkbox"/> low

### CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

<b>Market orientation</b>	<b>Off-farm income</b>	<b>Relative level of wealth</b>	<b>Level of mechanization</b>
<input type="checkbox"/> subsistence (self-supply)	<input type="checkbox"/> less than 10% of all income	<input checked="" type="checkbox"/> very poor	<input checked="" type="checkbox"/> manual work
<input checked="" type="checkbox"/> mixed (subsistence/ commercial)	<input type="checkbox"/> 10-50% of all income	<input checked="" type="checkbox"/> poor	<input type="checkbox"/> animal traction
<input type="checkbox"/> commercial/ market	<input type="checkbox"/> > 50% of all income	<input type="checkbox"/> average	<input checked="" type="checkbox"/> mechanized/ motorized
		<input type="checkbox"/> rich	
		<input type="checkbox"/> very rich	

<b>Sedentary or nomadic</b>	<b>Individuals or groups</b>	<b>Gender</b>	<b>Age</b>
<input checked="" type="checkbox"/> Sedentary	<input checked="" type="checkbox"/> individual/ household	<input checked="" type="checkbox"/> women	<input type="checkbox"/> children
<input type="checkbox"/> Semi-nomadic	<input type="checkbox"/> groups/ community	<input checked="" type="checkbox"/> men	<input checked="" type="checkbox"/> youth
<input type="checkbox"/> Nomadic	<input type="checkbox"/> cooperative		<input checked="" type="checkbox"/> middle-aged
	<input type="checkbox"/> employee (company, government)		<input checked="" type="checkbox"/> elderly

<b>Area used per household</b>	<b>Scale</b>	<b>Land ownership</b>	<b>Land use rights</b>
<input type="checkbox"/> < 0.5 ha	<input checked="" type="checkbox"/> small-scale	<input type="checkbox"/> state	<input type="checkbox"/> open access (unorganized)
<input type="checkbox"/> 0.5-1 ha	<input type="checkbox"/> medium-scale	<input type="checkbox"/> company	<input type="checkbox"/> communal (organized)
<input checked="" type="checkbox"/> 1-2 ha	<input type="checkbox"/> large-scale	<input type="checkbox"/> communal/ village	<input type="checkbox"/> leased
<input type="checkbox"/> 2-5 ha		<input type="checkbox"/> group	<input checked="" type="checkbox"/> individual
<input type="checkbox"/> 5-15 ha		<input checked="" type="checkbox"/> individual, not titled	<b>Water use rights</b>
<input type="checkbox"/> 15-50 ha		<input checked="" type="checkbox"/> individual, titled	<input type="checkbox"/> open access (unorganized)
<input type="checkbox"/> 50-100 ha			<input checked="" type="checkbox"/> communal (organized)
<input type="checkbox"/> 100-500 ha			<input type="checkbox"/> leased
<input type="checkbox"/> 500-1,000 ha			<input type="checkbox"/> individual
<input type="checkbox"/> 1,000-10,000 ha			
<input type="checkbox"/> > 10,000 ha			

<b>Access to services and infrastructure</b>	
health	poor <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> good
education	poor <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> good
technical assistance	poor <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> good
employment (e.g. off-farm)	poor <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> good
markets	poor <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> good
energy	poor <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> good
roads and transport	poor <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> good

drinking water and sanitation  
financial services

poor      good  
poor      good

## IMPACTS

### Socio-economic impacts

Crop production decreased        increased  
 crop quality decreased        increased  
 fodder production decreased        increased  
 fodder quality decreased        increased  
 risk of production failure increased        decreased  
 production area (new land under cultivation/ use) decreased        increased

### Socio-cultural impacts

food security/ self-sufficiency reduced        improved

### Ecological impacts

soil cover reduced        improved  
 soil loss increased        decreased  
 soil accumulation decreased        increased  
 soil crusting/ sealing increased        reduced  
 soil organic matter/ below ground C decreased        increased  
 vegetation cover decreased        increased  
 drought impacts increased        decreased

### 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

### Climate-related extremes (disasters)

local hailstorm not well at all       very well  
 local snowstorm not well at all       very well  
 heatwave not well at all       very well  
 drought not well at all       very well  
 epidemic diseases not well at all       very well

## ADOPTION AND ADAPTATION

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

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  
 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

- The cacti are highly productive with minimum inputs.
- It does not require much water
- The cacti are even productive in poor soil and by growing cacti on these soils, it also reduces erosion.
- The reduced risk of drought deteriorated yields is important as climate change leads to more extreme weather event, such as droughts. This will only increase in the future. Therefore the

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

- The significant cost related to labour.
- The increased risk of new pests. → More awareness is required so the new pests can be identified, allowing proper and timely action.

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

cactus's ability to cope with climate change (resilience to climate fluctuations) is a great advantage and increasingly important.

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

- Due to the suitability of cacti on marginal lands, the soil is partly covered permanently by vegetation in these areas which protects these degraded lands. Therefore, cacti cultivation could offer incentive to prevent land degradation.
  - The technology offers increased resilience of the environment and its involved livelihoods. This is because cacti are more resilient to climate change induced effects such as increased droughts and increasing (summer) temperatures, as result of their high-water content and efficiency. Therefore, this technology is better suited for the future.
- The possible knowledge gap for farmers to switch from their conventional/traditional agricultural practices to a more innovative one could be a bottleneck for out-scaling the technology. → This bottleneck can be overcome, by developing social capital such as (e.g.) institutions or farmers networks to disseminate knowledge. A good example is the field days for farmers organized ICARDA.
  - The risks of pests and diseases is a weakness of the cacti as these plants are vulnerable to this. Also, due to the density and mono-cropping of the cacti, the pest/ disease may spread easily and rapidly over the field. Eventually, risking the production of the cacti, thus possibly reducing the income of local farmers. → A solution may be found in changing the agricultural activities. An example of such a possible solution is the introduction of intercropping, this could increase biodiversity and reduce the potential loss of income in case of a pest-outbreak.

## REFERENCES

**Compiler**  
Joren Verbist

**Reviewer**  
Rima Mekdaschi Studer  
William Critchley

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**Last update:** Jan. 28, 2022

#### 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\\_5994/](https://qcat.wocat.net/en/wocat/technologies/view/technologies_5994/)

#### Linked SLM data

n.a.

#### Documentation was facilitated by

Institution

- International Center for Agricultural Research in the Dry Areas (ICARDA) - Lebanon Project
- ICARDA Institutional Knowledge Management Initiative

#### Key references

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