Forest area in the mountains with several species: Eucalyptus spp., Dichrostachys cinerea and Lantana camara on steep slopes. (Jacques Tavares)

Afforestation (Cape Verde)

Arborização / floresta (Portuguese)

DESCRIPTION

Afforestation is one of the key technologies to address the fragility of ecosystems: it provides better protection against erosion and makes better use of rainfall in order to maintain the sustainability of agricultural systems.

Mountain forest areas are considered protective due to their role in regulating water (infiltration of storm water, regulation of surface runoff, and ground water recharge) within the watershed. The main species used are Prosopis juliflora, Parkinsonia aculeata, Jatropha curcas, Atriplex spp, Acacia holosericea, Acacia victoriae, Lantana camara and others, in arid areas and Eucalyptus camaldulensis, Grevillea robusta, Pinus and Cupressus ssp. in highland and humid areas.

Purpose of the Technology: The climatic conditions are characterized by high spatial and temporal variability of the rainfall. The rains are concentrated in two or three months (August and September or October); the highlands and the N-NE parts are wetter compared to the low lands or coastal areas, which are very dry. The average annual rainfall is about 225 mm over the whole island; it has declined since the 1960s, with negative effects on farming conditions, and water supply. However, in areas located more than 500 m above sea level and exposed to trade winds, rainfall can exceed 700 mm. About 20% of the precipitation is lost through runoff, 13% infiltrates the soil and recharges aquifers and 67% evaporates. The evaporation loss is a limiting factor for any agriculture or forestry. Therefore, it is necessary to adapt the afforestation implementation to the specific local conditions (slope, stone cover, climate, etc). To overcome and minimize the problem of water scarcity, several measures are applied: (a) caldeira or half-moon structures achieved with earth or stone; (b) contour furrows or level bench terraces with stone walls arranged along the contour; (c). small dams to protect gullies. The aim is to maximize retention of water and control surface runoff. This not only allows better infiltration of water for the tree plantations, but also protects against soil erosion and facilitates groundwater recharge.

Establishment / maintenance activities and inputs: The success of the reforestation may be indicated not only by the area covered but also by the number of introduced plants. In 1975, there were about 3,000 ha of afforested land. By 2011, there are over 90,000 ha of afforested land with almost 50 million trees. Afforestation has focused mainly on the island of Santiago and Santo Antão, (13% of the total area reforested). Nowadays, more than 20% of the country is afforested. The forest has had a great importance in the context of combating desertification, rehabilitation of vegetation cover, in meeting energy needs and forage production and in developing agrosilvopastoral systems, as well as having undoubtedly contributed to a significant modification of the landscape in Cape Verde. The afforestation activities also contributed to increase biodiversity of some species of birds, including "Galinha di mato" (Numida meleagris), "Codorniz" (Coturnix coturnix), "Passarinha" (Halcyon leucocephala) and others.

Natural / human environment: The forest species are mainly used for land protection and for production of fuel wood and coal. Because of the poor growing conditions, the forest species are not well suited to the construction industry or wood processing.

LOCATION

Location: Ribeira Seca, Santiago Island, Cape Verde, Cape Verde

No. of Technology sites analysed:

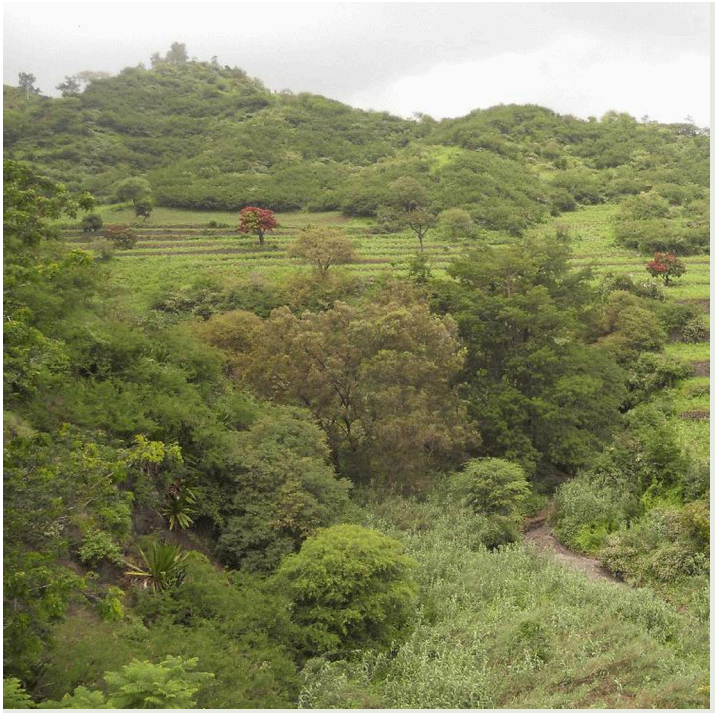
Geo-reference of selected sites
- -23.588, 15.074

Spread of the Technology: evenly spread over an area (71.5 km^2)

In a permanently protected area?:

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



Summit area invaded by Dichrostachys cinerea and Lantana camara towards the bottom. In the middle and foot slope areas there is an association of rainfed agriculture with fruit trees (mangoes) on land protected with stone terraces (Jacques Tavares)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [ ] improve production
- [x] reduce, prevent, restore land degradation
- [x] 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: Ja - Silvo-pastoralism

Grazing land

- Cut-and-carry/ zero grazing

Animal type: goats, cows

Forest/ woodlands

- Tree plantation, afforestation: tropical mountain systems plantation - Eucalyptus spp., tropical mountain systems plantation - Pinus spp.. Varieties: Mixed varieties

Tree types: Acacia species, Cupressus species, Eucalyptus camaldulensis, Grevillea robusta, Pinus species, Prosopis juliflora, Parkinsonia aculeata, Jatropha curcas, Atriplex spp, Lantana camara

Products and services: Nature conservation/ protection

Water supply

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

Purpose related to land degradation

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

Degradation addressed

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

biological degradation - Bc: reduction of vegetation cover, Bh: loss of habitats

water degradation - Hg: change in groundwater/aquifer level

SLM group

- natural and semi-natural forest management
- irrigation management (incl. water supply, drainage)

SLM measures

vegetative measures - V1: Tree and shrub cover

structural measures - S2: Bunds, banks

TECHNICAL DRAWING

Technical specifications

Treatment of slope before afforestation

Technical knowledge required for field staff / advisors: moderate (It's needed sufficient knowledge to choice species according to their suitability to the natural and human environment)

Technical knowledge required for land users: low

Main technical functions: control of raindrop splash, improvement of ground cover, stabilisation of soil (eg by tree roots against land slides), increase of infiltration, increase of groundwater level / recharge of groundwater

Secondary technical functions: increase in organic matter, increase / maintain water stored in soil, reduction in wind speed

Retention/infiltration ditch/pit, sediment/sand trap
Vertical interval between structures (m): 2
Spacing between structures (m): 5
Depth of ditches/pits/dams (m): 0.2
Width of ditches/pits/dams (m): 0.8
Length of ditches/pits/dams (m): 100
Height of bunds/banks/others (m): 0.4
Width of bunds/banks/others (m): 0.4
Length of bunds/banks/others (m): 100

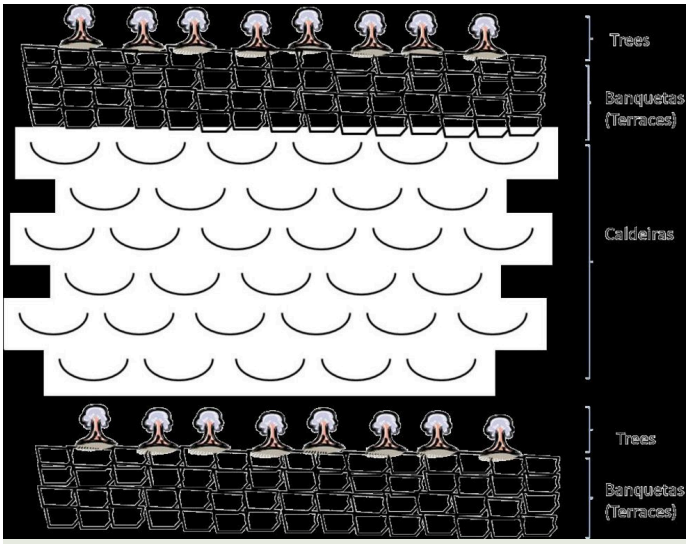
Construction material (earth): land from the local construction of the ditch is used in the construction of banks, that can be rein

Slope (which determines the spacing indicated above): 30 - 60%

Lateral gradient along the structure: 0%

For water harvesting: the ratio between the area where the harvested water is applied and the total area from which water is collected is: 1:3

Vegetation is used for stabilisation of structures.



Author: Jacques Tavares

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated:
- Currency used for cost calculation: **n.a.**
- Exchange rate (to USD): 1 USD = n.a
- Average wage cost of hired labour per day: n.a

Most important factors affecting the costs

The labour affects the costs more than other factors. Paid labour is a way to achieve additional income for many people in this area. The employer (Directorate General of Agriculture, Sylviculture and Livestock of the Ministry of Rural Development) provides 90% of the cost of the equipment. The lifetime of the equipment is 10-15 years.

Establishment activities

1. Quantification of the area to be afforested (Timing/ frequency: None)
2. Production of plants in nursery (500 - 1300 plants) (Timing/ frequency: None)
3. Treatment of area (slope) with building terraces (15 m / person / day) (Timing/ frequency: None)
4. Treatment of area (slope) with: Making half-moons “Caldeiras” (3 / person / day) (Timing/ frequency: None)
5. 4.Excavating the pits (10 / person / day): 60x60x60 cm (Timing/ frequency: None)
6. Planting (50 /person / day): 5 to 5 metres (Timing/ frequency: None)
7. Initial maintenance (8 /persons / day) (Timing/ frequency: None)
8. Cleaning and marking on curves level (Timing/ frequency: In April)
9. Construction of the retention / infiltration ditch and opening of the surface of culture (Timing/ frequency: April to June)

Establishment inputs and costs

Specify input	Unit	Quantity	Costs per Unit (n.a.)	Total costs per input (n.a.)	% of costs borne by land users
Labour					
Labour	ha	1.0	28218.0	28218.0	
Equipment					
Tools	ha	1.0	410.0	410.0	10.0
Plant material					
Seeds	ha	1.0	942.0	942.0	
Total costs for establishment of the Technology				**29'570.0**	
Total costs for establishment of the Technology in USD				*29'570.0*	

Maintenance activities

1. forest cleaning (Timing/ frequency: None)
2. forest cleaning (Timing/ frequency: In the dry session)

Maintenance inputs and costs

Specify input	Unit	Quantity	Costs per Unit (n.a.)	Total costs per input (n.a.)	% of costs borne by land users
Labour					
Forest cleaning	ha	1.0	142.0	142.0	52.0
Total costs for maintenance of the Technology				**142.0**	
Total costs for maintenance of the Technology in USD				*142.0*	

NATURAL ENVIRONMENT

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

Agro-climatic zone
- [x] humid
- [x] sub-humid
- [x] semi-arid
- [x] arid

Specifications on climate
Average annual rainfall in mm: 800.0
Thermal climate class: tropics. average temperature equal to 26 ° C

The exposure and altitude are factors diterminantes for agroclimatic estratização. the higher areas and targeted to the SE are more humid.

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

Landforms
- [ ] plateau/plains
- [ ] ridges
- [x] mountain slopes
- [x] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [x] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [x] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

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

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

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

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

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

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

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

Water quality refers to:

Is salinity a problem?
- [ ] Ja
- [ ] Nee

Occurrence of flooding
- [ ] Ja
- [ ] Nee

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

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

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

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

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

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

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

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

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

Gender
- [ ] women
- [ ] men

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

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha

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

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

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

Water use rights

- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [x] 500-1,000 ha
- [x] 1,000-10,000 ha
- [ ] > 10,000 ha

- [x] individual, titled
- [x] Diocese

- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

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

IMPACTS

Socio-economic impacts

fodder production	decreased	increased ✓	
fodder quality	decreased	✓ increased	
energy generation (e.g. hydro, bio)	decreased	✓ increased	Firewood to the community
drinking water availability	decreased	✓ increased	
expenses on agricultural inputs	increased ✓	decreased	
economic disparities	increased ✓	decreased	

Socio-cultural impacts

food security/ self-sufficiency	reduced	✓ improved	It reduces the options of land use
cultural opportunities (eg spiritual, aesthetic, others)	reduced	✓ improved	
conflict mitigation	worsened ✓	improved	
situation of socially and economically disadvantaged groups (gender, age, status, ehtnicity etc.)	worsened	✓ improved	Any sex has the same opportunity on the assets of the forest
livelihood and human well-being	reduced	✓ improved	It improves air quality, promotes the production of endemic species and its use as medicine

Ecological impacts

groundwater table/ aquifer	lowered	✓ recharge
evaporation	increased	✓ decreased
soil moisture	decreased	✓ increased
soil cover	reduced	✓ improved
soil loss	increased	✓ decreased
soil organic matter/ below ground C	decreased	✓ increased
emission of carbon and greenhouse gases	increased	✓ decreased
wind velocity	increased	✓ decreased
Invasive species	increased ✓	decreased
competition	increased ✓	decreased

Off-site impacts

water availability (groundwater, springs)	decreased	✓ increased
reliable and stable stream flows in dry season (incl. low flows)	reduced	✓ increased
downstream flooding (undesired)	increased	✓ reduced
downstream siltation	increased	✓ decreased
buffering/ filtering capacity (by soil, vegetation, wetlands)	reduced	✓ improved
wind transported sediments	increased	✓ reduced
damage on neighbours' fields	increased ✓	reduced

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

The high costs are associated with its implementation; afterwards they are significantly reduced and the technology builds up the benefits.

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all	very well

Climate-related extremes (disasters)

local rainstorm	not well at all	very well	Answer: not known
local windstorm	not well at all	very well	
drought	not well at all	very well	
general (river) flood	not well at all	very well	Answer: not known

Other climate-related consequences

reduced growing period	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%

Number of households and/ or area covered

None. It's a project of the government

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

- Ja
- Nee

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

- Production of firewood and grass

  How can they be sustained / enhanced? make more forest operations such as pruning or cutting of new seedlings
- Protection of soil

  How can they be sustained / enhanced? strengthen maintenance operations

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

- Increases the quality of the landscape and reduces the loss of soil by runoff

  How can they be sustained / enhanced? increasing the tree cover in areas with low coverage
- Encourages the production of livestock, and fuel wood

  How can they be sustained / enhanced? integrate the community in managing the forest, and manage it in a sustainable way.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- impossibility of farming in the forest lands off-farm income creation to compensate
- Lack of involvement of farmers in the management of forest areas capacity building of land users in forest management strategies, elaboration of contracts between State and land users for the management of forest perimeters

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- Reduces the percentage of land for agricultural production increase productivity in cultivated land and reduce the need for the use of forest land, and implement new production technologies such as greenhouses

REFERENCES

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Full description in the WOCAT database
https://qcat.wocat.net/af/wocat/technologies/view/technologies_1523/

Linked SLM data
Approaches: Protection des versants https://qcat.wocat.net/af/wocat/approaches/view/approaches_2673/

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