left: Stainless Steel Fodder Silo (Photo: Michalakis Christoforou)

Fodder provision to goats and sheep to reduce grazing pressure on natural vegetation

Cyprus - Παροχή σιτηρεσίου στα αιγοπρόβατα ως εναλλακτική τροφή με σκοπό τη μείωση της υπερβόσκησης στα φυσικά οικοσυστήμα(greek)

Use of different types of fodder in order to reduce grazing impact on natural vegetation

Goats graze on almost all plants even on thorny shrubs. The pastoralist in the past (some still do now a days) use to spread seeds on the grazing area in order to provide fodder for the animals. Another method is to provide fodder within the farm using dry seeds of wheat, barley, soya etc which can be stored in big silos.
The purpose of this technology is to provide to the animals with the food they need in order to minimize or even stop them from grazing on the wild flora such as shrubs, trees and annual plants. Within the study area, most of the vegetation is vanished and only traces of plant species can be found. Even the thorny shrubs like Callicotome villosa and Rhamnus oleiodes are suffering from overgrazing.
Fodder can be provided in-farm and out-farm. In-farm fodder is provided using a silo in which dry fodder can be store, mixed and deliver to the animals mechanically. Out-farm fodder is provided seasonally since the seeds should be seeded and plants must grow up before eaten by the animals
By providing fodder to the animals in-farm, grazing is avoided since the animals remain within the farm. This way, animal diseases transmission from one farm to another can be minimized. Also, animals may travel a long distance to find food whose energy miight be less than the energy they use. Seeding on the hills will attract the goats and stop them from grazing on other wild plant species. Minimizing grazing will allow to the vegetation to recover and grow up providing good aesthetic view and also shelter for the wild animals. Furthermore, vegetation increase will contribute to the decrease of soil erosion and the increase of organic matter.

Location: Limassol
Region: Pissouri
Technology area: 10 - 100 km2
Conservation measure: agronomic, structural
Stage of intervention: mitigation / reduction of land degradation
Origin: Developed through land user`s initiative, recent (<10 years ago)
Land use type:
Grazing land: Extensive grazing land
Land use:
Grazing land: Extensive grazing land (before), Cropland: Annual cropping (after)
Climate: semi-arid, arid, tropics
WOCAT database reference: T_CYP001en
Related approach:
Compiled by: Michalakis Christoforou, Cyprus University of Technology
Date: 2014-05-15

Classification

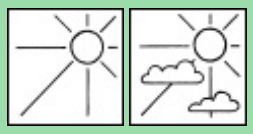
Land use problems:

- overgrazing due to a large amount of animals, drought, erosion (expert's point of view)
drought, poor calcareous soils, incomes are not enough to buy food (land user's point of view)

Land use

Extensive grazing land
Grazing land: Extensive grazing land (before)
Cropland: Annual cropping (after)
rainfed
extensive grazing land
rainfed

Climate

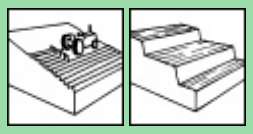


semi-arid
arid

Degradation

Biological degradation: reduction of vegetation cover

Conservation measure



Agronomic: Vegetation/soil cover
Structural: Others (Use of Silos in order to provide fodder to the animals)

Stage of intervention

- Prevention
- Mitigation / Reduction
- Rehabilitation

Origin

- Land users initiative: recent (<10 years ago)
- Experiments / Research
- Externally introduced

Level of technical knowledge

- Agricultural advisor
- Land user

Main causes of land degradation:
Direct causes - Human induced: overgrazing
Direct causes - Natural: change in temperature, change of seasonal rainfall, droughts
Indirect causes: poverty / wealth

Main technical functions:

- increase of biomass (quantity)
- promotion of vegetation species and varieties (quality, eg palatable fodder)
- control of animal feeding on natural vegetation

Secondary technical functions:

Environment

Natural Environment

Average annual rainfall (mm)

- > 4000 mm
- 3000-4000 mm
- 2000-3000 mm
- 1500-2000 mm
- 1000-1500 mm
- 750-1000 mm
- 500-750 mm
- 250-500 mm
- < 250 mm

Altitude (m a.s.l.)

- > 4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 500-1000
- 100-500
- <100

Landform

- plateau / plains
- ridges
- mountain slopes
- hill slopes
- footslopes
- valley floors

Slope (%)

- flat
- gentle
- moderate
- rolling
- hilly
- steep
- very steep

Soil depth (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- >120

Growing season(s): 120 days(March to June), 100 days(September to December)
Soil texture: coarse / light (sandy)
Soil fertility: low
Topsoil organic matter: medium (1-3%)
Soil drainage/infiltration: poor (eg sealing /crusting)

Soil water storage capacity: low
Availability of surface water: poor / none
Biodiversity: low

Tolerant of climatic extremes: seasonal rainfall increase, heavy rainfall events (intensities and amount)
Sensitive to climatic extremes: temperature increase, seasonal rainfall decrease, droughts / dry spells

Human Environment

Grazing land per household (ha)

<0.5
0.5-1
1-2
2-5
5-15
15-50
50-100
100-500
500-1,000
1,000-10,000
>10,000

Land user: Individual / household, large scale land users, Leaders / privileged, men and women
Population density: 10-50 persons/km2
Annual population growth: negative
Land ownership: state
Land use rights: open access (unorganised), individual
(More than 70% of the land belongs to the government (forestry department) and the land is open to everybody. The pastoralists do not pay rent for using the land. The land which belongs to individuals is used by the owners or is been rented to the pastoralists)
Relative level of wealth: average, which represents 10% of the land users; 10% of the total area is owned by average land users

Importance of off-farm income: 10-50% of all income: Some of the pastoralists who apply the SLM technology, have apartments which they rent to tourists during the summer season
Access to service and infrastructure: low: health, employment (eg off-farm), financial services; moderate: education, technical assistance, market; high: energy, roads & transport, drinking water and sanitation
Market orientation: mixed (subsistence and commercial), Equipment and structure subsidy
Livestock density: > 100 LU /km2

Implementation activities, inputs and costs

Establishment activities

- Cereal seeds
- legume seeds
- Buy or make a Silo

Establishment inputs and costs per ha

Inputs	Costs (US$)	% met by land user
Labour	116.00	100%
Construction material		
- stainless steel Silo	2589.00	100%
Agricultural		
- seeds	427.00	100%
Other		
- fodder transfer tubes	1000.00	100%
TOTAL	**4132.00**	**100.00%**

Maintenance/recurrent activities

- spreading seeds

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$)	% met by land user
Labour	233.00	100%
Agricultural		
- seeds	427.00	100%
TOTAL	**660.00**	**100.00%**

Remarks:
Cost for applying fodder is affected by 3 factors: a) the price of the Silo which is applied only once, b) the cost of the seeds and c) the labor needed for spreading the seeds. The slope in the area where the technology is applied is steep and makes the seeding difficult.
Cost were calculated according to the farmers opinion which was confirmed by the agricultural department. Seeds and labor are calculated as units per ha and the silo per unit (farm)

Assessment

Impacts of the Technology

Production and socio-economic benefits

+++ increased fodder production
+++ increased animal production
+++ reduced risk of production failure
+++ increased farm income
+++ simplified farm operations
++ decreased workload
++ increased product diversification
+ decreased labour constraints

Production and socio-economic disadvantages

+ increased expenses on agricultural inputs

Socio-cultural benefits

+++ conflict mitigation
+++ improved conservation / erosion knowledge
++ improved food security / self sufficiency

Socio-cultural disadvantages

Ecological benefits

+++ reduced surface runoff
+++ improved soil cover
+++ reduced soil loss
+++ increased animal diversity
++ increased soil moisture
+ reduced evaporation

Ecological disadvantages

Off-site benefits

+++ reduced damage on neighbours fields
+++ reduced damage on public / private infrastructure

Off-site disadvantages

Contribution to human well-being / livelihoods

++ Shepherds who provide fodder and/or are seeding cereals and legumes on grazing land, produce more milk and meat. Therefore, they have higher incomes and a better life. They are able to send their children to school and provide a health care insurance to their families.

Benefits /costs according to land user

Benefits compared with costs	short-term:	long-term:
Establishment	very negative	slightly positive
Maintenance / recurrent	neutral / balanced	slightly positive

Shepherds who apply the technology and are in a better socio-economical status are satisfied with their incomes but they believe that things could get better. Shepherds who don't apply the technology are poor, not satisfied with the incomes they receive and at the same time they are negative in applying the technology although they see other shepherds being in a better socio-economic status than them.

Acceptance / adoption:

100% of land user families (2 families; 100% of area) have implemented the technology with external material support. New farmers-shepherds can have up to 60% funding from EU and government funds for construction and equipment
0% of land user families (0 families; 0% of area) have implemented the technology voluntary.
There is no trend towards (growing) spontaneous adoption of the technology. The cost of buying fodder is extremely high. Also the equipments (silo) is considered to be expensive.

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
By providing fodder in and out of the farm the animals receive a better quality of fodder and the right quantities of fodder they need. → experts can give advices to the shepherds about the type of fodder, and the quantity during different seasons	Not all shepherd are able to buy the Silo and large amounts of fodder to store in the silo → Government funding can cover the cost of the silo
Through grazing in a specific area marked and seeded by the shepherd, the animals avoid direct contact with other animals. This minimizes the spread of diseases between animals of different farms. → Shepherds should come to an agreement about the area their animals graze and create borders	The Randi forest area is suffering from prolonged droughts. Seeding cereals in the grazing land will not be achieved without rain. →
Seeding cereals and legumes within the grazing areas decreases overgrazing on shrubs and annual plants → in the case where the shepherd is leading the animals, he should not allow the animals to graze on shrubs	It is difficult to spread seeds on the rocky hills →
The presence of a Silo in a farm makes fodder provision easier and therefore less work is required → Government funding can cover the cost of the silo	Buying fodder is expensive →
seeding in the grazing area leads to improved soil cover which minimizes soil erosion →	
Using the Silo for providing fodder, they spend less hours in the farm. →	
By providing fodder, the quality and quantity of milk and meat is better →	
By keeping the animals in the farm, they save work hours and also the threat of animal poisoning is minimized →	

Graze land forestation with Ceratonia siliqua (carob trees) in the Mediterranean

Greece - Φύτευση βοσκότοπου με Ceratonia siliqua (χαρουπιές) στη Μεσόγειο (EL)

Graze land forestation with Ceratonia siliqua (carob trees)

A stand of Ceratonia siliqua (carob trees) is established within an area used for grazing. Tree density is average (6 m grid configuration) and the majority of maintenance input is limited to the first 3 years. Once established, grazing can continue with few limitations. Ceratonia siliqua (carob tree) is very characteristic of the Mediterranean region, thus blending in very well with the local landscape, especially in the rugged agro-pastoral areas of the Mediterranean islands. After the successful establishment of the plantation, intense irrigation is no longer required and livestock can be allowed in the afforested area which has been upgraded to an improved agro-pastoral or agroforestry land. This improvement facilitates a healthier ecosystem that mitigates land degradation by stabilizing soil, increasing infiltration and organic matter and promoting flora and fauna. In addition to those traits, Ceratonia siliqua is fire resistant and can promote market diversification for the farmer. The main drawback of this technology is the reduction in livestock and other crop production during the first decade of application until trees are mature.
The purpose of this technology is multifold. The primary goal is to increase ecosystem services provided by the treated area, especially for grazing. The farmer takes advantage of the qualities of carob trees for providing: (a) Fodder to the livestock from the carob pods as well as leaves from cuttings; (b) Shade to the livestock during the summer months; (c) Better soil retention, water infiltration etc. A secondary goal is to increase market diversification with the direct exploitation of carob beans for various products, such as carob honey and carob flour. These products give added value to the land and allow the farmer to increase his income in a more sustainable way. At the same time much is gained from various other ecosystem services relevant to habitat and supporting services for the fauna of the area, such as birds and honey-bees. The aesthetic value of the landscape which strongly linked with Cretan traditions and pastoralism lifestyle is enhanced. The touristic attraction of the area is greatly improved providing new options for recreational activities and exploitation through actions such as agro-tourism.
Initially, few structural measures are required, mostly related to preparing slopes and soil for sapling planting and establishing irrigation infrastructure. A palisade that will effectively prevent livestock from damaging young trees needs to be maintained during the first 10 years of application of the technology. 2-year-old saplings are planted in a grid configuration with spacing of 6 m and actively managed for at least 3 years. Management includes watering, fertilization and replacement of dead or weak saplings.
The average annual precipitation in the area is 690 mm and the climate is classified as subhumid. Average annual temperature is 17.5 oC with 7 months below 18 °C but above 5 °C, thus classifying the area as subtropical. In the location where the technology is applied, land is mostly individually owned and distributed among a few families of a community of about 100 inhabitants. Although the financial means of the land user who applies this technology are more or less on par with those of the rest of the community, he has a wider empirical education and relatively higher social status acquired thought his involvement with the commons.

left: Mature plantation of Ceratonia siliqua (Photo: I. Daliakopoulos)
right: Pruned stand of Ceratonia siliqua (Photo: I. Daliakopoulos)

Location: Heraklion
Region: Melidochorion/Kastriotis
Technology area: 0.05 km^2
Conservation measure: vegetative
Stage of intervention: prevention of land degradation
Origin: Developed externally / introduced through project, 10-50 years ago
Land use type:
Mixed: Agro-pastoralism
Mixed: Agro-silvopastoralism
Land use:
Mixed: Agro-pastoralism (before),
Mixed: Silvo-pastoralism (after)
Climate: subhumid, subtropics
WOCAT database reference: T_GRE008en
Related approach:
Compiled by: Ioannis Daliakopoulos, Technical University of Crete
Date: 2013-12-06
Contact person: Ioannis Tsanis, Technical University of Crete, Greece, tsanis@hydromech.gr

Classification

Land use problems:

- The main problems are reduced land cover that progressively leads to soil erosion, combined with the lack of sufficient water resources in the wider area. (expert's point of view)
Land users perceive a problem of reduced pasture fodder availability thus residing to more expensive solutions (land user's point of view)

Land use

Agro-pastoralism
Agro-silvopastoralism
Mixed: Agro-pastoralism (before)
Mixed: Silvo-pastoralism (after)
extensive grazing land
mixed rainfed - irrigated

Climate

subhumid

Degradation

Biological degradation: reduction of vegetation cover

Conservation measure

Vegetative: Tree and shrub cover

Stage of intervention

- Prevention
- Mitigation / Reduction
- Rehabilitation

Origin

- Land users initiative
- Experiments / Research
- Externally introduced: 10-50 years ago

Level of technical knowledge

- Agricultural advisor
- Land user

Main causes of land degradation:
Direct causes - Human induced: overgrazing

Main technical functions:
- improvement of ground cover

Secondary technical functions:
- improvement of topsoil structure (compaction)
- stabilisation of soil (eg by tree roots against land slides)
- increase in organic matter
- promotion of vegetation species and varieties (quality, eg palatable fodder)

Environment

Natural Environment

Average annual rainfall (mm)

- > 4000 mm
- 3000-4000 mm
- 2000-3000 mm
- 1500-2000 mm
- 1000-1500 mm
- 750-1000 mm
- 500-750 mm
- 250-500 mm
- < 250 mm

Altitude (m a.s.l.)

- > 4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 500-1000
- 100-500
- <100

Landform

- plateau / plains
- ridges
- mountain slopes
- hill slopes
- footslopes
- valley floors

Slope (%)

- flat
- gentle
- moderate
- rolling
- hilly
- steep
- very steep

Soil depth (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- >120

Soil fertility: medium
Topsoil organic matter: medium (1-3%)
Soil drainage/infiltration: good

Soil water storage capacity: medium
Ground water table: > 50 m
Availability of surface water: medium
Water quality: good drinking water
Biodiversity: high

Sensitive to climatic extremes: seasonal rainfall decrease, droughts / dry spells for the first 3 years

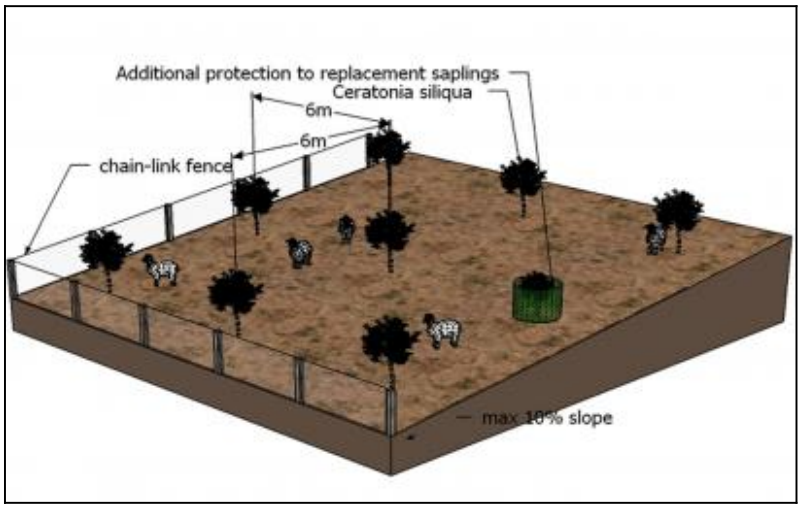
Human Environment

Mixed per household (ha)

- <0.5
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1,000
- 1,000-10,000
- >10,000

Land user: Individual / household, medium scale land users, Leaders / privileged, mainly men
Population density: < 10 persons/km2
Annual population growth: negative
Land ownership: individual, titled
Land use rights: individual
Water use rights: communal (organised)
Relative level of wealth: average

Importance of off-farm income: > 50% of all income:
Access to service and infrastructure: low: employment (eg off-farm), roads & transport, financial services; moderate: health, technical assistance, market, energy, drinking water and sanitation; high: education
Market orientation:



Technical drawing

A stand of Ceratonia siliqua (carob trees) is established within an area used for grazing. For at least 10 years the area is fenced adequately to exclude livestock; once trees are mature sheep can return to graze. If a tree needs to be replaced after establishment, it can be individually fenced. (I. Daliakopoulos)

Implementation activities, inputs and costs

Establishment activities

- Planting saplings
- Grafting
- Slope/soil preparation
- Chain-link fencing
- Irrigation piping

Establishment inputs and costs per ha

Inputs	Costs (US$)	% met by land user
Labour	3760.00	0%
Equipment		
- machine use	3020.00	0%
Construction material		
- Chain-link fence	1900.00	0%
- Pipes	270.00	0%
Agricultural		
- seedlings	820.00	0%
TOTAL	**9770.00**	**0.00%**

Maintenance/recurrent activities

- Fertilization
- Replacing dead or weak trees
- Pruning
- Watering

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$)	% met by land user
Labour	350.00	0%
Agricultural		
- seedlings	280.00	0%
- fertilizer	160.00	0%
- water	6.00	0%
TOTAL	**796.00**	**0.00%**

Remarks:

Assessment

Impacts of the Technology

Production and socio-economic benefits

+++ increased fodder production
+++ increased fodder quality
+++ diversification of income sources
++ reduced expenses on agricultural inputs
++ increased product diversification
+ increased wood production
+ increased farm income

Production and socio-economic disadvantages

+++ reduced animal production
++ increased risk of crop failure
++ increased expenses on agricultural inputs
++ decreased farm income

Socio-cultural benefits

+++ increased recreational opportunities
++ improved cultural opportunities
+ improved conservation / erosion knowledge

Socio-cultural disadvantages

Ecological benefits

+++ reduced fire risk
+++ increased plant diversity
+++ increased beneficial species
+++ increased / maintained habitat diversity
++ improved soil cover
++ increased nutrient cycling recharge
++ reduced soil loss
++ increased animal diversity
++ increased biological pest / disease control
+ increased soil moisture
+ reduced surface runoff
+ increased biomass above ground C

Ecological disadvantages

Off-site benefits

Off-site disadvantages

Contribution to human well-being / livelihoods

Benefits /costs according to land user

	Benefits compared with costs	short-term:	long-term:
	Establishment	negative	positive
	Maintenance / recurrent	slightly negative	positive

Acceptance / adoption:

There is no trend towards (growing) spontaneous adoption of the technology.

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Restoration and protection of pastureland from further degradation. → Maintain the vegetation cover and infrastructure as much as possible, retain a sustainable livestock density.	Decreased income though the reduction of livestock density (exclusion) for at least 10 years. → Receive financial assistance (subsidies) per excluded animal.
Provision of additional market opportunities to the land user. → Provide incentives for exporting, education on small business logistics, online marketing, etc.	Cannot implement in higher altitude pastureland due to the nature of the carob tree. → Perform afforestation with Mulberries (Morus nigra)
Increased income through the provision of free fodder for the livestock. → Maintain the vegetation cover and infrastructure as much as possible.	Decreased income though the reduction of livestock density (exclusion) for at least 10 years. → Receive financial assistance (subsidies) per excluded animal. Voluntary contribution of local farmers to benefit from economies of scale (for unions).
Restoration and protection of pastureland from further degradation. → Maintain the vegetation cover and infrastructure as much as possible.	Decrease of vegetation under the tree canopy. → Reduce carob tree density.
Provision of additional market opportunities to the land user. → Succeed in marketing alternative products. Secure a sustainable income from the alternative production sources.	

Carob tree protection from rats

Cyprus - Προστασία χαρουπόδενδρων απο προσβολές αρουραίων και ποντικών

Carrob tree protection from rat attacks include protection of trees directly by using aluminium layers as rings on the neck of the carob trees in order to keep rats away from climbing on the threes and thus causing problens on fruits and new branches. Furthermore, poisonus rat baits are attached on the trees in case the aluminium layers can not be used.

Carob trees are attacked every year by rats who nibble the trunk stem of the tree, remove the bark of the trunk and the branches sucking the juice and eat the mature fruits. Rats nibble the bark of the tree in order to reduce their teeth size which tends to enlarge year by year. This results in the death of the tree branch or even of the entire tree. The tree may also show symptoms of hemiplegia. Rats run on the tree through the trunk. Apart from the direct effect of rat attacks on carob trees, rats also cause other problems to humans and animals. Rats are vectors for serious pest and diseases
The rat population increases rapidly when there is enough food (such as carobs) available, and the population grows even faster in the absence of natural enemies. .
Through interrupting the access from the ground to the tree trunk, or by pruning the branches which are connected to the ground, the rats are hindered from climbing the trees. Rats can also be controlled through the use of chemical baits. However, these baits should only be used by experts who know where and how to place them in order to avoid that other animals come in contact with the baits. Natural enemies such as cats, snakes and birds (e.g. Bam owl (Tyto alba)) should be breeded and established on the carob trees, and farmers, hunters and locals should be informed not to kill the natural enemies of rats.
The carob trees can be protected from rats by covering the tree neck and trunk from the ground up to 1 meter with a hard material such as aluminium with a slippery surface. This way the rats are not able to climb the trees since they will slither on the ring layer.
The carob tree protection will increase the production of carobs and therefore the income of the growers. Already established carob trees could provide a good income to growers with low production cost. The population of rats will decrease since the major source of food will not be provided anymore. Educating farmers, hunters and the local population about the benefits of natural enemies will allow that the environment regulates the rat population by itself.

left: Aluminium frame instalation on carob tree trunk (Photo: Costas Michael)
right: Instalation of Plastic tube bait traps in the field (Photo: Costas Michael)

Location: Limassol
Region: Pissouri
Technology area: 50 km²
Conservation measure: structural
Stage of intervention: prevention of land degradation, mitigation / reduction of land degradation
Origin: Developed through land user`s initiative, 10-50 years ago
Land use type:
Cropland: Tree and shrub cropping
Climate: semi-arid, subtropics
WOCAT database reference: T_CYP003en
Related approach:
Compiled by: Michalakis Christoforou, Cyprus University of Technology
Date: 2014-06-01
Contact person: Costas Michael, Department of Agriculture, Tel: +357-26-804567 Fax: +357-26-306320 email: costasmichael@ymail.com

Classification

Land use problems:

- Rat attacks on carob trees cause severe problems for plants health and the fruit quality and production. (expert's point of view)
Carob growers: Rats are attacking the carob trees causing the death of the trees and damage of fruits. Locals: The rat population increased during the last 30 years especially in areas where carobs are grown. Agricultural officer: Rat population increased rapidly causing serious problems in carob production due to heavy rainfall in 2012 and to the hunting and killing of the natural enemies such as snakes and birds by the locals and the farmers. (land user's point of view)

Land use

Tree and shrub cropping

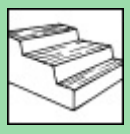
Climate

semi-arid

Degradation

Biological degradation: increase of pests / diseases, loss of predators

Conservation measure



Structural: Others (covering the tree trunk with aluminium layer)

Stage of intervention

- Prevention
- Mitigation / Reduction
- Rehabilitation

Origin

- Land users initiative: 10-50 years ago
- Experiments / Research
- Externally introduced: recent (<10 years ago)

Level of technical knowledge

- Agricultural advisor
- Land user

Main causes of land degradation:
Direct causes - Human induced: other human induced causes, Hunting and killing the natural enemies such as snakes and birds

Main technical functions:
- reduction of rat population
- protection of carob trees and fruits

Secondary technical functions:

Environment

Natural Environment

Average annual rainfall (mm)

- > 4000 mm
- 3000-4000 mm
- 2000-3000 mm
- 1500-2000 mm
- 1000-1500 mm
- 750-1000 mm
- 500-750 mm
- 250-500 mm
- < 250 mm

Altitude (m a.s.l.)

- > 4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 500-1000
- 100-500
- <100

Landform

- plateau / plains
- ridges
- mountain slopes
- hill slopes
- footslopes
- valley floors

Slope (%)

- flat
- gentle
- moderate
- rolling
- hilly
- steep
- very steep

Soil depth (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- >120

Growing season(s): 210 days(mid October to mid May)
Soil texture: medium (loam)
Soil fertility: medium
Topsoil organic matter: medium (1-3%), low (<1%)
Soil drainage/infiltration: good

Soil water storage capacity: low
Ground water table: 5 - 50 m
Availability of surface water: poor / none
Water quality: for agricultural use only
Biodiversity: low

Tolerant of climatic extremes: temperature increase, seasonal rainfall increase, seasonal rainfall decrease, heavy rainfall events (intensities and amount), wind storms / dust storms, floods, droughts / dry spells, decreasing length of growing period
If sensitive, what modifications were made / are possible: The use of aluminium layers covering the trunk of carob trees is not affected by the climatic conditions. Climatic conditions such as heavy rain could affect the use of plastic tubes which include poisonous bait or the direct poisonous cubes placed on the tree branches.

Human Environment

Cropland per household (ha)

- <0.5
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1,000
- 1,000-10,000
- >10,000

Land user: Individual / household, Small scale land users, common / average land users, men and women
Population density: 10-50 persons/km2
Annual population growth: negative
Land ownership: individual, not titled, individual, titled
Land use rights: individual
Relative level of wealth: poor, which represents 80% of the land users; 50% of the total area is owned by poor land users

Importance of off-farm income: > 50% of all income: Since rat attack is the most damaging factor affecting the growth of carob trees and the quality of the product, the land users who apply the technology have more income with unsignificant yield losses caused by other factors
Access to service and infrastructure: low: health, employment (eg off-farm), financial services; moderate: education, technical assistance, market; high: energy, roads & transport, drinking water and sanitation
Market orientation: mixed (subsistence and commercial)
Mechanization: manual labour
Livestock grazing on cropland: yes

Technical drawing

Aluminium layers are placed aroud the bark of carob trees as a ring. The aluminium is thin and light thus does not affect the growth of the tree. The hight of the aluminium is more than 50cm so that the rats can not climb or jumb on the bark of the tree (Costas Michael)

Implementation activities, inputs and costs

Establishment activities

- covering the tree trunk with an aluminium layer

Establishment inputs and costs per ha

Inputs	Costs (US$)	% met by land user
Labour	265.00	100%
Equipment		
- tools	1.00	100%
Construction material		
- aluminium layer	1116.00	100%
- iron nails	11.00	100%
TOTAL	**1393.00**	**100.00%**

Maintenance/recurrent activities

- Control of aluminium layers

Remarks:
The costs are affected by the trunk diameter and the plant height
The costs were calculated for 8 persons working 8 hours per day and per ha. The costs were calculated on the 28th of August 2015.

Assessment

Impacts of the Technology

Production and socio-economic benefits	Production and socio-economic disadvantages
+ increased crop yield	
+ reduced risk of production failure	
+ reduced expenses on agricultural inputs	
+ decreased labour constraints	

Socio-cultural benefits	Socio-cultural disadvantages
++ improved food security / self sufficiency	
+ improved health	

Ecological benefits	Ecological disadvantages
+++ Control of rat population	
+++ Improved quality of carob trees and fruits	

Off-site benefits	Off-site disadvantages
++ reduced damage on neighbours fields	

Contribution to human well-being / livelihoods

++ The technology improved both livelihoods and human health. The growers income has increased more than 10-20% due to the reduction of the damage caused by rats every year. The reduction of the number of rats minimized the risk of human pathogens such as typhus which was very common in these areas.

Benefits /costs according to land user

Benefits compared with costs	short-term:	long-term:
Establishment	slightly positive	very positive
Maintenance / recurrent	very positive	positive

Due to the damage caused on the carob trees by rats already, the trees will need some time (2-3 years) to create new branches able to produce fruits. Furthermore no new damages occur on trees. During the first 3-5 years the aluminium layer can remain on the trees. After this period the aluminium should be replaced with a larger one due to the enlargement of the tree trunk.

Acceptance / adoption:

100% of land user families (10 families; 100% of area) have implemented the technology voluntary. Due to the lack of effective and cheap ways for controlling rat attack on carob trees the land users are adopting the technology, and so far they get positive results.
There is little trend towards (growing) spontaneous adoption of the technology. Few other land user are interested in adopting the technology. Many other land users are not adopting the technology because they inherited the land and they are not actually working on the land in order to make profit.

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
the technology can be used over a long time → use of non-oxidizing material	the aluminium layer should be replaced in time because the trees are growing in size → install larger aluminium layers and lold it with spring
the aluminium layer can be bent easily → both vertical edges should be hold each other by the use of a spur	The aluminium (metal) can overheat during summer time → Spray the layer with white paint
low cost →	the aluminium layer can be a target for thieves who steal metal →
easy installation →	
easy to install →	
the technology can be used over a long time →	

Metallic fences to prevent damages to pastures from wild boars

Italy

CONSTRUCTION OF FENCES TO KEEP WILD BOAR OFF PASTURE LAND

the regulations implemented by the Pollino national park to protect the wild fauna have led to large numbers of wild boar in the local area. Numbers of wild boar have also increased because of breeding with non-native species (a Hungarian strain) on the part of hunting associations. Numbers have increased so much that currently these animals have even reached rural areas destined for pasture, livestock farming and cultivation. To protect crops and pastures more fences have been built. Typically these fences are constructed out of pales made from local wood and galvanised iron netting.
Protection of pasture land and cropland
The construction of fences requires an initial investment in order to buy the wooden pales and iron netting. Generally the pales come from local woods, often from the farm itself, and are felled and prepared by local farmers who also usually construct the fences themselves. The height of the fences ranges from 1m to 1.20
Production methods are characterised by a medium level of mechanisation (only the most demanding operations are carried out using mechanical means), the production system is essentially mixed, a small part is destined for personal consumption whilst the bulk of production is destined for local markets. The property is predominantly privately owned but also includes some public land, especially in the case of pasture land. Most farms in the area are livestock farms whilst the agricultural component is destined exclusively for private consumption. The area is partially included in two bordered national parks, i.e. Pollino national park and val d'agri national park. This peculiar situation creates a very natural environment allowing the presence of many wild species.

left: Metallic fence (Photo: Giovanni Quaranta)
right: Metallic fence (Photo: Giovanni Quaranta)

Location: Basilicata
Region: CASTELSARACENO
Technology area: 0.1 - 1 km2
Conservation measure: structural
Stage of intervention: prevention of land degradation
Origin: Developed through land user`s initiative, 10-50 years ago
Land use type:
Cropland: Annual cropping
Grazing land: Extensive grazing land
Climate: subhumid, temperate
WOCAT database reference: T_ITA005en
Related approach:
Compiled by: Velia De Paola,
Date: 2014-06-27
Contact person: Giovanni Quaranta, University of Basilicata

Classification

Land use problems:

- The wild boar tend to dig into the ground in search of food and, in doing so, leave soil open to processes of erosion and permanently degrade grass cover. (expert's point of view)
Severe damage to grass cover and crops (land user's point of view)

Land use

Annual cropping
Extensive grazing land
extensive grazing land
rainfed

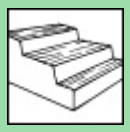
Climate

subhumid

Degradation

Soil erosion by water: loss of topsoil / surface erosion,
Biological degradation: reduction of vegetation cover, quantity / biomass decline, quality and species composition /diversity decline

Conservation measure



Structural: Walls / barriers / palisades

Stage of intervention

- Prevention
- Mitigation / Reduction
- Rehabilitation

Origin

- Land users initiative: 10-50 years ago
- Experiments / Research
- Externally introduced

Level of technical knowledge

- Agricultural advisor
- Land user

Main causes of land degradation:
Indirect causes: increase and spreading of wild boars

Main technical functions:

Secondary technical functions:
- improvement of ground cover
- increase of biomass (quantity)

Environment

Natural Environment

Average annual rainfall (mm)

- > 4000 mm
- 3000-4000 mm
- 2000-3000 mm
- 1500-2000 mm
- 1000-1500 mm
- 750-1000 mm
- 500-750 mm
- 250-500 mm
- < 250 mm

Altitude (m a.s.l.)

- > 4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 500-1000
- 100-500
- <100

Landform

- plateau / plains
- ridges
- mountain slopes
- hill slopes
- footslopes
- valley floors

Slope (%)

- flat
- gentle
- moderate
- rolling
- hilly
- steep
- very steep

Soil depth (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- >120

Growing season(s): 120 days(march to august)
Soil fertility: medium
Topsoil organic matter: medium (1-3%)
Soil drainage/infiltration: good

Soil water storage capacity: medium
Ground water table: 5 - 50 m
Availability of surface water: medium
Water quality: good drinking water
Biodiversity: medium

Tolerant of climatic extremes: temperature increase, seasonal rainfall increase, heavy rainfall events (intensities and amount), wind storms / dust storms, floods, droughts / dry spells, decreasing length of growing period
Sensitive to climatic extremes: seasonal rainfall decrease

Human Environment

Cropland per household (ha)

- <0.5
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1,000
- 1,000-10,000
- >10,000

Land user: Individual / household, Small scale land users, common / average land users, mainly men
Population density: 10-50 persons/km2
Annual population growth: negative
Land ownership: individual, titled
Land use rights: individual
Relative level of wealth: average 90% of the total area is owned by average land users

Importance of off-farm income: 10-50% of all income: Most of the off farm income derives from public sector, i.e. Municipality, Mountain Community, Region and other public bodies. Very few farmer members run local shops or handcraft.
Access to service and infrastructure: low: employment (eg off-farm); moderate: health, education, technical assistance, market, energy, roads & transport, drinking water and sanitation, financial services
Market orientation:

Implementation activities, inputs and costs

Establishment activities

- Wood pales and network
- wood pales
- Iron net

Establishment inputs and costs per unit

Inputs	Costs (US$)	% met by land user
Labour	5000.00	100%
Construction material		
- wood	3310.80	100%
- iron net	5405.40	100%
TOTAL	**13716.30**	**100.00%**

Maintenance/recurrent activities

- Checking fence for repairs

Maintenance/recurrent inputs and costs per unit per year

Inputs	Costs (US$)	% met by land user
Labour	81.08	100%
TOTAL	**81.08**	**100.00%**

Remarks:
The total cost for the construction of 1,000 metres of fencing is spread over a period of 20 years on the basis of the duration of the structure

Assessment

Impacts of the Technology

Production and socio-economic benefits

+ increased fodder production
+ reduced risk of production failure
+ increased farm income

Production and socio-economic disadvantages

+ increased expenses on agricultural inputs

Socio-cultural benefits

++ improved conservation / erosion knowledge

Socio-cultural disadvantages

Ecological benefits

++ reduced soil loss
++ reduced soil compaction
++ increased / maintained habitat diversity
+ reduced surface runoff
+ increased biomass above ground C
+ increased beneficial species

Ecological disadvantages

Off-site benefits

+ reduced damage on neighbours fields
+ reduced damage on public / private infrastructure

Off-site disadvantages

Contribution to human well-being / livelihoods

+

Benefits /costs according to land user

Benefits compared with costs	short-term:	long-term:
Establishment	slightly positive	slightly positive
Maintenance / recurrent	slightly positive	slightly positive

Acceptance / adoption:

100% of land user families have implemented the technology with external material support. support by the national park
0% of land user families have implemented the technology voluntary.
There is little trend towards (growing) spontaneous adoption of the technology.

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
The technology helps preserve pastures and protects against damage to crops → If the National Park of Pollino would also support activities to prevent damage caused by wild boar instead of focusing solely on the conservation of wild local species (boar).	The only disadvantage is the high initial cost of building fences which is, however, partly mitigated by the possibility to use the fences also as boundary marker dividing one property from another. →
If the National Park of Pollino would also support activities to prevent damage caused by wild boar instead of focusing solely on the conservation of wild local species (boar). → Greater economic support for the building of fences.	Disadvantage solely related to high cost of construction. → More subsidies

Pasture manuring (application of manure from shelter)

Italy

Application of manure in valuable pastures to increase grass recover and reduce shrub encroachment

This is a technique used on animal husbandry farms with either deep litter housing systems (sheep and goat manure) or manure heaps (cattle manure). Manure spreading is carried out twice a year but on different land. In the case of deep litter housing systems fresh straw is continuously spread over soiled litter in layers. After around six months the deep litter bedding is removed and mechanically spread on pasture lands or arable land. In the case of cattle farms animal waste is transferred daily to the farm's manure heap where it is left to decompose for at least a year. Also in this case straw is added for the animals' comfort and hygiene and is added to the manure heap together with faeces. Once the manure is ready it is spread on areas of land which can be farmed using mechanical means In the case of arable cropland manure is immediately buried by ploughing, in the case of pasture land it is spread at the beginning of autumn and left on the surface without ploughing (if not occasionally a harrow might be used to break down the manure to increase even distribution and penetration).
Increase growth of palatable species, increase value of grazing area
The technique is an agronomic measure which is applied on meadows, pastures and cropland in an area with a sub-humid climate, moderate scope and shallow clayey soil. As to the context of production, it is characterised by a medium level of mechanisation (only the most demanding operations are carried out using mechanical means), the production system is essentially mixed, a small part is destined for personal consumption whilst the bulk of production is destined for local markets. The property is predominantly privately owned but also includes some public land, especially in the case of pasture land. Most farms in the area are livestock farms whilst the agricultural component is destined exclusively for private consumption.

Location: Basilicata
Region: Castelsaraceno
Technology area: 0.1 - 1 km2
Conservation measure: agronomic
Stage of intervention: prevention of land degradation
Origin: Developed through land user`s initiative, traditional (>50 years ago)
Land use type:
Cropland: Annual cropping
Grazing land: Extensive grazing land
Climate: subhumid, temperate
WOCAT database reference: T_ITA003en
Related approach:
Compiled by: Velia De Paola,
Date: Before 1992
Contact person: Giovanni Quaranta, University of Basilicata

Classification

Land use problems:

- Decrease of value of pastures due to under grazing and shrub encroachment (expert's point of view)
Decrease of value of pastures due to under grazing and shrub encroachment (land user's point of view)

Land use

Annual cropping
Extensive grazing land
extensive grazing land
rainfed

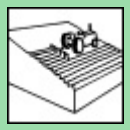
Climate

subhumid

Degradation

Biological degradation: quality and species composition /diversity decline

Conservation measure



Agronomic: Organic matter / soil fertility

Stage of intervention

- Prevention
- Mitigation / Reduction
- Rehabilitation

Origin

- Land users initiative: traditional (>50 years ago)
- Experiments / Research
- Externally introduced

Level of technical knowledge

- Agricultural advisor
- Land user

Main causes of land degradation:
Direct causes - Human induced: other human induced causes, Undergrazing, decrease in land use and land management
Indirect causes: labour availability

Main technical functions:

Secondary technical functions:
- increase in organic matter
- promotion of vegetation species and varieties (quality, eg palatable fodder)

Environment

Natural Environment

Average annual rainfall (mm)

- > 4000 mm
- 3000-4000 mm
- 2000-3000 mm
- 1500-2000 mm
- 1000-1500 mm
- 750-1000 mm
- 500-750 mm
- 250-500 mm
- < 250 mm

Altitude (m a.s.l.)

- > 4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 500-1000
- 100-500
- <100

Landform

- plateau / plains
- ridges
- mountain slopes
- hill slopes
- footslopes
- valley floors

Slope (%)

- flat
- gentle
- moderate
- rolling
- hilly
- steep
- very steep

Soil depth (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- >120

Growing season(s): 120 days(March to august)
Soil fertility: medium
Topsoil organic matter: medium (1-3%)
Soil drainage/infiltration: good

Soil water storage capacity: medium
Ground water table: 5 - 50 m
Availability of surface water: medium
Water quality: good drinking water
Biodiversity: medium

Tolerant of climatic extremes: temperature increase, seasonal rainfall increase, heavy rainfall events (intensities and amount), wind storms / dust storms, floods, droughts / dry spells, decreasing length of growing period
Sensitive to climatic extremes: seasonal rainfall decrease

Human Environment

Cropland per household (ha)

- <0.5
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1,000
- 1,000-10,000
- >10,000

Land user: Individual / household, Small scale land users, common / average land users, mainly men
Population density: 10-50 persons/km2
Annual population growth: negative
Land ownership: individual, titled
Land use rights: individual
Relative level of wealth: average, which represents 90% of the land users;

Importance of off-farm income: > 50% of all income: Most of the off farm income derives from public sector, i.e. Municipality, Mountain Community, Region and other public bodies. Very few farmer members run local shops or handcraft.
Access to service and infrastructure: low: employment (eg off-farm); moderate: health, education, technical assistance, market, energy, roads & transport, drinking water and sanitation, financial services
Market orientation:

Implementation activities, inputs and costs

Establishment activities

-

Maintenance/recurrent activities

- Emptying of deep litter bedding or manure hap
- Spreading of manure on 3 hectares of pasture land
- Hire of manure spreader

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$)	% met by land user
Equipment		
- machine use	932.38	100%
TOTAL	**932.38**	**100.00%**

Remarks:
Assuming that the production of manure (as described above) happens on farm, the critical point of the application of the technique is the availability of equipment for spreading. The largest farms buy the equipment spending from 35,000 to 40,000 euro depending on the machines' working capacities. The smaller farms (which represent the vast majority) rent this equipment (from third parties) twice a year at an overall cost of around €70 an hour.

Assessment

Impacts of the Technology

Production and socio-economic benefits

++ increased fodder production
\+ increased fodder quality
\+ increased farm income

Production and socio-economic disadvantages

\+ increased demand for irrigation water

Socio-cultural benefits

Socio-cultural disadvantages

Ecological benefits

++ increased soil moisture
++ increased biomass above ground C
++ increased nutrient cycling recharge
++ increased soil organic matter / below ground C
\+ reduced surface runoff
\+ increased plant diversity
\+ reduced invasive alien species
\+ increased beneficial species
\+ increased / maintained habitat diversity

Ecological disadvantages

Off-site benefits

Off-site disadvantages

Contribution to human well-being / livelihoods

\+

Benefits /costs according to land user

Benefits compared with costs	short-term:	long-term:
Establishment	not specified	not specified
Maintenance / recurrent	neutral / balanced	neutral / balanced

Acceptance / adoption:

10% of land user families have implemented the technology with external material support. Part of the implementing farms have adopted the technology thanks to support in buying ad hoc machinery
90% of land user families have implemented the technology voluntary.
There is little trend towards (growing) spontaneous adoption of the technology. High cost of fuel are reducing the rate of adoption given the high machinery requirements

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
The farms try to concentrate their activities and so they try to improve local (close by) pastureland. The technology increases the grass productivity and so helping farms to reduce time of grazing. → Supporting ad hoc machinery and equipment.	The technology is difficult to apply on very steep slope lands → No way
It's the only natural way to fertilize pasture and croplands. This avoids the use of chemical fertilizers and external inputs. This also provides great beneficial effects on the milk/meat quality through better grass. → Providing subsides both to machinery and organic production	This is considered as a heavy work (mainly dirty). The use of machinery is the only way to implement it → No way

Ploughing and seeding of fodder species to recover degraded grazing areas

Italy

left: Ploughed and seeded pasture (Photo: Matteo Jucker Riva)
right: improvement of grass cover in managed field as compared to unmanaged (Photo: Matteo Jucker Riva)

Location: Basilicata
Region: Castelsaraceno
Technology area: 0.1 - 1 km2
Conservation measure: agronomic
Stage of intervention: rehabilitation / reclamation of denuded land
Origin: Developed through land user`s initiative, traditional (>50 years ago)
Land use type:
Grazing land: Extensive grazing land
Climate: subhumid, temperate
WOCAT database reference: T_ITA004en
Related approach:
Compiled by: Velia De Paola,
Date: 2014-06-26
Contact person: Giovanni Quaranta, University of Basilicata

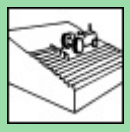
Ploughing and seeding of fodder species to recover old degraded grazing areas and maintain valuable pastures against shrub encroachment and decrease of palatable species

The technology consists of seeding pastureland with high palatable species whenever they are purely represented. In order to ensure a quality grass cover for grazing areas, pastures are ploughed (removing non-palatable shrubs) and planted with a variety of grains: i.e. oats, barley, alfalfa. This operation is periodically repeated (every tree-four years) according to the state of the grasses.
Regeneration of degraded pastures
The technique is an agronomic measure which is applied to degraded pastures (often modest areas of pasture land closest to farm sheds and stables). As to the context of production, it is characterised by a medium level of mechanisation (only the most demanding operations are carried out using mechanical means), the production system is essentially mixed, a small part is destined for personal consumption whilst the bulk of production is destined for local markets. The property is predominantly privately owned but also includes some public land, especially in the case of pasture land. Most farms in the area are livestock farms whilst the agricultural component is destined exclusively for private consumption.

Classification

Land use problems:

- Change of vegetation in pastures: encroachment of unpalatable species (expert's point of view)
The problem is degraded pastures (presence of non-palatable shrubs). (land user's point of view)

Land use	Climate	Degradation	Conservation measure
			
Extensive grazing land extensive grazing land rainfed	subhumid	Biological degradation: quality and species composition /diversity decline	Agronomic: Vegetation/soil cover

Stage of intervention

- Prevention
- Mitigation / Reduction
- Rehabilitation

Origin

- Land users initiative: traditional (>50 years ago)
- Experiments / Research
- Externally introduced

Level of technical knowledge

- Agricultural advisor
- Land user

Main causes of land degradation:
Direct causes - Human induced: other human induced causes, Undergrazing

Main technical functions:
- increase of biomass (quantity)
- promotion of vegetation species and varieties (quality, eg palatable fodder)

Secondary technical functions:
- increase of infiltration
- increase / maintain water stored in soil

Environment

Natural Environment

Average annual rainfall (mm)

- > 4000 mm
- 3000-4000 mm
- 2000-3000 mm
- 1500-2000 mm
- 1000-1500 mm
- 750-1000 mm
- 500-750 mm
- 250-500 mm
- < 250 mm

Altitude (m a.s.l.)

- > 4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 500-1000
- 100-500
- <100

Landform

- plateau / plains
- ridges
- mountain slopes
- hill slopes
- footslopes
- valley floors

Slope (%)

- flat
- gentle
- moderate
- rolling
- hilly
- steep
- very steep

Soil depth (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- >120

Growing season(s): 120 days(March to august)
Soil fertility: medium
Topsoil organic matter: medium (1-3%)
Soil drainage/infiltration: good

Soil water storage capacity: medium
Ground water table: 5 - 50 m
Availability of surface water: medium
Water quality: good drinking water
Biodiversity: medium

Tolerant of climatic extremes: temperature increase, seasonal rainfall increase, heavy rainfall events (intensities and amount), wind storms / dust storms, floods, droughts / dry spells, decreasing length of growing period
Sensitive to climatic extremes: seasonal rainfall decrease

Human Environment

Grazing land per household (ha)

- <0.5
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1,000
- 1,000-10,000
- >10,000

Land user: Individual / household, Small scale land users, common / average land users, mainly men
Population density: 10-50 persons/km2
Annual population growth: negative
Land ownership: individual, titled
Land use rights: individual
Relative level of wealth: average, which represents 90% of the land users;

Importance of off-farm income: 10-50% of all income: Most of the off farm income derives from public sector, i.e. Municipality, Mountain Community, Region and other public bodies. Very few farmer members run local shops or handcraft.
Access to service and infrastructure: low: employment (eg off-farm); moderate: health, education, technical assistance, market, energy, roads & transport, drinking water and sanitation, financial services
Market orientation: mixed (subsistence and commercial)
Livestock density: > 100 LU /km2

Implementation activities, inputs and costs

Establishment activities

-

Maintenance/recurrent activities

- Ploughing with machinery and add fertilizer if needed
- Seeding

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$)	% met by land user
Labour	54.04	100%
Equipment		
- machine use	270.27	100%
Agricultural		
- seeds	202.70	100%
TOTAL	**527.01**	**100.00%**

Remarks:
The most determinate factor affecting costs of the technique is the availability of equipment for spreading. The largest farms buy the equipment spending from 35,000 to 40,000 euro depending on the machines' working capacities. The smaller farms (which represent the vast majority) rent this equipment at a cost of around €50 an hour.
The above costs have been calculated according to the average of small farm's records.

Assessment

Impacts of the Technology

Production and socio-economic benefits

+++ increased fodder production
++ increased fodder quality
+ reduced risk of production failure
+ increased farm income

Production and socio-economic disadvantages

++ increased expenses on agricultural inputs

Socio-cultural benefits

Socio-cultural disadvantages

Ecological benefits

++ improved soil cover
++ increased biomass above ground C
++ increased beneficial species
+ improved excess water drainage
+ recharge of groundwater table / aquifer
+ reduced hazard towards adverse events
+ increased nutrient cycling recharge
+ reduced soil compaction

Ecological disadvantages

+ increased surface water runoff
+ decreased soil organic matter
+ increased soil sealing / compaction
+ increased soil erosion locally
+ reduced biodiversity / crop diversity
+ increased habitat fragmentation
+ increased niches for pests

Off-site benefits

Off-site disadvantages

+ decreased buffering / filtering capacity

Contribution to human well-being / livelihoods

Benefits /costs according to land user

Benefits compared with costs	short-term:	long-term:
Establishment	slightly negative	slightly positive
Maintenance / recurrent	slightly negative	slightly negative

Acceptance / adoption:

90% of land user families have implemented the technology with external material support. The activities were initially supported by a regional program with a subside equal to 50% of the total cost. However the technology proved not very efficient from the economic point of view, hence the subsidies where suspended.
10% of land user families have implemented the technology voluntary.
There is no trend towards (growing) spontaneous adoption of the technology.

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
The technology can improve productivity and help restore the most valuable pastures, especially those situated near the animal housing structures → Subsidies where available in the past but didn't prove effective or beneficial.	Removing soil surfaces in order to seed the lands can create condition for soil degradation if not performed adequately → Increasing farmers awareness and skills for good agricultural practices
The technology can improve very degraded pastureland but is not very useful when the pasture is only partly degraded → In order to increase the technology supports to machinery use should be provided, since they are the main relevant cost/barrier to adopt the technology.	High cost of machinery/equipment and their difficult use in tough environmental conditions (stony lands and steep slopes). →

Resilience analysis Tool

Result summary

About this Resilience Assessment
Authors:
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Date of Submission:
05-01-2016

Main sources of information:
local knowledge
local knowledge

References in the WOCAT database:
GRE 08; ;

Greece
Gre_1

Carob afforestation on grazing land for land restoration and income diversificatio

Disturbances affecting the land management system:

The following disturbances affect the land management system, and could change dramatically the environment making it unusable for land users:

Type of disturbance:	 fires	 droughts	 pests / diseases
Frequency:	**Between 1 and 5 years**	**Between 1 and 5 years**	**Between 5 and 10 years**
Risk of permanent changes to the environment after a disturbance:	**Medium**	**Low**	**Low**

Impact of land management on resilience to disturbances:

This is the impact that the land management practices have in preventing, mitigating and fostering recovery after. All together they indicate which effect the land management has on the resilience of the system to disturbances:

Land Management practice 1: ***Grazing land afforestation with carob trees***	++	0	++
Land Management Practice 2: ***Controlled grazing in spring months and tree protection***	++	-	++
Overall impact of land management on resilience to disturbances	Very positive	**Negative**	Very positive

*Legend: ++ Very positive; + Positive; 0 Neutral; - Negative; -- Very negative

Human and natural environment of the land management system:

A brief description of the features of the land management system assessed

Land use type		Environment		Management	
	Present land use(s): ***Fp: Plantations; Ms: Silvo-pastoralism;***		Climate: ***subhumid***		Main measure: ***Vegetative; Management***
	Past land use(s): ***Gi: Intensive grazing/ fodder production; Mp: Agro-pastoralism;***		Land forms: ***hill slopes***		Land managers: ***Individual/household, , Leaders / privileged, mainly men***

Current state of the land management system:

We have asked ***Land users, Land managers, and local experts*** to assess the provision of benefits and the state of the environment in the land management system. These are the most important benefits / services that the environment should provide:

(P1) Animal and plant productivity
(P3) land available for production
(E3) reduced erosion
(E5) above ground biodiversity
(S2) Cultural services(e.g maintaining traditional landscape)

And these are the most important environmental properties that allow the land management system to remain valuable:

Category ***Fauna:***

Low number of wild / domestic grazers

High number of predators

Category ***Soil and Water:***

Favourable soil structure

Low soil erosion

Category ***Landscape:***

Presence of different landscape elements and vegetation patterns

Connectivity between healthy areas

Category ***Vegetation:***

Presence of a mixture of grasses, shrubs and trees (complex vegetation structure)

Continuity of vegetation canopy/cover

Land users, Land managers, and local experts have provided the following evaluation of the state of the environment and the provision of benefits/services:

State of the environment:		Provision of benefits /Services:	
Category	Evaluation	Category	Evaluation
Fauna:	**Healthy**		
Soil and Water:	**Healthy**	Productive benefits /services:	**Undecided**
Landscape:	**Degraded**	Ecological benefits/Services:	**Insufficient**
Vegetation:	**Healthy**	Socio-cultural benefits /Services:	**Sufficient**

Concluding remarks

External factors affecting the resilience of land management system:

What external factors ***increase the pressure*** on the environment of the land management system? How they are likely to evolve in the future?*	What external factors *enable sustainable land management* ? How they are going to evolve in the future?*
Overgrazing(-)	**Subsidies for land use activity (=)**
Removal of natural vegetation (=)	**Subsidies for land management or nature conservation(=)**
	A specific land use activity:(=)

*Forecasted evolution of ext. Factors in the next 10 years: (+) increase, (=) Stable, (-) Decrease

Under what conditions can the disturbances induce a permanent change to the land management system?

Fire:
If there is no restriction of grazing after the fire for many years in order the carob trees to regrow.

Drought:
If the trees are new (less than 3-5 years) and there is no sufficient irrigation in case of a drought

Pests / diseases:
not possible to define

What are the conditions for a positive evolution of the land management system?

If pruning and managed grazing is maintained;
If Carrob fruit value remains high
If the land avoids frequent wildfires
If land is not abandoned due to other financial reasons.

Sources used to compile the questionnaire:

Bottema, S., 1980. Palynological investigations on Crete. Review of Palaeobotany and Palynology 31, 193–217.

Briassoulis, H., 2003. Crete: Endowed by nature, privileged by geography, threatened by tourism? Journal of Sustainable Tourism 11, 97–115.

Chartzoulakis, K.S., Paranychianakis, N.V., Angelakis, A.N., 2001. Water resources management in the island of Crete, Greece, with emphasis on the agricultural use. Water Policy 3, 193–205.;

Multi-specific plantation of semiarid woody species on slopes

Spain - Plantación pluriespecífica de especies leñosas de ambiente semiárido en laderas

Plantation of native woody species using planting holes on slopes

This technology is a restauration technology implemented on degraded south-facing slopes of a semiarid mountain range. The restoration technology consisted of a plantation of seedlings of a variety of native woody species, mostly shrubs, using deep (60cm depth) planting holes. Microcatchments were established upslope the planting hole in suitable areas. Seedlings were protected from extreme radiation and predation by biodegradable seedling shelters. The target area was highly degraded due to long-term overexploitation of resources under harsh environmental conditions. Failed previous reforestation actions on bench terraces led to further degradation in some areas. Degradation resulted in low plant cover, decreased plant biodiversity, lack of riparian vegetation on the ramblas (ravines with intermittent flow), soil erosion, development of gullies, and frequent floods. To address this problem, the Forest Administration implemented a restoration program on the south-facing slopes of the Albatera-Crevillente mountain range. The program was implemented in 2006-07.
The purpose of the plantation is the restoration of diversity and cover of vegetation on degraded south-facing slopes of a semiarid mountain range, erosion control, and flood prevention.
The target area is the south-facing side of a mountain range in a semiarid area of Southeast Spain. Exploitation of resources over centuries, mostly grazing and wood gathering, under harsh environmental conditions, led to very low plant cover, mostly consisting of dwarf shrubs sparsed in a matrix of bare soil, lack of riparian vegetation on the ramblas (ravines with intermittent flow), soil erosion, development of gullies, and frequent floods. The exploitation of the land was drastically reduced during the second half of the 20th century due to the general rural land abandonment trend that started in Spain around the 1950's driven by critical socio-economic changes such as the use of fossil fuels and the sharp increase in activity in the tourism and services business sectors, mostly in the coast land. However, despite the reduction, or even complete abandonment, of rural activity on the mountain range area, there was no sign of spontaneous recovery from degradation. Soil erosion and floods were of major concern for the resource managers in the area (Public Forest Administration), and a number of reforestation and restoration programs have been implemented in the area, with varying degree of success. In more recent decades, new pressures appeared in the mountain area, such as agricultural expansion into the range area (1970s), mining activities (late 1990's - early 2000's), and urbanization (2000s). Rural tourism and recreation are new activities in the mountain range area. For the time being, the intensity of these activities is low to moderate. However there is already some evidence of incipient degradation associated to recreation, and some regulation is being demanded by environmental NGOs.

left: Walking excavator preparing planting holes (Photo: S.Bautista)
right: Detail of a planted seedling showing one of the applied planting treatments: microcatchment and seedling shelter (Photo: S.Bautista)

Location: Spain/Alicante
Region: Albatera
Technology area: 5.7 km^2
Conservation measure: vegetative
Stage of intervention: rehabilitation / reclamation of denuded land
Origin: Developed externally / introduced through project, recent (<10 years ago)
Land use type:
Forests / woodlands: Natural
Land use:
Forests / woodlandsrests / woodlands: Natural (before), Forests / woodlandsrests / woodlands: Plantations, afforestations (after)
Climate: semi-arid, subtropics
WOCAT database reference: T_SPA013en
Related approach:
Compiled by: Susana Bautista, Universidad de Alicante
Date: 2014-07-01

Classification

Land use problems:

- Erosion, water scarcity, low productivity, loss of soil functions (water infiltration, nutrient cycling), low biodiversity, loss of landscape structure (expert's point of view)
Low productivity, aridity, erosion (land user's point of view)

Land use

Natural
Forests / woodlandsrests / woodlands: Natural (before)
Forests / woodlandsrests / woodlands: Plantations, afforestations (after)
plantation forestry

Climate

semi-arid

Degradation

Soil erosion by water: loss of topsoil / surface erosion, offsite degradation effects, Biological degradation: reduction of vegetation cover, quantity / biomass decline, quality and species composition /diversity decline

Conservation measure

Vegetative: Tree and shrub cover

Stage of intervention

- Prevention
- Mitigation / Reduction
- Rehabilitation

Origin

- Land users initiative
- Experiments / Research
- Externally introduced: recent (<10 years ago)

Level of technical knowledge

- Agricultural advisor
- Land user

Main causes of land degradation:
Direct causes - Human induced: deforestation / removal of natural vegetation (incl. forest fires), over-exploitation of vegetation for domestic use
Indirect causes: poverty / wealth

Main technical functions:

- control of dispersed runoff: retain / trap
- improvement of ground cover
- increase in nutrient availability (supply, recycling,...)

Secondary technical functions:

- control of dispersed runoff: impede / retard
- control of concentrated runoff: retain / trap
- increase of surface roughness
- improvement of surface structure (crusting, sealing)
- improvement of topsoil structure (compaction)
- stabilisation of soil (eg by tree roots against land slides)
- increase in organic matter
- increase of infiltration
- increase / maintain water stored in soil
- promotion of vegetation species and varieties (quality, eg palatable fodder)

Environment

Natural Environment

Average annual rainfall (mm)

- > 4000 mm
- 3000-4000 mm
- 2000-3000 mm
- 1500-2000 mm
- 1000-1500 mm
- 750-1000 mm
- 500-750 mm
- 250-500 mm
- < 250 mm

Altitude (m a.s.l.)

- > 4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 500-1000
- 100-500
- <100

Landform

- plateau / plains
- ridges
- mountain slopes
- hill slopes
- footslopes
- valley floors

Slope (%)

- flat
- gentle
- moderate
- rolling
- hilly
- steep
- very steep

Soil depth (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- >120

Growing season(s): 240 days(November-June)
Soil texture: medium (loam)
Soil fertility: low
Topsoil organic matter: medium (1-3%)
Soil drainage/infiltration: good

Soil water storage capacity: medium
Ground water table: > 50 m
Availability of surface water: poor / none
Water quality: for agricultural use only
Biodiversity: medium

Tolerant of climatic extremes: temperature increase, seasonal rainfall increase, seasonal rainfall decrease, decreasing length of growing period
Sensitive to climatic extremes: heavy rainfall events (intensities and amount), droughts / dry spells

Human Environment

Forests / woodlands per household (ha)

	<0.5
	0.5-1
	1-2
	2-5
	5-15
	15-50
	50-100
	100-500
■	500-1,000
	1,000-10,000
	>10,000

Land user: employee (company, government), large scale land users, Leaders / privileged, men and women
Population density: 100-200 persons/km2
Annual population growth: 2% - 3%
Land ownership: state
Land use rights: open access (unorganised)

Importance of off-farm income: > 50% of all income:
Access to service and infrastructure: moderate: employment (eg off-farm), financial services; high: health, education, technical assistance, market, energy, roads & transport, drinking water and sanitation
Market orientation: No forestry production
Purpose of forest / woodland use: nature conservation / protection, recreation / tourism

Technical drawing

Test (Test)

Implementation activities, inputs and costs

Establishment activities

- Soil preparation and planting holes
- Soil and microcatchment preparation
- Fertilization plantation (holes)
- Fertilization microcatchment
- Plantation
- Plantation (microcatchments)
- Tree shelter placement
- tree shelter placement (Microcatchments)

Establishment inputs and costs per ha

Inputs	Costs (US$)	% met by land user
Labour	1343.00	100%
Equipment		
- machine use	853.00	100%
Agricultural		
- seedlings	252.00	100%
- biocides	154.00	100%
- Tree shelters	424.00	100%
TOTAL	**3026.00**	**100.00%**

Maintenance/recurrent activities

Remarks:

Assessment

Impacts of the Technology

Production and socio-economic benefits	Production and socio-economic disadvantages

Socio-cultural benefits	Socio-cultural disadvantages
+ increased recreational opportunities	
+ improved conservation / erosion knowledge	

Ecological benefits	Ecological disadvantages
++ improved harvesting / collection of water	
++ reduced evaporation	
++ reduced surface runoff	
++ improved soil cover	
++ increased biomass above ground C	
++ increased nutrient cycling recharge	
++ increased soil organic matter / below ground C	
++ reduced soil loss	
++ increased plant diversity	
++ increased / maintained habitat diversity	
+ increased soil moisture	
+ increased animal diversity	
+ increased beneficial species	

Off-site benefits	Off-site disadvantages
+ reduced downstream flooding	

Contribution to human well-being / livelihoods
+ Recreational use

Benefits /costs according to land user

Benefits compared with costs	short-term:	long-term:
Establishment	slightly negative	positive
Maintenance / recurrent	not specified	not specified

Acceptance / adoption:

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome