



Protective pine plantations on degraded slopes and in gullies, Tanzania. (Hanspeter Liniger)

In a nutshell

Definition: Planted forests, or ‘plantations’, comprise trees established through planting seedlings and / or through direct seeding. Species may be native or introduced. Establishment may be on previously forested land or land that was not forest before. The purpose of planted forests can be either (1) commercial; or (2) for environmental / protective use; or (3) for rehabilitation of degraded areas. It may be a combination of more than one of these. The challenge is to develop planted forests that are financially viable as well as ecologically sustainable. The applicability and sustainability of planted forests depends on what they replace and how they are managed and harvested. Planted forests cannot act as a substitute for natural forests, they should rather complement and mutually reinforce the environmental and production services of the latter. In developing countries seventy percent of people depend on trees and forests as their major source of fuelwood. Due to declining supplies, planted forests are an increasingly important source of fuelwood and other forest products. Proper sustained management of planted forests is the only way to avoid shortages of wood and further deforestation of natural forests - planted forests lessen the need to log natural forests. However, there are very controversial opinions about the sustainability of planted forests, especially related to industrial large-scale monoculture plantations. On-going debate concerns whether planted forests constitute the best answer to the growing demand for wood, and whether they are an efficient way of ‘carbon-offsetting’. In some situations planted forests can be excellent to rehabilitate degraded land, leading to improvements of the environment, whereas a similar plantation can have negative impacts elsewhere. A further key aspect is whether the mature trees are harvested, and if so, whether the stand is replanted (or left to coppice) or abandoned. It is at establishment and harvesting when most environmental damage can be done. Environmental guidelines need to be adhered to, or developed where inexistent.

Applicability: Planted forests with fast-growing species should only be established in areas with no water constraints.

Resilience to climate variability: Even small areas of planted forests (given the warning about water consumption above) can positively influence the microclimate, which can enhance the resilience to climate variability.

Main benefits: Rehabilitation of degraded areas (e.g. eroded or overgrazed areas), increased availability of wood products, fuelwood, and some non-wood forest products. They can lead to employment and income generation. There is reduced pressure on natural forests; planted forests are carbon sinks (unless they replace natural forests), especially on marginal agricultural land and degraded soils – and only if replanted / left to coppice after use.

Adoption and upscaling: Delineation of clear resource rights with respect to planted forests is essential. Research is important for scientifically based information about appropriate management, species compositions and the impact on the ecosystem. Capacity building and training should be provided to all stakeholders. Incentives may be needed for the establishment of planted forests, especially for the rehabilitation of degraded areas.

Development issues addressed	
Preventing / reversing land degradation	+++
Maintaining and improving food security	+
Reducing rural poverty	+
Creating rural employment	++
Supporting gender equity / marginalised groups	+
Improving crop production	na
Improving fodder production	+
Improving wood / fibre production	+++
Improving non wood forest production	+
Preserving biodiversity	+
Improving soil resources (OM, nutrients)	+
Improving of water resources	+/-
Improving water productivity	+
Natural disaster prevention / mitigation	++
Climate change mitigation / adaptation	++
Climate change mitigation	
Potential for C sequestration (tonnes/ha/year)	1.2 – 2*
C Sequestration: above ground	+++
C Sequestration: below ground	++
Climate change adaptation	
Resilience to extreme dry conditions	+
Resilience to variable rainfall	++
Resilience to extreme rain and wind storms	++
Resilience to rising temperatures and evaporation rates	++
Reducing risk of production failure	+

**for the first 20-30 years of afforestation in drylands, depending on the selected tree species (FAO, 2004 and GTZ, 2009)*

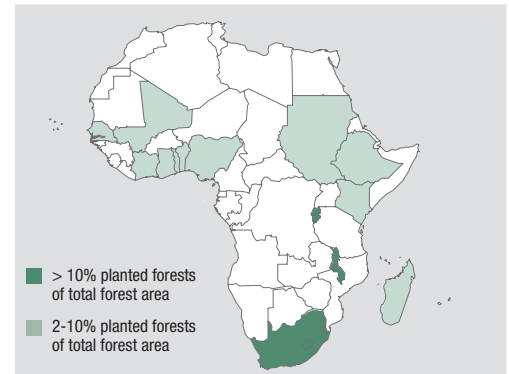
Origin and spread in Africa

Origin: Large-scale plantation of exotic tree species in Africa originated during the colonial period with foreign investments and regulated by governments. Nowadays, there is a shift from previously government controlled management towards increased involvement of the private sector and small-scale producers. Since the 1960s, the emphasis has been maintained on fast-growing species primarily grown for supplying industrial wood (pulp and paper industry, fuelwood). In 2000, the total plantation area in Africa was 8,036,000 ha of which 42% are commercial-industrial plantations. Planted forests represent, only a very small fraction of the total forest cover in SSA (between 0.3% - 2.3% of the total).

Mainly in (more than 10% planted forests of total forest area): Burundi, Cape Verde, Lesotho, Malawi, Rwanda, Swaziland, South Africa.

Partly in (between 2-10% planted forests of total forest area): Benin, Ivory Coast, Ethiopia, Ghana, Kenya, Mali, Madagascar, Nigeria, Sudan, Senegal, Togo.

Plantation forestry is negligible in countries with large tracts of natural forests.



Spread of planted forests in SSA.

Principles and types

Technical aspects of sustainable planted forest management:

- **Sustaining soil fertility:** confining harvesting of forest products to stem wood, use of soil conservation measures, and application of fertilizer, etc.
- **Proper harvesting planning,** e.g. careful re-use of extraction routes.
- **Selection of species:** diversity of trees enhances resilience to pests and diseases and to climate variability / change.
- **Natural corridors** to enhance biodiversity especially of industrial plantations.
- **Fire breaks** to limit the extent of fires, often combined with access roads.

Planted forests vary from strictly protected conservation forests to highly productive, short rotation plantations. In this continuum the boundary between different categories is often indistinct.

Plantations for industrial purposes are mainly 'fast-wood' plantations, and are intensively commercially managed. They are usually blocks of single species producing round wood at high growth rates - often initiated with government support or through corporate investment projects. They may also have an environmental protection rationale. To be sustainable, industrial plantations should provide fair job opportunities, consider the environmental aspects of monoculture plantations, not be established on productive agricultural land nor replace natural forests. Commercial industrial plantations may also focus on the production of non-wood forest products (NWFP) such as gum arabic. There is a recent trend towards plantations to lock up carbon in 'carbon-offsetting schemes'. One risk is of farm land being taken out of production for this.

Out-grower schemes bring in private landowners (individuals / communities) into wood production. Forest companies are guaranteed a steady supply without being involved in land acquisition, whereas out-growers profit from employment opportunities and income. Out-grower schemes have potential to contribute to rural wealth creation, resulting in smaller and diverse production units.

Plantations for energy production form a main source of fuelwood in SSA. Most of these fuelwood plantations are within the public sector and the maintenance is often relatively neglected. For sustainable management clear land resource use rights must be given to land users.

Environmental / protective plantations have the purpose of protection and provision of environmental stabilisation. They can decrease soil erosion, stabilise slopes, fix sand dunes, serve as windbreaks, etc. Usually they are initiated with government support or project funding. Environmental plantations are gaining more importance with the increasing awareness of desertification.

Farm / home plantations and woodlots can provide a substantial amount of fuelwood and timber. Trees may be within an agroforestry system, homestead gardens or woodlots. Woodlands around small-scale farms can protect against shortages of fuelwood and construction poles, can be used for fodder production or for NWFPs, and have the potential to produce industrial wood.

Wood is the most important energy source in SSA, and the pressure on wood resources rises. Therefore farm plantations should be encouraged and alternative renewable energy resources (wind, solar) and energy-saving stoves promoted.



Top: Watering nursery seedlings for desertification control, Senegal. (Lyes Ferouki)
Middle: Eucalyptus plantation for timber and fuelwood production, Ethiopia. (Hanspeter Liniger)
Bottom: Environmental protective plantations on steep slopes, Eritrea. (Mats Gurtner)

Applicability

Land degradation and causes addressed

Biological degradation: loss of biodiversity in monocultures

Physical soil deterioration: little soil cover and undergrowth can lead to sealing and crusting

Chemical soil deterioration: loss of soil nutrients due to short rotations of industrial plantations

Soil erosion: especially in fast growing and high rotation industrial plantations with insufficient soil cover, and during establishment and harvesting phases
Planted forests can rehabilitate badly degraded land, helping to restore protective and environmental functions.

Planted forests which are under government tenure are very often poorly managed and financially not viable, leading to illegal logging and fires.

Land use

Mainly forest and mixed land.

The species planted vary in different regions; overall, conifers account for 52 percent, broadleaves for 37 percent, and unspecified for 11 percent. In order of importance the main coniferous genera by area are *Pinus*, *Cunninghamia*, *Picea*, *Larix* and *Cryptomeria* whilst the main broadleaf genera are Eucalyptus, Acacia, Tectona, and Populus species.

The majority of the trees are exotics with emphasis on short rotation plantations, only little emphasis on growing valuable indigenous trees due to slow growth rate and low economic return.

Ecological conditions

Climate: Humid zones emphasis on high value industrial plantations. Plantations used for commercial purposes are not suitable for water scarce areas due to restricted water availability for fast growing tree species and their ability to deplete already dry soils. In the dry zone (e.g. Sahelian region) planted forests are mainly for fuelwood production and for providing improved environmental conditions (e.g. sand dune stabilisation, windbreaks, etc.).

Terrain and landscape: There are terrain restrictions for planted forests related to very steep slopes and respecting riparian buffer zones.

Soils: No restrictions.

Socio-economic conditions

Farming system and level of mechanisation: Commercial fuelwood and environmental plantations are often owned and managed by the public sector: little mechanisation is involved. Large-scale industrial plantations are usually managed with a high degree of mechanisation – especially for harvesting. Farm plantations can be found in highly populated areas where not enough fuelwood from public forests is available.

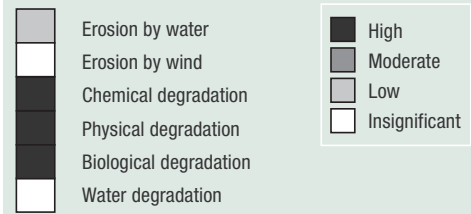
Market orientation: Very large-scale commercial industrial plantations; plantations providing fuelwood and timber for subsistence and some commercial use; small-scale farm plantations for subsistence and some commercial use.

Land ownership and land use / water rights: Plantations are mainly owned by governments, partly by large industrial corporations and some by individual farmers. Industrial plantations in SSA are more than 50% publicly owned and about 34% privately owned. Non-industrial plantations are 62% publicly owned and 9% privately owned, and 29% are unspecified. In South Africa plantations are mainly owned by companies and small growers.

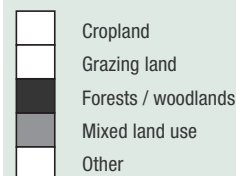
Skill / knowledge requirements: Theoretically a very high level of knowledge about the impacts of planted forests on the ecosystem is required.

Labour requirements: The establishment and the harvesting of large-scale plantations can be very labour demanding. Maintenance of farm plantations do not need much labour input.

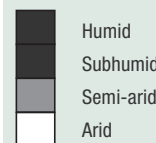
Land degradation



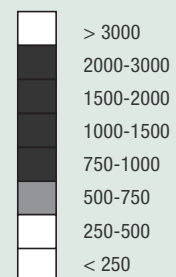
Land use



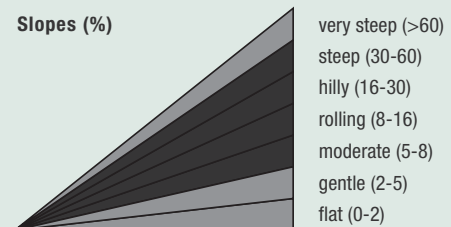
Climate



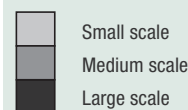
Average rainfall (mm)



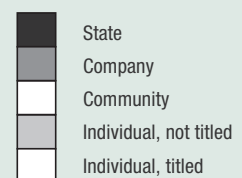
Slopes (%)



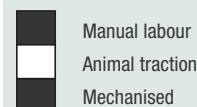
Farm size



Land ownership



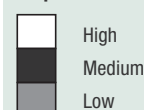
Mechanisation



Market orientation



Required labour



Required know-how



Economics

Establishment and maintenance costs

Establishment costs: The establishment of a new forest usually implies very high initial investments, especially if established on a large-scale.

The extra investments for a management change from an 'old' planted forest system to 'sustainable management' does not involve very high 'establishment' costs. Those are mainly related to the development of a management plan, resource rights, regulations, etc.

Seedling production: 500 US\$/ha

Land preparation, planting: ≈ 1,500 US\$/ha

Maintenance costs: Tending, maintenance, pest and fire control: 600 US\$/ha

Comment: It is very difficult to provide figures to the costs of planted forests. There are large differences by the type of planted forests, by initial conditions and by country.

Production benefits

Tree	Rotation length (year)	Productivity (m ³ /ha/year)
Eucalyptus		
Congo	7	30
Rwanda	8	8.5
South Africa	8-10	18-20
Pines		
Malawi	20-25	17
Madagascar	15-18	6-10
Mozambique	18-28	11

(Source: FAO, 2001)

Comment: The figures above show the rotation length and the productivity of different commonly used tree species in planted forests.

Benefit-Cost ratio

Planted forests (by purpose)	short term	long term	quantitative
Industrial	–	++	Benefit-cost ratio at 10% discount ratio, Ghana: Teak: 4.9 (<10 ha) Cedrela: 3.5 (<10 ha) Pine: 1.8 (<10ha)
Energy production	--	+	
Environmental	--	-/+	
Farm plantations	–	++	

-- negative; – slightly negative; -/+ neutral; + slightly positive; ++ positive; +++ very positive

(Source: FAO, 2002)

Comment: Generally there is very limited data available related to the benefit-cost ratio of planted forests. However, the internal rate of return achievable with well-managed planted forests ranges between 5 and 20% depending on soil fertility, topography, species choice, growth performance, incidence of pests and fire and market prices for timber.

Efficiency in plantation management and success in achieving sustainable wood supply depends mainly on whether a plantation is publically or privately owned, and how it is managed. It is important here to distinguish between *financially* well managed plantations and *sustainably* managed. Usually, privately owned, forest plantations are well managed in financial terms - being aimed at profit maximisation. In Southern Africa it has been demonstrated that privately owned plantations can be profitable due to the integration of the plantation with wood processing companies. Many public sector plantations are poorly managed in financial terms being not profit oriented; however, often they have environmental and social benefits as objectives, which are not quantifiable.

Example: Industrial wood production by small farmers in the central highlands of Kenya

Economic analyses of cropping and tree enterprises have been carried out in some locations in the central highlands of Kenya. The average gross margin from trees per farm per year was Kshs 57,808 (US\$ 734). This figure includes the contribution of coffee and tea, which was 65% of the total. Fruits contribute 28%, while timber and firewood contribute 8%. For 70-80% of the households the trees grown on farms function also as major sources of fuelwood. The remainder obtain their supply of firewood from neighbours or nearby forests. Following a temporary ban in 1999 on the sale of timber from government-owned forest plantations and natural forests, there has been an increase in the sale of timber from farms, and some farmers have formed associations to facilitate the marketing of timber. Accurate information on the profitability of this new timber enterprise is not available. However, the farmers also face many problems like lack of knowledge about tree management and market, permits needed for the felling and transport, etc. (Chamshama and Nwonwu, 2004).

Example: South Africa

Small-scale out-grower schemes in South Africa represent an investment of more than R 50 million (US\$ 7 million), which should generate revenues of about R 175 million (US\$ 24 million) for growers when the plantations are harvested. The small timber growers supplement their livelihoods with growing of food crops on the periphery of their woodlots. They make good profits and many have extended their operations from a single woodlot to three or four. Furthermore, the local community benefits from increased participation in the monetary market and from job opportunities created by the contracting by the companies of support services for planting, maintenance, harvesting and transportation. Small growers and rural communities also benefit from training programmes offered by the forest companies (Chamshama and Nwonwu, 2004).

SUSTAINABLE PLANTED FOREST MANAGEMENT

Impacts

Benefits	Land users / community level	Watershed / landscape level	National / global level
Production	<ul style="list-style-type: none"> +++ increased availability of fuelwood + diversification of production + increased availability of NWFP 	<ul style="list-style-type: none"> +++ reduced risk and loss of production +++ decreased pressure on natural forests + improved access to clean drinking water 	<ul style="list-style-type: none"> + improved food and water security
Economic	<ul style="list-style-type: none"> + job creation (depending on the previous land use) + increased and diversified household income of small-scale land users (through farm plantations) 	<ul style="list-style-type: none"> +++ less damage to off-site infrastructure ++ stimulation of economic growth ++ diversification and rural employment creation 	<ul style="list-style-type: none"> +++ improve livelihood and human well-being
Ecological	<ul style="list-style-type: none"> ++ improved soil cover ++ regulation of micro- and meso-climate ++ rehabilitation of degraded areas and restoring productive and environmental functions (e.g. due to over-grazing) ++ prevent soil erosion ++ used as windbreaks, shelterbelts, etc. ++ reduced pressure on farm manure ++ stabilisation of slopes, riverbanks, etc. ++ less nutrient mining than cropland + increased biodiversity + regulation of ground water (e.g. salinity) + increased soil organic matter and soil fertility 	<ul style="list-style-type: none"> +++ reduced degradation and sedimentation + intact ecosystem 	<ul style="list-style-type: none"> ++ reduced land degradation and desertification incidence and intensity ++ increased resilience to climate change ++ carbon sequestration (when applied on degraded land / soil)
Socio-cultural	<ul style="list-style-type: none"> +/- can help to preserve the social and cultural values attached to forests + community institution strengthening 	<ul style="list-style-type: none"> + increased awareness for environmental 'health' 	

	Constraints	How to overcome
Production	<ul style="list-style-type: none"> • Large-scale plantations are often monocultures 	<ul style="list-style-type: none"> → mixed plantations, with intercropping, use of natural corridors to enhance biodiversity, etc.
Economic	<ul style="list-style-type: none"> • Lack of markets and access to markets • Establishment of plantations can be expensive and often rely on donor funding • Long time period between planting and harvesting of trees with no or only limited income (especially a problem in out-grower schemes) • Availability of fertilizers (e.g. phosphorous) • Availability of land and competition with other land use (e.g. demand for cropland and grazing land) and land grab for establishment of industrial plantations for wood or NWFP can lead to a loss of agricultural land affecting small-scale land users with no clear land tenure • Can increase pressure on natural forests by replacing tree diversity with monocultures that flood the market with cheap / fast growing wood. 	<ul style="list-style-type: none"> → furthering the establishment of market and value chain → credit schemes for small-scale land users to establish farm plantations → providing of credits from timber companies → support for small woodlots and farm plantations and regulations for new plantations, assessment of the economic, environmental and social sustainability of new forests, ensure land use rights for small-scale users and promotion of out-grower schemes
Ecological	<ul style="list-style-type: none"> • Exotic tree species can spread at the expense of native forests, affecting the entire ecosystem • Water need: fast growing species can have a very high demand of water and can have an irreversible negative impact especially in water scarce areas • Plantations can have high water use leading to lower streamflows, etc. and strongly influence the hydrological system of an area • Water competition with crops e.g. eucalyptus trees and limited availability of water in dry areas • Susceptibility of planted forests to pest and diseases especially in plantations • Monoculture plantations can damage the ecosystem 	<ul style="list-style-type: none"> → appropriate selection of species → considering the demand for water of the selected species, take into account sensitive and water scarce areas → watershed management planning, considering off-site effects of plantations → select less competitive tree species (e.g. <i>Grevilla robusta</i>) with a reduced water demand and high water use efficiency, manage trees by pruning → diversification of species can remarkably reduce the risk to pest and diseases, maintaining optimum stocking levels
Socio-cultural	<ul style="list-style-type: none"> • Lack of know-how in management, species composition, improper establishment, etc. 	<ul style="list-style-type: none"> → needs good training and education in the proper management of planted forests

Adoption and upscaling

Adoption rate

There is an increase in the area of planted forests in SSA, the annual rate of planting in Africa is estimated to be about 194,000 ha. However, the adoption rate for sustainable management of planted forests is not known and is rather difficult to assess, since a clear delineation of what is sustainable and what is not, is very difficult. The out-grower scheme has been adopted with great success in Southern Africa (especially South Africa, Swaziland and Zimbabwe).

Upscaling

Policy framework: Forest management must be integrated into a coordinated national framework with a clear forest policy. The forestry sector needs to be strengthened, and formulation and implementation of national and sub-national sustainable forest policies and programmes are necessary.

Land tenure: Publicly owned and managed plantations tend to display low productivity. Public bodies should seek the involvement of the private sector (smallholders, communities, companies, etc.) to support and encourage the efficient financial management of planted forests.

Capacity building: Capacity building and good training in sustainable management of planted forests is needed for all stakeholders involved (e.g. smallholders, communities and forests services, commercial users).

Research: More research is required about the impacts of planted forests on water resources (decreasing or increasing water availability) and on biodiversity, for a better understanding of the behaviour of different tree species, etc. Knowledge and expertise should be enhanced - related also to suitable indicators for monitoring planted forest resources.

Timber market: (1) Small-scale land users and communities need to be empowered by improving their access to markets and market information; (2) Certification of planted forests provides an opportunity but needs clear regulations and standards for declaration of the source of wood, and also considers social and ecological aspects. (3) Promotion of the out-grower scheme, as a successful way for private landowners to participate in wood production.

Farm plantations: The establishment of farm plantations should be further promoted and supported through an enabling policy framework and financial incentive packages for private investors. Farm plantations can strengthen the economic situation of land users as well as reduce the pressure on natural forests.

Incentives for adoption

Incentives for the establishment of new planted forests are very often needed due to the long period before economic benefit is gained. However, only those afforestation projects which are known to be ecologically and socially viable should be financially supported. Incentives for private tree planting and the establishment of farm plantations should be created, since they can provide fuelwood and other woody products and decrease the pressure on natural forests. For the creation of new large-scale planted forests, e.g. for rehabilitation of degraded areas, investments either from donors or from the government / public sector are needed, and the involvement of local communities should be guaranteed.

Enabling environment: key factors for adoption

Inputs, material incentives, credits	+
Training and education	++
Land tenure, secure land use rights	+++
Access to markets	++
Research	+

Example: Ethiopia

The Government of Ethiopia has initiated collaborative plantation management programmes to address growing problems of illegal logging and forest encroachment by involving local communities. The government expects cooperation by allocating communities rights to establish and manage plantations for certain periods and by guaranteeing them a share in the profits from the timber. The guaranteed equal and fair profit-sharing agreements between state and community groups have attracted many smallholders to tree planting and can help strengthen the communities' commitment to sustainable forest management. Since the 1990s the government has increasingly granted community management rights favouring more community involvement in forest management, including planted forests, leading to some plantations allocated to communities. New regional land administration policies allow issue of landownership certificates to landholders, and owners have the right to lease their plots to others for up to 25 years; however, land still cannot be officially bought or sold (Nawir et al., 2007).

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CASUARINA TREE BELT FOR SAND DUNE FIXATION - SENEGAL

The *bande de filao*, a 200 m wide belt of *Casuarina equisetifolia* trees, was established along the Senegalese coast from Dakar to St.Louis, to protect the adjacent Niayes region from wandering sand dunes. The Niayes, a territory of 5-30 km width covering a surface of 4,200 km², is known for its favourable conditions for vegetable production. However, droughts, deforestation and overgrazing have caused gradual desertification and loss of stabilising vegetation cover on sand dunes. The dunes began to advance at a rate of up to 10-12 m per year and threatened villages and production areas.

The establishment of the tree belt started in the 1970s and continued until the late 1990s. The exotic nitrogen-fixing *Casuarina equisetifolia* was found to perfectly fit into the harsh ecological environment with its poor sandy soils, strong winds, shifting sand and proximity to the sea. Seedlings were raised in nurseries, then planted on a 2.5 x 2.5 m grid – protected by palisades and irrigated at the initial stage. The *filao* belt covers an area of about 9,700 ha and effectively halts wind erosion and movement of sand dunes, resulting in multiple positive impacts on the environment and the 120,000 people living in the area: it provides protection of villages, allowing vegetable production in inter-dunal depressions, and last but not least - builds up resources of wood. Without the tree belt, life in the Niayes would not be possible. Furthermore, wind speed was reduced also on the sea side, making inshore fishery possible during the whole year (before it was limited to 3 months).

The big challenge is to gradually replace the stands of *Casuarina* trees that have reached senescence (after approx. 30 years). A management plan has been developed to assure the continuity of this important protective system.



SLM measure	Vegetative
SLM group	Sustainable Planted Forests Management
Land use type	Forest (afforestation); Off-site land use: annual crops (vegetables) and fishery
Degradation addressed	Biological degradation: reduction of vegetation cover; Erosion by wind: loss of topsoil: uniform displacement, off-site degradation
Stage of intervention	Prevention and rehabilitation
Tolerance to climate change	Increased tolerance towards drought, floods, storms

Establishment activities

1. Initial protection with palisades (1 m high; 70 m from the coast; 1 year before planting).
2. Establish 0.5 m high palisades at a spacing of 10 - 20 m (depending on dune slope) perpendicular to wind direction; made of *Guiera senegalensis* on poles of *Euphorbia balsamifera* (before planting, November-June).
3. Enclosure: wire fence protects young plants from roaming animals.
4. Excavation of wells for watering of seedlings in nurseries and initial irrigation of the planted seedlings.
5. Production of seedlings in tree nurseries (January-February).
6. Plantations of seedling on a 2.5 x 2.5 m grid (1,600 plants/ha).
7. Guarding the plantation site (for protection of seedlings).

Maintenance / recurrent activities

1. Watering *filao*s during first year.
2. Guarding the plantation.
3. After 25-30 years replace the whole stand with new seedlings.

Labour requirements

For establishment: high
For maintenance: low (maintenance is needed only in 1st year after establishment; if high inputs for replacing the whole stand after 25-30 years are taken into account, overall maintenance is medium)

Knowledge requirements

For advisors: medium
For land users: high

Photo 1–2: Tree plantation in Lompoul. (Julie Zähringer)

Photo 3: *Casuarina* seedlings ready for planting (front), establishment of palisades to protect planted seedlings (middle), and a *Casuarina* plantation aged seven years (in the background). (Mailly et al. 1994)

Photo 4: Areal view: the tree belt protects not only the settlements and vegetable production areas in the south-west, but also the inshore area of the Atlantic ocean, making fishery possible all year round. (Google)

Case study area: Lompoul, Niayes, Senegal



Establishment inputs and costs per ha

Inputs	Costs (US\$)
Labour	no data
Equipment	no data
Agricultural inputs: 1600 seedlings	225
TOTAL	no data
% of costs borne by land users	0%

Maintenance inputs and costs per ha per year

Inputs	Costs (US\$)
Labour; Equipment; Agricultural inputs;	no data
TOTAL	no data

Remarks: Costs for establishment are high. All inputs were fully subsidised. Implementing agency was governmental 'Service des Eaux et Forêts' with funding from ACDI and USAID. Reestablishment starts after 25-30 years when trees reach senescence.

Benefit-cost ratio

Inputs	short term	long term
Establishment	slightly positive	very positive
Maintenance	slightly positive	very positive

Remarks: Land users emphasise that without the technology they would not be able to live in this area.

Adoption

The *Casuarina* tree was established along the littoral between St. Louis and Dakar, covering an area of 97 km². Project support included provision of tree seedlings, technical assistance and rewarding labour. High establishment costs make a spontaneous spread of the technology difficult.

Ecological conditions

- Climate: semi-arid
- Average annual rainfall: 250-300 mm
- Soil parameters: low soil fertility, low organic matter content (< 1%); sandy texture, good infiltration and drainage, low storage capacity
- Slope: no data
- Landform: sand dunes (slopes and interdunal depressions)
- Altitude: < 100 m a.s.l.

Socio-economic conditions

- Size of land per household: no data
- Type of land user: poor medium-scale land users; technology is implemented in groups / by community
- Population density: 65 persons/km²
- Land ownership: state / individual (not titled)
- Land use rights: communal (organised)
- Level of mechanisation: manual labour / animal traction / mechanised
- Market orientation: mainly subsistence (forest land)

Production / economic benefits

- +++ Increased wood production
- +++ Increased production of litter used as mulch and for composting by vegetable farmers or by fishermen to smoke fish

Ecological benefits

- +++ Reduced wind velocity
- +++ Reduced soil loss
- +++ Increased biomass
- ++ Increased soil organic matter / below ground carbon
- ++ Reduced hazard towards adverse events (drought, floods, storms)
- ++ Increased soil cover (with litter)
- ++ Improved carbon storage

Socio-cultural benefits

- ++ Increased recreational opportunities
- ++ Community institution strengthening

Off-site benefits

- +++ Reduced wind transported sediments
- +++ Sand dune stabilisation
- +++ Improved vegetation cover
- +++ Making establishment of settlement possible in the region
- +++ Making horticulture possible in the region
- +++ Making fishery possible all year round and therefore creating an additional income source
- +++ Reduced damage on public / private infrastructure
- +++ Reduced damage on neighbours fields

Remark: The technology focuses on off-site benefits!

Weaknesses → and how to overcome

- High establishment costs for large scale plantations.
- *Casuarina equisetifolia* trees reach senescence after 30-50 years and do not regenerate naturally → plantation activities need to be taken up again; In the hinterland reforestation with local *Cocos* should be tried.
- Increased demand for irrigation water.
- Making all year round fishery possible and therefore loosing labour force for vegetable cultivation.
- Increased amount of plastic waste (due to attraction of tourists).

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AFFORESTATION AND HILLSIDE TERRACING - ERITREA

Tree plantations in combination with hillside terracing to protect upper catchment areas are a widespread technology in the Central and Northern Highland Zone of Eritrea. In the early 1990s a large area was treated in the Toker catchment, northwest of Asmara. The first step was to establish hillside terraces on the steeper slopes where it is essential to conserve soil and water for improved growth of trees and other vegetation. The terraces comprise earthen embankments laid out along the contour, reinforced with stone risers, combined with a trench on the upper side to harvest runoff water. The trenches are subdivided into basins (by ties) to avoid lateral flow of runoff water. In a second step, trees were planted at a spacing of 2 m (in the trenches).

Mostly fast growing eucalyptus was used, with a very small percentage of the indigenous African olive (*Olea africana*) - which has good survival rates but grows very slowly. Afforested areas are closed for any use until the trees reach maturity: they are protected by guards. In 1995, the Ministry of Agriculture handed over user rights to communities allowing cut-and-carry of grass and cutting of trees (with permission of the government).

The technology requires appreciable expense, labor and expertise, but if maintained well, it results in multiple ecological and economic benefits: Soil cover has improved, water is conserved, the severe problems of soil erosion have been reduced, and dams further downstream are protected from siltation. Trees have become an important source of income for the rural communities, wood is a valuable resource mainly needed for construction, and also as fuel.

Since the 1960s, several afforestation campaigns have been initiated by the government, mainly using food-for-work or cash-for-work approaches as incentives. Nowadays, local tree planting initiatives (on community or individual level) without external support are dominant.



SLM measure	Vegetative and structural
SLM group	Sustainable Planted Forest Management
Land use type	Plantations, afforestation
Degradation addressed	Surface and gully erosion; Decline of vegetation cover, diversity and biomass; Loss of surface water; Lowering of ground water level
Stage of intervention	Rehabilitation
Tolerance to climate change	Sensitive to climatic extremes (e.g. rainfall decrease, especially in case of monocultures)

Establishment activities

1. Mark contour lines using a line level. Spacing between terraces depends on slope, vegetation status, soil depth. In the case study area horizontal spacing between terraces is 2.5 m.
2. Terraces are built (inward-sloping) by digging out trenches (0.5 m deep) and piling up risers (minimum 0.75 m high). Risers should be reinforced with stones (where available).
3. The trenches are separated into basins by ties at an interval of 2-5 m to avoid eventual lateral movement of water.
4. Dig planting pits (0.5 x 0.5 x 0.5 m), at 2 m intervals, in the trenches.
5. Plant tree seedlings (mainly eucalypts, some African olives); fill pit with top soil (optional: mix with 1 spade of manure).
6. Spot weeding and softening soil around the pits to improve percolation of water and soil aeration (during rainy season).
7. Supplementary irrigation during dry spells (using jerry / watering cans).
8. Prohibit open grazing. Area closure is done collectively.

All activities are carried out manually.

Maintenance / recurrent activities

1. Maintenance of structures (before onset of rainy season).
 2. Replacement of missing plants at onset of rains (10% replacement of seedlings is expected in the 1st year).
 3. Spot weeding and softening soil.
 4. Supplementary irrigation.
- All activities are carried out manually.

Labour requirements

For establishment: high
For maintenance: low

Knowledge requirements

For advisors: medium
For land users: high

Photo 1: Construction of hillside terraces: trees will be planted in the ditches at a spacing of 2 meters between plants. (Fikreyesus Ghilay)

Photo 2: An upper catchment area protected by hillside terraces and tree planting in the Central Highlands of Eritrea. (Mats Gurtner)

Case study area: Serejeka, Central Highlands, Eritrea



Establishment inputs and costs per ha

Inputs	Costs (US\$)
Labour: 660 person-days	1,760
Equipment / tools: hand tools	50
Agricultural inputs: seedlings and transportation	600
Construction material: stones (locally available)	0
TOTAL	2,410
% of costs borne by land users	73%

Maintenance inputs and costs per ha per year

Inputs	Costs (US\$)
Labour: 180 person-days	480
Equipment / tools: specify	0
Agricultural inputs: seedlings and transportation	100
TOTAL	580
% of costs borne by land users	83%

Remarks: Labour costs include construction of hillside terrace, pitting, planting and spot weeding and cultivation. According to the work and payment norms of the Ministry of Agriculture the cost of 1 person-day is US\$ 2.66. Production cost of one seedling is US\$ 0.2. Maintenance costs include terrace maintenance, re-pitting and replanting of seedlings. Costs are calculated for gentle slopes with terraces spaced at 2.5 m.

Benefit-cost ratio

Inputs	short term	long term
Establishment	slightly negative	very positive
Maintenance	neutral	positive

Remarks: Initial labour inputs payout on the long term.

Ecological conditions

- Climate: semi-arid
- Average annual rainfall: 400 -450 mm
- Soil parameters: low fertility; shallow depth; low organic matter content; sandy-loam texture
- Slope: more than 50%
- Landform: hill slope, mountain slopes, ridges
- Altitude: 2,300 - 2,400 m a.s.l.

Socio-economic conditions

- Socio-economic conditions
- Size of land per household: 0.5-1 ha cropland and 0.01-0.05 ha forest land
- Type of land user: small-scale, poor, land user groups
- Land ownership: state
- Land use rights: communal (organised)
- Level of mechanisation: manual labour and animal traction
- Market orientation: subsistence (self-supply), partly mixed (subsistence and commercial)

Production / economic benefits

- +++ Increased wood production
- +++ Increased fodder production (cut-and-carry of grass)
- +++ Diversification of income sources (selling timber and grass)

Ecological benefits

- +++ Improved soil cover; increased biomass / above ground carbon
- +++ Reduced surface runoff
- +++ Reduced soil loss
- ++ Increased soil moisture
- ++ Increased soil organic matter
- ++ Recharge of ground water

Socio-cultural benefits

- +++ Community institutions strengthened
- +++ Improved food security / self sufficiency
- +++ Improved conservation / erosion knowledge
- ++ Conflict mitigation
- + Increased recreational opportunities

Off-site benefits

- +++ Reduced downstream flooding and siltation
- + Increased stream flow in dry season

Weaknesses → and how to overcome

- Establishment cost is high and labour-intensive → provision of hand tools and demanded seedlings.
- Fast growing eucalyptus trees have a high rate of water consumption; Indigenous trees are not favoured → encourage people to protect naturally regenerated indigenous trees, assist villagers to get market channels for products of indigenous trees.
- Community mobilisation and high knowledge of land users is required → awareness raising campaigns, strengthen village institutional arrangements, assist villages by-laws.
- Land use rights: because the afforestation area is communal, nobody feels responsible for maintenance → promote plantations by individual households.

Adoption

Acceptance of afforestation areas has increased, since user rights have been given to land users: Communities located in Toker upper catchment areas have taken the initiative to maintain and protect their woodlots. Moreover, there is a trend toward locally initiated hillside terracing and tree planting without external initiative / incentives, apart from the provision of seedlings (through Ministry of Agriculture). The afforestation area covers approx. 30 km² with high potential to enlarge.

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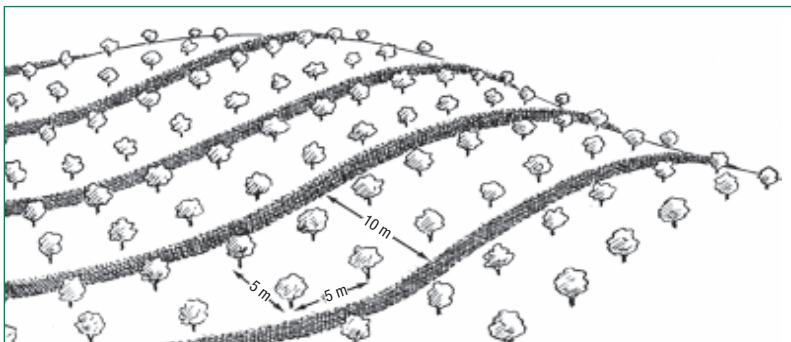
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SAND DUNE STABILISATION - NIGER

Stabilisation of mobile sand dunes is achieved through a combination of mechanical measures including palisades, and biological measures such as live fences and sowing of grass. These measures seek to stop sand encroachment and stabilise sand dunes on-site, in order to protect villages, cultivated land, roads, waterways and other infrastructure. The technology is currently applied on a very large-scale in the Niger river basin.

Palisades are made either of millet stalks, or doum or date palm fronds, according to availability in the region. They are established in a perpendicular direction to the wind, at a spacing of 10 – 20 meters depending on severity of sand encroachment and level of land degradation. The closer the spacing, the more effective is the protection. Tree seedlings or cuttings are planted on a 5 m x 5 m grid, with a density of 400 trees per hectare. Species include *Euphorbia balsamifera*, *Prosopis chilensis*, *Ziziphus mauritiana*, *Acacia senegal* and *Bauhinia rufescens*. Grass seeds are broadcasted.

The increasing speed at which desertification is progressing in Sahelian countries makes this technology one of the main instruments for combating the impacts of climate change. Land that has been sown with grass needs to be enclosed in the early years to avoid interference by animals.



SLM measure	Structural and vegetative
SLM group	Sustainable Planted Forest Management
Land use type	Agro-silvopastoral
Degradation addressed	Desertification; Soil erosion by wind and water; Biological degradation
Stage of intervention	Prevention (partly mitigation)
Tolerance to climate change	Tolerant to temperature increase and rainfall decrease, but sensible to droughts and floods

Establishment activities

1. Preparation of tree cuttings or seedlings.
2. Preparation of palisades made either of millet stalks, *Leptadenia pyrotechnica*, or doum or date palm fronds, according to availability in the region.
3. Marking of planting lines perpendicular to wind direction.
4. Preparation of soil (April-May): dig holes for the cuttings or seedlings.
5. Dig trenches for the palisades.
6. Set up the palisades (spacing: 10 m).
7. Transport cuttings or seedlings to the sites.
8. Planting of cuttings or seedlings (spacing: 5 m).
9. Sowing of grass.
10. Spreading of manure (for grass and trees).

Maintenance / recurrent activities

1. In the first years: weeding and protection against animals, maybe using enclosure of land that has been sown with grass seeds.
2. Replacing of missing plants.
3. Strengthening of palisades and replacing those that have been destroyed.
4. Regular trimming of trees and shrubs to reduce competition with agricultural crops.

Labour requirements

For establishment: high
For maintenance: high

Knowledge requirements

For advisors: low
For land users: moderate

Photo 1–2: Palisades with growing vegetation.

Photo 3: Two SLM experts examine a sand dune in the Niger river basin near Niamey. (All photos by Moussa Inja).

Drawing: Layout of palisades and tree planting for sand dune stabilisation. (Ministry for Agricultural Development, Niger)

Case study area: Kareygorou, Tillabéry, Niger



Establishment inputs and costs per ha

Inputs	Costs (US\$)
Labour: 75 person-days	113
Palisades: 1,000 bundles	200
Agricultural inputs:	
- Seedlings / cuttings (400)	80
- Organic manure (1.5 t)	75
Transport: palisades, seedlings and organic manure	200
TOTAL	668
% of costs borne by land users	100%

Maintenance inputs and costs per ha per year

Inputs	Costs (US\$)
Labour: 10 person-days	15
Palisades: 15 bundles	3
Agricultural inputs: seedlings (20)	4
TOTAL	22
% of costs borne by land users	100%

Remarks: Figures are based on estimates. Costs for seedlings / cuttings are indicated for *Euphorbia balsamifera*. For other tree species costs need to be doubled or tripled (higher production costs at the nursery).

Benefit-cost ratio

Inputs	short term	long term
Establishment	positive	very positive
Maintenance	positive	very positive

Remarks: The technology is efficient in the mid to long term when it supports natural regeneration of ecosystems. In the Niger River basin, however, the benefits are lower.

Ecological conditions

- Climate: semi-arid
- Average annual rainfall: 250-500 mm
- Soil parameters: good drainage; low soil organic matter
- Slope: high dunes with steep slopes (> 20%)
- Landform: mainly dunes
- Altitude: 0-100 m a.s.l.

Socio-economic conditions

- Size of land per household: 1-2 ha
- Type of land user: mainly poor land user groups / community
- Population density: 10-50 persons/km²
- Land ownership: mostly individual, untitled
- Land use rights: individual, communal (organised)
- Market orientation: mostly subsistence (self-supplying), partly mixed (subsistence and commercial)
- Level of mechanisation: manual labour

Production / economic benefits

- +++ Increased crop yield (indirectly; through protection from moving sand dunes)
- +++ Increased farm income
- +++ Increased animal production
- +++ Increased fodder quality and fodder production

Ecological benefits

- +++ Increased soil cover
- +++ Increased biomass / above ground carbon
- +++ Reduced wind velocity
- +++ Reduced soil loss
- +++ Increased animal diversity
- ++ Increased soil fertility

Socio-cultural benefits

- +++ Conflict mitigation
- +++ Strengthening of community institutions through mutual help with technology implementation
- +++ Improved cultural opportunities

Off-site benefits

- +++ Less damage on public / private infrastructure
- +++ Less damage on neighbours' fields
- +++ Less wind-transported sediments

Weaknesses → and how to overcome

- Implementation constraint: high implementation costs → improve access to technical and financial support.
- Maintenance constraint: the nature of the land discourages people from maintaining the established measures → establish management committees for maintenance of the implemented measures.
- Labour constraint: the technology requires high input in terms of labour → strengthen community work and solidarity between communities.
- Ecological constraint: negative impacts on existing *Leptadenia* plants due to excessive cutting for palisades → find other species for making the palisades.
- Legal constraint: conflicts arise when land is claimed by people → define tenure before land is claimed.

Adoption

Spontaneous adoption of the technology is growing because desertification is in progression and sand dunes endanger people's livelihoods.

Main contributors: Abdoulaye Sambo Soumaila, Groupe de Recherche d'Etude et d'Action pour le Développement (GREAD), Niamey, Niger; leffnig@yahoo.fr

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SUSTAINABLE FOREST MANAGEMENT IN DRYLANDS



Natural dryland forest with high biodiversity, Tanzania. (Hanspeter Liniger)

In a nutshell

Definition: Sustainable Forest Management (SFM) in drylands aims to ensure that the goods and services derived from the forests meet present-day needs, while at the same time securing their continued availability and contribution to long term development.

In Sub-Saharan Africa, forests and trees contribute significantly to rural livelihoods in the drylands accounting for more than 25% of rural household income. Forests have multiple functions and uses. They play a significant role in conservation of biodiversity adapted to the harsh ecological conditions. They provide ecosystem goods including fruits, gum arabic, shea nut (*karité*) butter, fodder for livestock, medicines and provide services such as desertification control, conservation and improvement of water quality. However they are relatively fragile and easily affected by drought, erosion, fires, browsing, and particularly, cutting for firewood. Forestry needs to be part of a comprehensive and sustainable land use planning and management strategy, and there is an urgent need for the forestry sector to show clear commitment and to work with other sectors in improving and designing appropriate policies and mechanisms. In addition SFM in drylands has to move towards participatory and community-based management with an integrated landscape planning approach.

SFM in drylands includes actions aimed at safeguarding and maintaining the forest ecosystem and its functions, reduced deforestation, fire management, restoration through natural regeneration or assisted natural regeneration, selective tree planting and felling. Main techniques used for sustainable management are: spatial zoning for various users, restricted interventions, protective measures, best practice in non-wood forest products harvesting, grazing management planning and improved governance.

Applicability: SFM is applicable to, and crucial for, any type of primary or secondary forests in the drylands.

Resilience to climate variability: SFM for forest diversity is a prerequisite to ensure a functioning ecosystem, and to maintain resilience to climate variability and change. A well-managed and diverse natural forest can adapt better to changes.

Main benefits: Protection of biodiversity, protection against water and wind erosion, improved water management and quality, improved livelihoods and human well-being through income diversification (e.g. beekeeping, ecotourism, etc.) and hence increased food security and poverty alleviation as well as improved governance. Hindering further deforestation and expanding the restoration of natural forests can provide an immense contribution to CC mitigation and adaptation.

Adoption and upscaling: A legal and institutional framework, including the integration of forests in overall sustainable landscape and rural development planning is needed in order to ensure a sustainable use of forest resources in drylands, and sustainable provision of the related social, economic and environmental goods and services.

Development issues addressed

Preventing / reversing land degradation	+++
Maintaining and improving food security	+
Reducing rural poverty	++
Creating rural employment	++
Supporting gender equity / marginalised groups	++
Improving crop production	+
Improving fodder production	++
Improving wood / fibre production	++
Improving non wood forest production	+++
Preserving biodiversity	+++
Improving soil resources (OM, nutrients)	+++
Improving of water resources	++
Improving water productivity	++
Natural disaster prevention / mitigation	+++
Climate change mitigation / adaptation	+++

Climate change mitigation

Potential for C Sequestration (tonnes/ha/year)	no data
C Sequestration: above ground	++
C Sequestration: below ground	++

Climate change adaptation

Resilience to extreme dry conditions	++
Resilience to variable rainfall	+++
Resilience to extreme rain and wind storms	+++
Resilience to rising temperatures and evaporation rates	++
Reducing risk of production failure	+++

Origin and spread

Origin: The sacred character of many forests helped to conserve them, as part of traditional community resource management systems. Forest degradation and deforestation began during the colonial era. Responses to degradation of forests also started during these times. As pressure on forests has increased, because of population growth, efforts were made to create protected forest areas. In the 1970s and 1980s many countries - with donor support - attempted to bring more forests under state tenure and protection. In recent times sustainable forest management based on community plans has been given increasing priority in the drylands of SSA. Successes are still only at the pilot stage.

Spread: 582 million ha are covered by forests in SSA of which 270 million ha (46%) are dry forests. Approximately 5% of Africa's forests are protected. However, protected areas are often still destroyed by illegal logging and overuse. No clear data is available about the spread of SFM in drylands, but it is only a very small area.

Dry forests are mainly situated in: Angola, Botswana, Burkina Faso, Cameroon, Central African Republic, Chad, Congo, DRC, Ethiopia, Gabon, Guinea, Kenya, Lesotho, Madagascar, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Senegal, South Africa, Sudan, Swaziland, Tanzania, Uganda, Zambia, Zimbabwe.

Principles and types

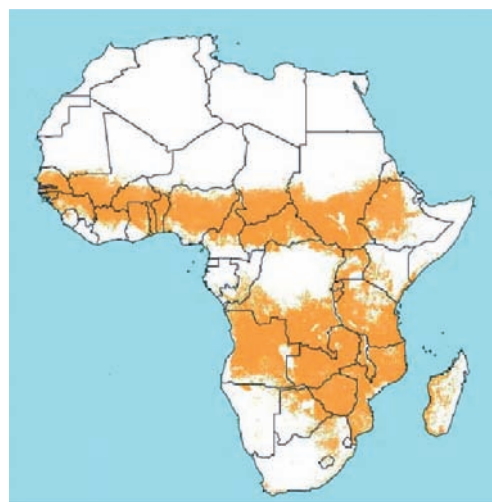
Securing forest resources: National and local forest authorities need to be strengthened to assess, maintain and protect the remaining forest resources. Protected areas must be safeguarded through adhering to laws and regulations for effective management. The delimitation of forests should be made clear, and sufficient cropland made available to people neighbouring the forests. Simultaneously, productivity of cropland and grazing land need to be improved to reduce pressure on the natural forests. Plans must correspond to the ecological, economic and social concerns of the people living within and around the area: thus community-based approaches and management plans are the most promising way forward. Compensation to communities – ideally through judicious rights to forest products - can be considered as a means for ensuring sustainable use of the resources.

Maintaining or enhancing biodiversity: Building better knowledge of forest ecology can help to preserve their biodiversity. Capacity needs to be strengthened to conduct biological inventories and a monitoring system of forest condition. There is also a need to include fauna within the forest in management decisions.

Promoting healthy and vigorous forests and rehabilitating forests: The health of overused forests can be improved through the adoption of adaptive forest management, including aspects such as review of rotation length, enhancement of natural regeneration (e.g. social fencing), enrichment planting, selective felling and controlled logging. Upgrading species diversity and richness are also a means to improve 'forest productivity', and to ensure high value production in a well managed natural forest.

Fire management: Knowledge and awareness raising about fire (incidence and behaviour) and how to avoid uncontrolled fires is key in successful prevention. Lack of funding and of sustainable fire management strategies are prominent in SSA. Fire management is largely an agricultural issue, and therefore the key is to involve the agricultural sector in the controlled use of fire. Monitoring and reporting mechanisms should be established, and the regional collaboration that started through AfriFireNet should be built upon.

Alternative livelihoods options help reduce unsustainable felling and logging activities. Non-wood forest products (NWFP) provide a sustainable input to peoples' welfare. NWFP can be honey from beekeeping, mushrooms, medicinal plants, shea nut butter (from *Vitellaria paradoxa*) for the cosmetic industry, gum arabic (from *Acacia senegal*), baobab for ropes and baskets, etc. New niche markets for 'green' and 'fair trade' products and payments for ecosystem services provide new income opportunities for forest users (see group Trends & new Opportunities).



Spread of dry forests in SSA. (Source: CIFOR, 2006)



Top: Fencing of dryland forests for natural regeneration, Burkina Faso. (NewTree)

Middle: Women carrying gathered fuelwood, Senegal. (Roberto Faidutti)

Bottom: Close-up of shea nuts (karité) ready to be processed, Burkina Faso. (Roberto Faidutti)

Applicability

Land degradation and causes addressed

Dryland forests are fragile and are affected by drought, degradation / deforestation and desertification. The main direct and indirect drivers include: population increase, growing demand for resources (grazing, cultivation, urban development, logging, etc.), poverty, social conflict, lack of market opportunities, no recognition of the importance of dryland forests, lack of appropriate policies, governance and investment, lack of integration among different sectors, lack of technical capacity etc. All these drivers are potentially exacerbated by climate change.

Biological degradation: loss of forest ecosystem, loss of biodiversity, followed by physical and chemical soil deterioration and water degradation.

The loss of natural forests in the drylands is immense and the trend still continues. Annual loss of natural forests - between 1.2% and 1.7% - is highest in West and Southern Africa.

Land use

Primary and secondary forests can be defined as natural forests. Dry forests cover a spectrum of vegetation types from deciduous forests with a continuous tree canopy to moist savannas, dry deciduous woodlands, dry savannas and very dry scrub (bush, brousse). Dry forest landscapes are very variable, with crop lands, grazing lands and woodlands existing side-by-side.

Dry forests are used as mixed land for agricultural production and grazing. Beside wood products such as fuelwood and building material, non-wood forest products used are honey, mushrooms, fruits, medicinal plants, spices, shea nut butter, gums, fodder, tree bark, etc.

Ecological conditions

Climate: scarce and unreliable rainfall with long dry spells; dryland forests cover arid, semi-arid and subhumid areas.

Terrain and landscape: no restrictions, however in many countries (e.g. Ethiopia) forests have been reduced to marginal areas like steep hills, etc.

Soils: no restrictions

Socio-economic conditions

Farming system and level of mechanisation: Sustainable management mainly on small-scale basis, mainly manual labour (e.g. hand felling) and low level of mechanisation.

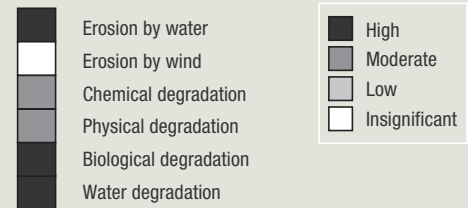
Market orientation: Subsistence to commercial system, by selling non-wood and or wood products on local market and also for increasing national / global market for special high value niche products.

Land ownership and land use / water rights: Land ownership is mainly state: some forests are on customary and trust lands, and may be managed through agreements with the chiefs or local councils on behalf of communities. Forests on private land are very limited with exceptions in South Africa and Zimbabwe. The areas of forests jointly managed with local communities or under the full responsibility of local communities are very limited. Open access forests and woodlands give rise to problems with destructive forest resource use.

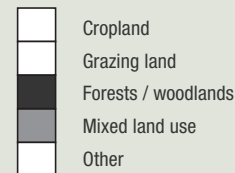
Skill / knowledge requirements: Sustainable forest management requires a high level of technical knowledge. Sound education of forest management services for supporting the land users in the sustainable use of the forests resources is needed.

Labour requirements: Labour requirements vary depending on the interventions needed (see principles and activities).

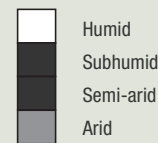
Land degradation



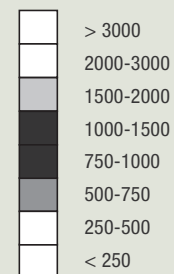
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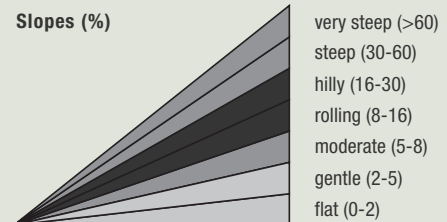
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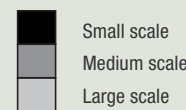
Average rainfall (mm)



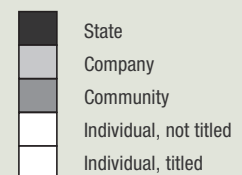
Slopes (%)



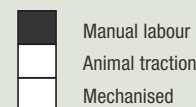
Farm size



Land ownership



Mechanisation



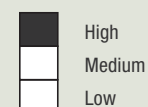
Market orientation



Required labour



Required know-how



Economics

Costs

Since Sustainable Forest Management (SFM) is mainly a management and organisational issue, the assessment of costs for establishment and maintenance is limited.

Production benefits

Apart from wood, natural forests provide a huge variety of products (non-wood forest products), which makes it difficult to quantify the production benefits of sustainable management in dryland forests. Recent studies are helping to put a price on the full range of forest goods and services. However research is needed on the value of environmental services such as water quality and supply, soil retention and fertility, carbon storage, and conservation of biodiversity, among other aspects. Furthermore, methodologies are required to calculate the direct or indirect cost of unsustainable forest management for comparison.

Benefit-Cost ratio

	short term	long term	quantitative
Community based forest management	–	++	No data available

-- negative; - slightly negative; +/- neutral; + slightly positive; ++ positive; +++ very positive;
(Source: FAO, 2002)

An estimated 65% of the population of Sub-Saharan Africa is rural and depends directly or indirectly on forests and woodlands for food, fuelwood, building materials, medicines, oils, gums, resins and fodder. The World Bank estimates that forests generate at least 20% of the disposable income of landless and poor families (WFSE, 2009).

Communities must be willing and economically able to involve themselves in sustainable forest management - they must receive greater economic benefits from conserving forests than from degrading them. Sustainable natural forest management should tangibly improve local economic welfare, and generate local economic benefits to sufficient levels, and in appropriate forms, to make SFM economically sound in the drylands also.

Since SFM is not yet widespread in SSA, it is difficult to make a realistic assessment of the economic aspects of natural forest management and the probability of change to sustainable management during the next two decades.

A mechanism for Reducing Emissions from Deforestation and Degradation (REDD), currently under negotiation, may provide incentives to reduce emissions from forests.

Example: Burkina Faso

The Kaboré Tambi National Park is situated approximately 100 km south of Ouagadougou in the south-central part of Burkina Faso, and covers 155,000 ha. Nine villages surrounding the park were surveyed, and 298 households completed a survey in 2008. Land cover in the park mainly consists of open forest with patches of savanna. The contribution of non-timber forest products to the rural household income was analysed. Fuelwood is the most important product collected from the forest: it accounts for 28% of household environmental and forest income on average. Fruits and shea nuts from *Vitellaria paradoxa* are the second most economically important wild forest product in the survey area (21%). Grass for roof thatching is another important non-timber forest product in the region, contributing 14% of household environmental and forest income. While fuelwood and thatching grass are mostly used for subsistence at the household level (86% and 84%), shea nuts and fruits are mainly source of cash income (66%) (CIFOR, 2008).

Example: Making Shea butter, Ghana

The production of shea butter is an important income earning activity for women in rural areas. Shea trees (*Vitellaria paradoxa*) grow wild in the semi-arid parts of the equatorial belt of central Africa. Shea butter is made out of the kernels and is used for cooking and for cosmetic purposes. The butter is increasingly valuable as an export commodity. However, lack of group business and management skills, competition from large-scale enterprises, inflation, and international commodity price fluctuations may hinder successful implementation of the technology. Bridge presses can now be used to mechanically extract shea butter and reduce the workload needed as they are easy to operate. The presses can be locally made and serviced. Although costs of processing by the improved and traditional methods are comparable, the benefits of the new technology are environmental (no need for fuel), time-saving (releasing time for other activities) and process simplification. However, the profitability of the shea butter production depends very much on high market prices (TECA-FAO, 2010).

SUSTAINABLE FOREST MANAGEMENT IN DRYLANDS

Impacts

Benefits	Land users / community level	Watershed / landscape level	National / global level
Production	<ul style="list-style-type: none"> ++ diversification of production ++ enhanced long term forest productivity ++ increased production of NWFP + increased wood production 	<ul style="list-style-type: none"> +++ reduced risk and loss of production + improved access to clean drinking water 	<ul style="list-style-type: none"> + improved food and water security
Economic	<ul style="list-style-type: none"> ++ provides a wide range of wood and non-wood products ++ income diversification + increased farm income 	<ul style="list-style-type: none"> +++ less damage to off-site infrastructure ++ diversification and rural employment creation (e.g. ecotourism) + stimulation of economic growth 	<ul style="list-style-type: none"> + improved livelihood and well-being
Ecological	<ul style="list-style-type: none"> +++ improved protection of forest species and habitats +++ rehabilitation of natural forests +++ improved micro-climate +++ biodiversity enhancement ++ helps to maintain soil and hydrological systems (e.g. clean water) ++ reduced soil erosion (by wind / water) ++ reduced wind velocity and dust storms ++ less frequent uncontrolled forest fires ++ increased soil organic matter and soil fertility ++ improved forest cover + improved water availability 	<ul style="list-style-type: none"> +++ reduced degradation and sedimentation ++ water availability ++ water quality ++ intact ecosystem 	<ul style="list-style-type: none"> +++ reduced degradation and desertification incidence and intensity +++ increased resilience to climate change ++ reduced C emissions ++ increased C sequestration ++ enhanced biodiversity
Socio-cultural	<ul style="list-style-type: none"> +++ community institution strengthening ++ less conflicts among different users ++ improved SLM / conservation / erosion knowledge 	<ul style="list-style-type: none"> +++ increased awareness for environmental 'health' +++ attractive landscape ++ reduced conflicts 	<ul style="list-style-type: none"> +++ protecting national heritage

	Constraints	How to overcome
Production	<ul style="list-style-type: none"> • Restricted short-time use ('exploitation') of forests can have negative effect on income 	<ul style="list-style-type: none"> → awareness of long term benefits and increase of other valuable ecosystem services provided through natural forests
Economic	<ul style="list-style-type: none"> • Inadequate budget for fire management • Availability of market for non-woody products and ecotourism 	<ul style="list-style-type: none"> → integration of fire management into overall forest management plan → support the diversified production and establishment of markets for NWFP and ecotourism
Ecological	<ul style="list-style-type: none"> • Impossibility of reconstituting forests exactly as they were 	<ul style="list-style-type: none"> → promote the role of secondary forests and allow most suitable conditions for regeneration towards natural forests
Socio-cultural	<ul style="list-style-type: none"> • Increasing population leading to increased demand on fuelwood • Fire management: weak capacity and social and political environments that do not sufficiently enable or empower the affected population to deal with the fire problem • Political constraints: secure land tenure of communities is often not given and regulatory constraints, with modern and customary laws that are often in conflict • Poverty leading directly to indiscriminate extraction of forest resources • Knowledge is inadequate, scattered and poorly disseminated in many of the spheres involved in sustainable forest resource management • Lack of knowledge in terms of appropriate techniques to ensure sustainability and on the current state of forest resources 	<ul style="list-style-type: none"> → promote alternative renewable energy resources (wind, solar) and energy saving stoves, establishment of home woodlots → allocation of land use rights as well as training and education in fire prevention and management → allocation of land use rights and consolidating / harmonisation of legal situation including customary laws → supporting poor communities in and around forests to improve their livelihoods and make them independent from destructive forest use, introduce alternative income options through non-woody forests products (e.g. beekeeping) or ecotourism → compilation and exchange of experiences made with SNFM, learning from others and capacity building of both government staff and community members → better linkages to research and regular monitoring and reporting about state of natural forests

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Adoption and upscaling

Adoption rate

The adoption rate of SFM in drylands tends to be very slow, and despite various efforts, sustainable management is not in place in most countries. However, in some areas of dry forests of savanna woodlands, progress has been made in this regard. Most of these areas are under community control.

Upscaling

The following aspects need to be considered for adoption and upscaling:

Legal and institutional framework: Integration of forest planning in an overall sustainable landscape planning approach, including all sectors from agricultural, pastoral, urban / rural and forest systems, is needed. Government and local administration must create enabling conditions for the establishment of proper SFM frameworks with clear regulations and control mechanism.

Legal titles, or at least confirmed land-use rights, are a prerequisite for villagers to define their forests boundaries and for community-based forest management.

Community-based approaches: Communities must be enabled to establish a clear management plan. Clear regulations and control mechanism need to be developed by forest services and local communities for the sustainable use of forests, and to avoid illegal use of the forests.

Awareness raising, education and capacity building: Local forestry services, land users and communities should be appropriately trained. Improved understanding of forestry issues through stakeholder meetings, user-friendly materials, documents in local language etc. is needed. It is necessary to become organised, coordinate efforts, share information and develop campaigns so that the governments adopt enabling policies, and to make sure people are informed about benefits of SFM.

Inventories and long term monitoring: Knowledge and expertise should be enhanced to assess and monitor forests and tree resources systematically.

Research related to SFM: This includes better knowledge of forest pests and diseases, and conditions related to adoption and upscaling, as well as better linkages to research institutions and networks for knowledge exchange.

Sustainable markets and networks for NWFP: So far there are many obstacles hindering the commercialisation - especially of NWFP of small-scale land users. The development of forest-based small enterprises and the establishment of local markets can enhance small-scale production of NWFP and hence reduce the pressure on timber harvesting. Priority should be given to strengthening the capacity of local producers of forest products, processors and traders, to ensure sustainable harvesting and management of forest resources while increasing the quality and added-value of the derived products.

Incentives for adoption

Micro-credit to establish small industries (e.g. for NWFP) can help build incentives towards better SFM. Furthermore, incentives are needed to bridge the time until trees become productive (e.g. for areas under natural regeneration). Recent discussions and development promote Payment for Ecosystem Services (PES) as an incentive for sustainable management. Clear commitment is needed to pay for the maintenance of the remaining forest resources.

Enabling environment: key factors for adoption

Inputs, material incentives, credits	+
Training and education	++
Land tenure, secure land use rights	+++
Access to markets	++
Research	++
Infrastructure	+
Conflicts of interest	++

The Network for Natural Gums and Resins in Africa (NGARA) was established in May 2000 to assist African producer countries and partners in formulating a co-ordinated strategy for the sustainable development of their natural gums and resin resources in order to improve rural livelihoods and environmental conservation. NGARA brings together members from varied fields, including farmers / collectors, traders, governments, non-governmental organisations, exporters and importers – all of whom have the common desire to improve the production and quality of locally produced gums and resins for domestic, regional and international markets. NGARA consists of 15 member countries. Since inception, NGARA has played an increasingly important role in the exchange of information on production and trade, training, technology transfer, assessment of resources and their sustainable use, enhancing capacities of stakeholders in beneficiary countries and harnessing efficient use of available resources by strengthening synergies. The establishment of NGARA was considered a significant step in the development of the gum arabic and resins sector in the dryland Sahel for ensuring food security, rural development and hence poverty alleviation (www.ngara.org).

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ASSISTED NATURAL REGENERATION OF DEGRADED LAND - BURKINA FASO

Assisted natural regeneration, as promoted by newTree in Burkina Faso, starts with enclosing 3 ha of degraded land with a solid fence. Fence materials (iron posts and galvanic wire) are externally sponsored and locally assembled and installed. Along the fence a dense living hedge of thorny trees (local tree species: e.g. *Acacia nilotica*, *A. senegal*, *Prosopis* sp, *Ziziphus mauritiana*) is planted. A strip of 10 m along the hedge is dedicated to agriculture. This area is equivalent to approximately 10% of the protected area. The rest is dedicated to natural regeneration of the local forest.

Once protected, natural vegetation rich in endogenous species can actively regenerate. Annual vegetation species inventories are made to monitor the biomass, biodiversity and the growth rate of the trees. The forest reaches a tree density of approximately 500 trees per hectare and consists of around 120 local species. Some enrichment planting of rare species enhances the allotments. The protected area is of paramount importance for biodiversity conservation.

Management activities in the protected area includes (1) seeding / planting of improved fodder species; and (2) establishing stone lines and half-moons (*demi-lunes*) for soil erosion control and water harvesting, (3) installing beehives for honey production; and (4) fodder production: the grass is cut, tied and carried to feed livestock outside the regeneration area.

Property rights for the protected area are clearly established through a contractual agreement that includes / respects traditional and government land rights. The local land users select the area, provide all labour inputs and ensure the long term management of the sites according to mutually agreed goals. Training is provided to enhance income generating activities – ranging from beekeeping and the production of high-value vegetable crops to the processing of non-timber forestry products – and to promote the use of fuel-efficient cooking stoves.



SLM measure	Management and vegetative
SLM group	Sustainable Forest Management in Drylands
Land use type	Before: Agro-silvopastoralism, wastelands; After: Agroforestry / Natural forest
Degradation addressed	Soil erosion by water and wind; Fertility decline; Sealing and crusting; Reduction of vegetation cover; Aridification
Stage of intervention	Rehabilitation
Tolerance to climate change	High tolerance

Establishment activities

1. Select an area of 3 ha of degraded land.
2. Establish a 1.5 m high fence around the selected area: install metal posts, manufacture / assemble chain-link fence materials (manually).
3. Plant a living hedge of spiny trees at a distance of 1 m to the fence, plants spaced at 0.4 m.
4. Reserve a 10 m strip along the fence / hedge for improved agriculture.
5. Plant a living hedge of *Jatropha curcas* to separate cropland from regeneration area.
6. Seed / plant improved fodder species within protected area.
7. Establish stone lines and half-moons for soil erosion control and water harvesting within protected area.
8. Install beehives (2-10 hives per protected area); purchase protection and harvesting equipment.
9. Construct fuel efficient cooking stoves.

Maintenance / recurrent activities

1. Supervise fence and protected area; repairing where necessary.
2. Replant / replace dead seedlings in living hedges.
3. Improved agriculture: agroforestry, water harvesting, compost application.
4. Beekeeping: monthly control of beehive; yield 2-3 times per year (manually with protection equipment).
5. Improved fodder production: cut grass and tie hay with simple tying machine (once a year after rainy season).

Labour requirements

For establishment: high

For maintenance: medium

Knowledge requirements

For advisors: medium

For land users: medium

Photo 1: The components of the system (from right to left): Metal fence, living hedge (recently planted seedlings), agricultural zone with SLM measures (e.g. agroforestry), forest regeneration area.

Photo 2: Fabrication of chain-link fence by land users.

Photo 3: Dense vegetation cover in the protected area behind the fence. (All photos by Franziska Kaguembèga-Müller)

Case study area: Soum Province; Burkina-Faso



Establishment inputs and costs for 3 ha

Inputs	Costs (US\$)
Labour	1,300
Equipment / tools: pick, shovel, hammer, glove, tong, iron rod	100
Agricultural inputs: training, seeds, compost	260
Components for fence construction: sand, gravel, rock and water, poles, galvanised wire, cement, tree seedlings	2,900
TOTAL	4,560
% of costs borne by land users	33%

Maintenance inputs and costs for 3 ha per year

Inputs	Costs (US\$)
Labour	730
Training	40
Agricultural inputs: seeds	40
TOTAL	810
% of costs borne by land users	95%

Remarks: A unit relates to a protected area of 3 hectares (average size; feasible and beneficial for participating land users, namely farm families / womens' groups). Labour for establishment includes: digging of planting pits / ditches, post installation, fabrication of chain-link fence materials, all plantations, stone lines, half-moons, etc. Components for fence construction are locally available.

Benefit-cost ratio

Inputs	short term	long term
Establishment	neutral	very positive
Maintenance	positive	very positive

Ecological conditions

- Climate: arid, semi-arid
- Average annual rainfall: 300 - 600 mm per year
- Soil parameters: soils are often very poor and overexploited; laterite
- Slope: mostly flat 0-2%
- Landform: mainly plains / plateau
- Altitude: 0-100 m a.s.l.
- Altitude: 2,300 - 2,400 m a.s.l.
- NewTree works in 2 different climatic zones with different ecological conditions

Socio-economic conditions

- Size of land per household: 3 ha
- Type of land user: small-scale, very poor or poor, implementation by families (up to 60 members) or groups (e.g. women's groups)
- Population density: 30 persons/km² in the Nord, 70 persons/km² in the centre
- Land ownership: state (officially); traditional family property rights (factually)
- Land use rights: families

Production / economic benefits

- +++ Increased wood production
- +++ Increased farm income and diversification of income sources
- ++ Increased fodder quality and quantity
- ++ Increased crop yield

Ecological benefits

- +++ Increased biomass / above ground carbon
- +++ Increased soil organic matter / below ground carbon
- +++ Improved soil cover
- +++ Increased nutrient cycling / recharge
- +++ Increased plant diversity / habitat diversity
- +++ Improved harvesting / collection of water
- +++ Reduced soil compaction and crusting
- ++ Reduced surface runoff / soil loss
- ++ Increased beneficial species (predators, earthworms, pollinators)
- ++ Reduced evaporation
- ++ Reduced wind velocity
- ++ Increased soil moisture

Socio-cultural benefits

- +++ Improved food security / self-sufficiency
- +++ Improved health
- ++ Improved conservation / erosion knowledge
- + Improved situation of socially and economically disadvantaged groups

Weaknesses → and how to overcome

- High investment costs → introduce income generating activities which amortise (help pay off) the initial investments and the waiting time until land users can harvest non-woody products from the forest; relocate the fence to enclose other degraded land when the living hedge is dense enough and takes over the function of protection.
- Insecurity of land rights is a constraint for implementation (government is official land owner) → conclude contractual agreements which include / respect traditional and government land rights.

Adoption

All land users have implemented the technology through receiving incentives (payment for labour and other inputs). Regeneration sites have been established in 5 different provinces (Soum in the North, Kadiogo, Kourweogo, Bouleimde and Oubritenga in the centre of Burkina Faso). There is high demand for establishment of further sites. The demonstration effect of improved agriculture within the fence (agroforestry, etc. resulting in higher yields) encourages farmers to adopt these measures in their fields outside the protected area also.

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INDIGENOUS MANAGEMENT OF TAPIA WOODLANDS - MADAGASCAR

For centuries, the population of the highlands of central and south-western Madagascar has sustainably managed and conserved the local tapia woodlands. These woodlands play an important economic role as a source of non-timber forest products (NTFP) such as wild silk, fruit, mushrooms, edible insects, and herbal medicines. Tapia trees (*Uapaca bojeri*) comprise up to 90% of all trees in these woodlands, bear an edible fruit, and their leaves nourish an endemic silkworm (*landibe*). *Landibe* silk is used to produce ritual burial shrouds throughout the highlands. Trading silk products and tapia fruits is a crucial source of cash income for the local communities.

The tapia woodlands are maintained by the local villagers through burning and selective cutting. Burning favours the dominance of pyrophytic (fire-tolerant) tapia trees and protects silkworms from parasites. Selective cutting of non-tapia species and pruning of dead branches also favours tapia dominance and perhaps growth. Other common species include the endemic *Sarcolaena eriophora* and the invasive *Pinus patula / khasya*. The tapia woodland is clearly an anthropogenically shaped forest. However, the creation and maintenance of the woodlands should be seen as positive transformation rather than a form of degradation.

Local and state-imposed regulations protect the woodlands from overexploitation. The Forest Service has placed restrictions on forest cutting and burning while allowing for traditional use rights. The collection of forest products is regulated through a type of common-property regime. For example, fuelwood collection is limited to dead trees or fallen branches. It is forbidden to break off large branches to access cocoons. Thanks to these protective regulations, forest boundaries are mostly stable, and woodland density has increased in several cases.



SLM measure	Management
SLM group	Sustainable Forest Management in Drylands
Land use type	Natural forest; silvopastoralism
Degradation addressed	Reduction of vegetation cover; Quantity biomass decline
Stage of intervention	Prevention and mitigation
Tolerance to climate change	Silk and fruit harvests vary from season to season but drivers are poorly understood (could include precipitation and temperature)

Establishment activities

The management of the tapia woodlands has evolved over centuries and in recent times has been supported by state imposed regulations. Thus no establishment activities can be listed here.

Maintenance / recurrent activities

1. Selective cutting of non-tapia species, especially invasive pines.
2. Pruning of dead branches.
3. Controlled burning mainly through under-story fires after the rainy season (January-May).
4. Collection of non-wood forest products such as fruits (September-December), medicinal plants, mushrooms, berries, insects, and hunting of mammals etc.
5. Collection of *landibe* silkworm twice a year (November-December and May-June). The cocoons are cooked, spun and woven into silk fabric.
6. Collection of fuelwood, limited to dead or downed wood.

Labour requirements

For establishment: na
For maintenance: low

Knowledge requirements

For advisors: na (traditional practice)
For land users: low (children often harvest fruit; silk cocoon harvest is easy)

Photo 1: Typical tapia woodland south of Antsirana.

Photo 2: Tapia woodland with some invasive pine trees bordering highland rice fields.

Photo 3: Small late wet season fire in a tapia woodland.

Photo 4: *Landibe* wild silk cocoon.

Photo 5: Bags of tapia fruit for sale on the side of the road. (All photos by Christian Kull)

Case study area: Antsirabe and Ambositra, Col des Tapia, Madagascar



Establishments inputs and costs per ha

Traditional method; no establishment phase and costs.

Maintenance inputs and costs per ha per year

Inputs	Costs (US\$)
Labour: 10 person-days for harvest of NTFP	20
Equipment / tools: specify	0
Agricultural inputs: specify	0
Construction material: specify	0
TOTAL	20
% of costs borne by land users	100%

Remarks: The estimation of costs is difficult - fruit are gathered over a two month period by school children going out for an hour in the early morning each day; the silkworms are collected by individuals (usually experienced collectors) on free days. In some areas, projects exist that run silkworm nurseries, establish firebreaks in the woodlands, grow and plant tapia seedlings, and finance the purchase of silk looms. These projects obviously require much larger budgets.

Benefit-cost ratio

Inputs	short term	long term
Establishment	na	na
Maintenance	positive	positive

Remarks: The larger rainy season silk harvest provides crucial cash income during the meagre months before the rice harvest. In 1998, the price of 200 cocoons was between US\$ 0.10-0.15. For a basket of tapia fruits villagers earned between 0.02-0.06 US\$/kg. During the harvest the tapia woodlands produce about 4 kg of fruits per ha (= US\$ 0.1-0.25/ha). Dependence upon woodlands for cash income varies from 0-40%.

Ecological conditions

- Climate: subhumid; 7 months of dry season
- Average annual rainfall: 1,000 – 1,500 mm
- Soil parameters: mostly nutrient-poor or rocky soils; low organic matter; high drainage; rockier, silica-rich soils compared to the main lateritic soils of highland Madagascar
- Slope: hilly to steep (20-80%)
- Landform: hill slopes
- Altitude: 800 - 1,800 m a.s.l.
- Tapia woodlands are short, endemic, sclerophyllous formations, resembling-Mediterranean oak forests or southern Africa's Miombo woodlands.

Socio-economic conditions

- Size of land per household: na (woodlands are communal)
- Population density: 20-40 persons/km² in the central highlands and 10-20 in the western highlands
- Type of land user: mainly small-scale, poor households
- Land ownership: state
- Land use rights: communal (organised)
- Level of mechanisation: manual labour
- Market orientation: subsistence (self-supply) and mixed (subsistence-commercial)

Woodlands are officially state-owned, but in practice managed by neighbouring communities (either unofficially, or increasingly through community-based management contracts).

Production / economic benefits

- ++ Increased cash income (through selling silk-fabrics and other NTFP)
- +++ Production of NTFP as important dietary supplements (berry, mushrooms, protein (insect), etc.)
- ++ Stable supply of fuelwood
- ++ Provisioning of medicinal plants

Ecological benefits

- +++ Maintenance of biomass,
- ++ Maintenance of soil cover and regulation of soil loss
- ++ Maintenance of endemic biodiversity

Socio-cultural benefit

- +++ Improved food security / self-sufficiency (different forest products)
- +++ Maintained cultural value (sacred forest)

Weaknesses → and how to overcome

- Partly individual indiscriminate cutting and / or strong use of fires leads to overuse of the forest resources → needs clear regulations, guidelines and observation of the rules by the local authorities as well as awareness raising about the multiple benefits of the forests.
- Invasion of exotic tree species such as pine and eucalyptus from private and village woodlots → the forest service has rightly been encouraging communities to cut these trees from the tapia forests without the need for complicated permits.
- Insecure land use rights → in 1996 a new legislation opened the way to officially decentralise management of state-owned renewable natural resources to adjacent communities, which would aid woodland protection by increasing stakeholder involvement.
- In some areas, silkworm populations have been very low for decades → recent projects seek to establish silk nurseries and reintroduce the worm.

Adoption

This system of woodland management is applied in almost all endemic tapia woodland areas. The area of these woodlands is 2,600 km² (study area: approx. 50 km²), affecting perhaps 100,000 people. It is a traditional practice – no incentives necessary.

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SUSTAINABLE RAINFOREST MANAGEMENT



Rainforest as natural habitat for mountain gorillas, Rwanda. (Hanspeter Liniger)

In a nutshell

Definition: Sustainable Rainforest Management (SRFM) in tropical and mountain areas aims to ensure that the goods and services derived from natural forests meet present-day needs while at the same time securing their continued availability and contribution to long term development. Central Africa contains the world's second largest area of rainforests and shelters some of the greatest biological diversity within the continent, and thus plays a vital role in global ecological services. Yet, illegal logging, agriculture and hunting seriously threaten the diversity and values of these forests. In many countries rainforests are now restricted to mountain areas, and to coastal and river areas. Mountain forests in particular play a crucial role in providing freshwater resources, and feeding rivers and groundwater tables which provide life to dry lowlands.

SRFM combines political and technical issues. On the political side, despite clear commitments of governments and local administrations (ratification of conventions, laws / regulations, etc.), effective measures for protection and sustainable management of the remaining natural forests must be better implemented at ground level. One major issue is improving country level integrated and participatory land use planning with a better recognition of the need for land tenure and customary rights to be afforded to the local populations. On the technical side, there are two main aspects: the protection and maintenance of undisturbed forest areas for conserving its rich biodiversity, and the sustainable management of forests for productive purposes either commercially or under a subsistence system, in other words how to balance profitability while still maintaining ecological and social integrity. Some critics say that conservation of biodiversity is not compatible with any use of the forests. However, for most of the population living in, or around, rainforest areas the use of forest products represents a vital means for food security. New trends and opportunities such as paying for ecosystem services should be further assessed and supported. This provides a promising solution to better integrate conservation and economic aspects.

Applicability: Applicable and crucial for any type of natural primary or secondary rainforests in tropical and mountain areas.

Resilience to climate variability: Rainforests are a common resource pool and how well the forest is maintained will determine how vulnerable community livelihoods and national development will be to climate change impacts.

Main benefits: Improved livelihoods and human well-being through income diversification and salaries from industrial forest sector, improved water availability since mountain rainforests are water towers for dryland areas, maintaining an ecosystem with rich biodiversity; hindering further deforestation can contribute immensely to the global carbon balance, providing a critical buffer against global climate change.

Adoption and upscaling: Success of SRFM depends on the establishment of policies based on poverty reduction and the active involvement of various stakeholders at the local, national, regional and international levels. Furthermore it requires financial resources, a political will, and social investment.

Development issues addressed

Preventing / reversing land degradation	+++
Maintaining and improving food security	+
Reducing rural poverty	++
Creating rural employment	+
Supporting gender equity / marginalised groups	+++
Improving crop production	na
Improving fodder production	+
Improving wood / fibre production	++
Improving non wood forest production	+++
Preserving biodiversity	+++
Improving soil resources (OM, nutrients)	+++
Improving of water resources	+++
Improving water productivity	++
Natural disaster prevention / mitigation	+++
Climate change mitigation / adaptation	+++

Climate change mitigation

Potential for C Sequestration (tonnes/ha/year)	no data
C Sequestration: above ground	+++
C Sequestration: below ground	+++

Climate change adaptation

Resilience to extreme dry conditions	+
Resilience to variable rainfall	+++
Resilience to extreme rain and wind storms	+++
Resilience to rising temperatures and evaporation rates	+++
Reducing risk of production failure	+++

Origin and spread

Origin: Prior to the colonial era, the sacred character of forests helped to conserve them as part of traditional community resource management systems. After the 1992 Earth Summit, Central African countries adopted laws and regulations including sustainable management plans, community involvement and conservation objectives. However, the execution of these regulations is not sufficiently successful.

Spread of rainforests: 180 million ha are covered by rainforests (out of 582 million ha of forests). They are mainly found within the Central African Republic (CAR), the Democratic Republic of Congo (DRC), Equatorial Guinea (EG), Gabon and the Republic of Congo. Rainforests are also found in Cameroon, the high mountain areas of Ethiopia, Kenya, West Africa (e.g. Benin, Ghana, Guinea Bissau, Guinea, Ivory Coast, Liberia, Nigeria, Sierra Leone and Togo) and in coastal zones in South Africa, Madagascar, etc.

Sustainable rainforest management mainly in: Forest management plans are in effect in Cameroon, Congo, Gabon and CAR. Cameroon and CAR have more than 75% of the concession with agreed management plans, whereas the larger DRC has none. In Central Africa, the forest area certified by the Forest Stewardship Council (FSC) was about 4.7 million ha in 2009: Cameroon (0.9 million ha), Congo (1.9 million ha) and Gabon (1.9 million ha). Cameroon, CAR and EG have more than 20% of their land under protection, whereas in Congo, DRC and Gabon the protected area ranges between 9-11% of the total land area.

Principles and types

Good Forest Governance is a prerequisite for sustainable rainforest management (SRFM). It is presently pursued through three approaches: (1) the Forest Law Enforcement and Trade (FLEGT) process; (2) independent third party observers; and (3) forest certification and / or legal systems operating in the Congo Basin.

Land use planning: SRFM needs to be part of a broader national land use planning process. All stakeholders from small farmers, communities, NGOs, the private sector and government technical services should be involved and collaborate very closely - giving special emphasis to social and ecological aspects. A collective assumption of responsibilities is needed, to bring a transformation of responsibilities from state to private structures such as communities, NGOs, and concession-holders. SRFM for carbon, biodiversity and water resources needs global planning and compensation mechanisms.

Community forestry: The management of forests with or by local communities is an important mechanism for addressing social equity while pursuing the sustainability of the forest resources. Maintenance and protection of forest resources can only be achieved through awareness raising and active involvement of communities. For maintaining valuable natural forest resources, clear land tenure and user rights must be given to communities.

Management plan procedures: Inventories on resources potentially available for annual allowable cut / harvest and logging maps are, today, standardised features of any management plan. Through these documents, sustainable logging practices are encouraged and promoted within a forest concession. This includes the demarcation of annual felling coupes (quotas), adherence to minimum harvest diameters, respect for seed-trees to conserve the biodiversity and economic value of the forest – and so forth. The construction of access roads must be carefully planned, as well as timber extraction procedures.

Diversification of production: New niche markets for non-woody forest products, 'green' and 'fair trade' products can increase the competitiveness and income of small-scale producers. Ecotourism involving local communities and Payments for Ecosystem Services (PES) can be promising new income and market opportunities for forest users.

Biodiversity conservation: Beside national and international protected areas, small-scale protected areas may be established at the local level which can preserve habitats and serve as refuges for animals. Protected area management needs to be integrated within the framework of land use planning. These areas, including their buffer zones, must contribute to local economic development through the promotion of NWFP, ecotourism and community forestry. Hunting, where legally permitted, should be controlled and reduced to a sustainable level. Mechanisms to pay for biodiversity conservation need to be established.



Area of rainforests in Sub-Saharan Africa.



Top: Teaching the sustainable use of rattans, Democratic Republic of Congo. (Robert Nasi)
Middle: Pit sawing eucalypt log, Uganda. (Jim Ball)
Bottom: View of natural rainforests in Guinea. (Jim Carle)

Applicability

Land degradation and causes addressed

Small-scale agriculture represents the main threat to the forest since expanding cropland and grazing land at the expense of forest land continues in many areas: it is effectively an intensification of the traditional system of slash and burn. In Central Africa, 32% of the rainforest is allocated to commercial logging concessions granted by governments to companies and individuals. Extensive forest logging does not generally lead to a significant loss of forest cover, and does not compromise forest sustainability directly. Yet forest roads penetrate and open up previously untouched forests, making them accessible, especially for hunting and illegal logging. Logging activities and the selective felling of certain tree species lead to a change in the biodiversity of the forests. Lack of buffer zones lead to polluted water courses. Increasing population pressure and the increasing demand for biofuels, or other NWFPs, may further heighten the threat to the remaining rainforest areas.

Biological degradation: loss of forest ecosystem, biodiversity, and wildlife

Water degradation: decline of water quality and regularity of flow

Physical and chemical soil deterioration: soil compaction, loss of nutrients

Land / forest use

Primary and secondary forests can be defined as natural forests. Within a tropical rainforest, different layers can be distinguished: the ground layer (the forest floor), the shrub layer, the understory, the canopy and the emergent layer.

Naturally, there is only limited use of dense tropical forest, mainly by hunter-gatherers. However, conversion to agricultural land and the application of shifting cultivation have made it possible to use the land for agricultural production. In tropical rainforests the timber market and logging activities play an important role in the use and abuse of the forests.

Ecological conditions

Climate: Tropical rainforests thrive under an annual rainfall of 1,750 - 3,000 mm, and mountain forests between 1,400-2,500 mm. In tropical rainforests, mean monthly temperatures exceed 18°C.

Terrain and landscape: No restrictions; however, in many countries forests have been reduced to inaccessible areas – especially steep hills.

Soils: Soils of rainforests are very susceptible to soil degradation after removal or change of vegetation cover (e.g. after clear cutting).

Socio-economic conditions

Farming system and level of mechanisation: From small-scale land use to mechanised commercial logging activities.

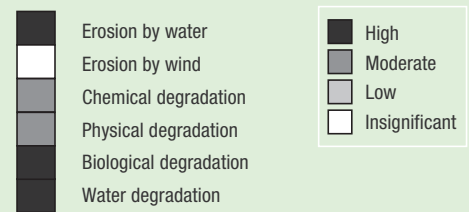
Market orientation: Rainforests are used by subsistence small-scale land users using wood and NWFp as well as for commercial timber or NWFp extraction. The forestry sector is a main job provider for rural population in many Central African countries.

Land ownership and land use / water rights: In most tropical African countries, the state has claimed legal ownership of forest land since the colonial period, even though the customary ownership of the same areas dates back centuries, perhaps millennia. Africa lags behind other tropical forest regions in forest tenure reform with less than 2% of the continent's tropical forests legally owned by, or designated to, forest communities or indigenous groups. To ensure sustainable management of forests, land tenure rights must be ensured for local communities.

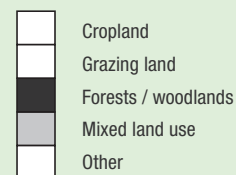
Skill / knowledge requirements: SRFM requires a very high level of know-how and technical knowledge regarding appropriate techniques. Good education of forest management services and local communities is a prerequisite.

Labour requirements: Labour requirements vary depending on interventions needed (see principles and types).

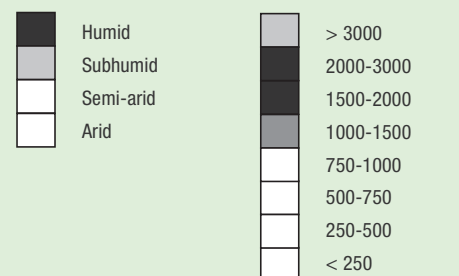
Land degradation



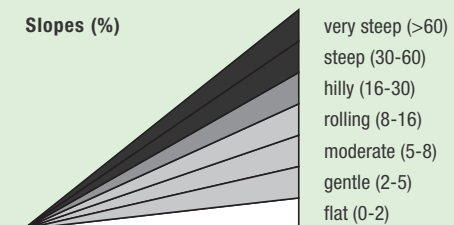
Land use



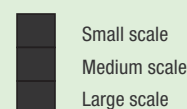
Climate



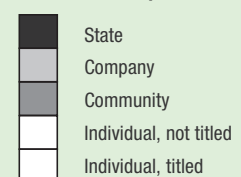
Slopes (%)



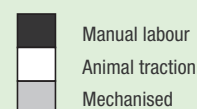
Farm size



Land ownership



Mechanisation



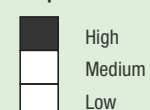
Market orientation



Required labour



Required know-how



Economics

Establishment and maintenance costs

Since Sustainable Rainforest Management (SRFM) is mainly a political and management issue, the assessment of costs is limited and depends closely on the specific technical and political aspects implemented.

	Cost (US\$/ha)	
	Establishment (2-4 year set up phase)	Maintenance (25 years operation)
Community forestry, Cameroon	2,600 – 32,000 (can be up to 59,000)	2,000

(Source: Ingram Verina, see case study on Community Forestry)

Community forestry in Cameroon includes very high establishment costs including marking the boundaries and agreeing on forest use zones, inventory of forest resources, management plans, etc. However, once established the operation of the system is at a low price.

Production benefits

It is difficult to give estimation about the production benefits of SRFM, since the benefits are related to management changes. However, recent studies are helping to put a price on the range of forest goods and services. Yet more research is needed on the value of environmental services such as water quality and supply, soil retention and fertility, carbon storage, and conservation of biodiversity, etc. Furthermore, methodologies are needed to calculate the cost of unsustainable forest management for comparison (FAO, 2008). People living in, and around, rainforests need to be rewarded as stewards / custodians of natural forests. Payments for Ecosystem Services (PES) comprise voluntary transactions for well-defined environmental services. New PES related markets for greenhouse gases, carbon, water and biodiversity are emerging around the world. The PES approach is still recent in Central Africa, and not widely implemented. Yet many sub-regional actors are beginning to pay close attention to this type of mechanism. As for donors, the African Development Bank launched a 'Congo Basin Forest Fund' in 2008 with more than US\$ 110 million, which will be partly devoted to setting up PES, including the fight against climate change. Similarly, the World Bank, with its Forest Carbon Partnership Facility, and the United Nations - UNDP, UNEP, FAO - have significant funding for implementing sub-regional programs for reforestation or avoided deforestation. Finally, the Global Environment Facility has started a 'Strategic Program to Support Sustainable Forest Management in the Congo Basin', which is also targeted towards PES. All this funding is for three main environmental services – carbon sequestration, biodiversity conservation, and watershed maintenance – which are just starting to be implemented in Central Africa.

Benefit-cost ratio

	short term	long term	quantitative
Community based forest management	--	++	No data available

-- negative; - slightly negative; -/+ neutral; + slightly positive; ++ positive; +++ very positive;

Since sustainable forest management is not yet widespread in SSA, it is difficult to make a realistic assessment of the economics, either current or potential, and the likely change to sustainable management during the next two decades. If communities are willing and economically able to involve themselves, they must receive greater economic benefits from conserving forests than from degrading them. Sustainable natural forest management must tangibly improve local economic welfare, and generate local economic benefits to sufficient levels and in appropriate forms to make SRFM economically sound.

Example: Forest certification

There has been some international recognition of progress made towards sustainable forest management in Central Africa through forest certification. Among several competing processes, the Forest Stewardship Council's (FSC) certification system is considered the most demanding at the international level - focusing not only on technical, but also social and environmental aspects of forest management. From zero hectares at the end of 2005, FSC-certified forest area ballooned to a total of about 4.7 million hectares in July 2009, spread over three countries: Cameroon (0.9 million ha), Congo (1.9 million ha) and Gabon (1.9 million ha) (FSC, 2010 and based on expert knowledge).

Example: Ecotourism Cameroon

In Cameroon the ecological and cultural diversity of the country is an asset for tourism. This could be a means to develop the forest sector outside of timber, woodcrafts and NWFP. Even though Cameroon is trying to make money from biodiversity, through ecotourism, this sector is still underdeveloped. In 2007, tourism revenues, namely ecotourism in protected and hunting areas, amounted to € 297,260 (appr. US\$ 365,000). Although some protected areas are visited by tourists there is a lack of adequate structures to valorise their resources. In 2008, 20 protected areas had information centres (Eba'a Atyi R. et al., 2009).

Example: Compensation payments

There are several initiatives in Central Africa to compensate protectors of biodiversity. There are three types: (1) 'freezing' potentially exploitable areas to promote conservation; (2) the labeling of goods produced in compliance with specific environmental standards; and (3) restrictions on practices impacting biodiversity in and around protected areas. Conservation concessions represent the most recent approach in the Congo Basin. The objective is to convert areas earmarked for logging into protected areas. No projects have started yet, but WWF and Conservation International (CI) have made proposals with the goal to conserve the habitat of several major species of large mammals. These conservation concession proposals have yet to convince the national governments to whom the land belongs. The reluctance of public authorities can almost certainly be attributed to the opportunity cost of these conservation concessions - estimated at 10-13 million Euros (US\$ 12-16 million) per year - as well as the complexity of national and local institutional arrangements to put in place. (Based on expert knowledge)

SUSTAINABLE RAINFOREST MANAGEMENT

Impacts

Benefits	Land users / community level	Watershed / landscape level	National / global level
Production	<ul style="list-style-type: none"> ++ diversification of production ++ increased production of NWFP ++ enhanced long term forest productivity + increased wood production 	<ul style="list-style-type: none"> +++ reduced risk and loss of production +++ improved access to clean drinking water 	<ul style="list-style-type: none"> + improved food and water security
Economic	<ul style="list-style-type: none"> ++ provides a wide range of wood and non-wood products ++ income diversification (e.g. beekeeping, ecotourism) + increased income 	<ul style="list-style-type: none"> +++ less damage to off-site infrastructure ++ markets for non-woody forest products (diversification) ++ new employment (e.g. ecotourism) and stewardship + stimulation of economic growth 	<ul style="list-style-type: none"> + improved livelihood and well-being
Ecological	<ul style="list-style-type: none"> +++ improved protection of biodiversity, endangered forest species and habitats +++ improved forest cover and stocking +++ reduced soil erosion (by water / wind) +++ improved water availability +++ increased soil fertility +++ improved micro-climate ++ restoration and protection of remaining natural forests 	<ul style="list-style-type: none"> +++ water availability +++ water quality +++ reduced degradation and sedimentation +++ intact ecosystem 	<ul style="list-style-type: none"> +++ decreased degradation and desertification incidence and intensity +++ increased resilience to climate change ++ reduced C emissions ++ increased C sequestration ++ enhanced biodiversity
Socio-cultural	<ul style="list-style-type: none"> +++ recognise value of stewards of natural forests +++ community involvement and strengthening ++ less conflicts among different users ++ improved knowledge and awareness raising on SRFM 	<ul style="list-style-type: none"> +++ increased awareness for environmental 'health' +++ attractive landscape ++ reduced conflicts 	<ul style="list-style-type: none"> +++ protecting national heritage

	Constraints	How to overcome
Production	<ul style="list-style-type: none"> • Restricted short time use ('exploitation') of forests 	<ul style="list-style-type: none"> → awareness of long term benefits and increase of other valuable ecosystem services provided through natural forests
Economic	<ul style="list-style-type: none"> • Commercial constraints due to uncontrollable international wood markets • Availability of market for non-woody products and ecotourism • Insufficient payments for ecosystem services (PES) 	<ul style="list-style-type: none"> → support the establishment of markets for NWFP and ecotourism → improved national and international support and more efforts needed in establishing fair PES mechanisms
Ecological	<ul style="list-style-type: none"> • Impossibility of reconstituting forests exactly as they were • Difficult to assess the long term impact of a management practice due to the slow-growing of trees • Forest resources are still not sufficiently understood – lack of knowledge and monitoring 	<ul style="list-style-type: none"> → promote the role of secondary forests and allow most suitable conditions for regeneration towards natural forests → more investment in research is needed esp. on the contribution of biodiversity, provisioning of water, etc.
Socio-cultural	<ul style="list-style-type: none"> • Political constraints: secure land tenure of communities often not given, modern and customary laws are often in conflict • Poverty leading directly to indiscriminate extraction of forest resources and dependency on timber market • Knowledge is inadequate, scattered and poorly disseminated • Lack of knowledge on the current state of forest resources • Laws and regulations exist but are not adequately supported, community forest plan may exist, but communities have not enough possibilities to stop illegal logging 	<ul style="list-style-type: none"> → allocation of land use rights and consolidating / harmonisation of legal situation including customary laws → improving the livelihoods of poor communities in and around forests and make them independent from destructive forests use, introduce alternative income options through NWFP or ecotourism → compilation and exchange of experiences made with SRFM, learning from others → capacity building of both government staff and community members and regular monitoring and reporting about state of natural forests → needs a clear political commitment and supervision of activities going on

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Adoption and upscaling

Adoption rate

Considerable efforts have been made to implement sustainable forest management approaches to forest concessions in Central Africa (from 125,000 ha in 2000, to over 11.3 million ha in 2008). These figures are likely to increase. However, the rate of SRFM adoption differs greatly between countries. Global concern about sourcing wood from sustainably managed areas is encouraging thanks to the launching of the Forest Law Enforcement, Governance and Trade (FLEGT) process and to the progressive adoption of certification. FSC-certified forest area increased from zero in 2005 to a total of about 4.7 million ha in 2009. However, the overall extent of certification still remains low. Currently, Cameroon is the only country where community and communal forestry concepts are translated into concrete actions.

Upscaling

Political and institutional commitment: Governments must have the political will to shift from industrial logging to community forestry and take actions to do so. SRFM should be integrated into a coordinated national framework with a clear forest policy.

Land tenure rights: Without clear land tenure rights and ownership for communities there is little scope for improving forest management.

Decentralisation and new forest management plans: All stakeholders from small farmers, local communities, NGOs, the private sector, and government technical services must be involved in the development of a management plan. A collective assumption of responsibilities is needed, bringing a transformation of responsibilities from state structures to private structures (NGOs, concession-holders, etc.).

Environmental sustainable logging concession: Logging cannot be banned totally in rainforests, therefore environmentally and socially sound solutions must be considered under new concessions. Forest concession should not threaten the livelihoods of local communities and lead to their marginalisation, therefore local management and enterprises should be supported. Clear rules and guidelines must be available and enforced.

Research and improving knowledge of the forest resources: Multidisciplinary approaches are needed to take into account the various aspects of sustainability. Inventories of biodiversity / wildlife habitat are required as well as information and knowledge related to appropriate / reduced impact logging techniques. Further collaboration with research for an all-encompassing view of natural resources and ecosystems is needed.

Awareness raising and capacity building: Local forestry services should be well educated and trained to coordinate and maintain SRFM. Local communities / land users need to have a good understanding of all aspects of SRFM - traditional knowledge supported by more scientific concepts.

Protected forests need better involvement of local communities in order to reduce damaging and illegal use of the forests. A prerequisite is establishment of clear regulations and control mechanisms by forest services and local communities to ensure commitment to safeguarding protected forests and benefit sharing (e.g. through ecotourism) among all stakeholders.

Incentives for adoption

Payment for Ecosystem Services (PES) can, and must, increasingly be an incentive for sustainable management. Clear commitments are needed to pay for the maintenance of the remaining forest resources. Certification is another tool to enhance the adoption of sustainable rainforest management.

Enabling environment: key factors for adoption

Inputs, material incentives, credits	+
Training and education	++
Land tenure, secure land use rights	+++
Access to markets	++
Research	++
Infrastructure	++
Conflicts of interest	++

Forest Governance

Improving forest governance in Central Africa is pursued through three approaches:

(1) The FLEGT (Forest Law Enforcement and Trade) process initiated by the European Union (EU), aims to culminate in the signing of a bilateral Voluntary Partnership Agreement (VPA) between each timber exporting country of the sub-region and the EU. Once signed, the VPAs will restrict timber exports to the EU to wood that meets the legal conditions agreed.

(2) In most countries of the sub-region, the process of linking Independent Observers (IO) with the monitoring of forest operations for greater transparency has been adopted. The IOs are generally recruited among international NGOs working to promote transparency. Cameroon, Congo and Gabon have also worked with the World Resource Institute (WRI) to develop interactive forestry atlases, making it available to users interested in basic information on forest concession management. In development by the Commission for the Forests of Central Africa (COMIFAC), the OFAC (Observatory for the Forest of Central Africa) will help all Central African countries to make a wide variety of forest sector data available in a transparent fashion, including: Forest cover, logging, biodiversity conservation and biodiversity development statistics. The private sector is also involved in initiatives to improve the law on forestry operations and enhance transparency. By the end of 2009, 25 certificates of legality (total area 2.6 million ha) have been granted to logging companies following audits by private auditors. Many companies are also involved in the Forest Transparency Initiative.

*(3) Forest certification and / or legality systems operating the Congo Basin.
(Based on expert knowledge)*

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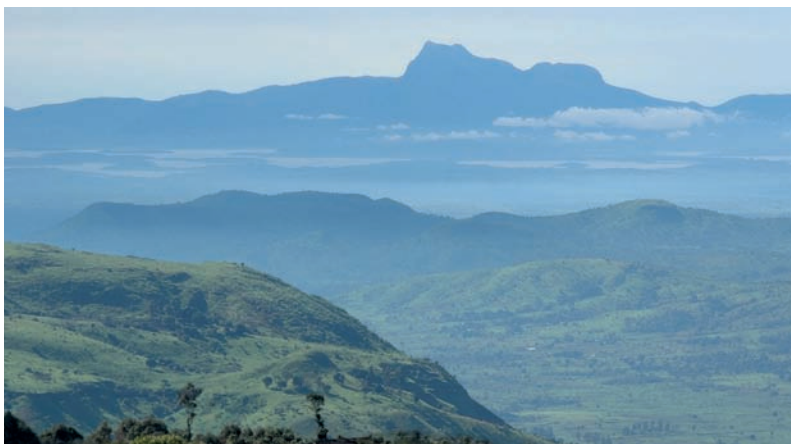
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FOREST BEEKEEPING - CAMEROON

Apiculture (beekeeping) has been traditionally practiced for at least a century in Cameroon, with forest-based apiculture increasing in the last two decades. The ancient art of honey hunting, and the more recent apiculture and its products like honey, wax, propolis, bee venom and royal jelly, are examples of non-timber forest products (NTFP). A number of projects were supporting production and marketing, due to the conservation and development benefits of beekeeping. Beekeeping has low establishment costs and requires little land or labour, and by providing a suitable environment for the hives in a favourable location (i.e. forest with a range of melliferous trees and plants and sufficient water available year round) it is possible to sustainably harvest a range of bee products on an annual basis.

For processing of the honey, the honeycomb is filtered and honey can be bottled and sold. Higher value is obtained by packaging and labelling. In Cameroon up to 4 US\$/kg can be achieved for good quality honey. It can also be sold for industrial use – for example bakeries, sweets. If combs are washed, the resulting honey-water can be made into wine. Wax needs to be melted and cleaned, and can then be sold ‘raw’ for a price of about 2-6 US\$/kg, or further processed into candles, soaps and creams.

In Cameroon, the consumer market is expanding and a small, niche export market for high quality, certified organic and fair trade wax, honey and propolis, is emerging. The exports to Europe and the US require quality assurance schemes that entail costs, expertise and collaboration between government and beekeepers. The number of hives per bee-farmer can vary considerably from a few up to 150 hives. Approximately 15 hives can be installed per hectare. Beekeepers can be good ‘guardians of the forests’, because they know that the forest provides both forage and water for the bees, and the water and materials needed to make hives and process apiculture products.



SLM measure	Management
SLM group	Sustainable Rainforest Management
Land use type	Natural forest
Degradation addressed	Indirectly deforestation / overuse of natural forests
Stage of intervention	Prevention
Tolerance to climate change	Unknown sensitivity of bees to climatic extremes; resilience of bees is assumed, but changes in honey quality and quantity depending on forage available with changes in forest cover / structure

Establishment activities

1. Construction of hives (traditional or modern, depending on skills and availability / cost of materials).
2. Place hives on forest trees or on stands, above the level of fires, as well as away from ant and termite colonies.

Maintenance / recurrent activities

1. Wait for natural colonisation or capture a swarm and transfer to hive.
2. Regular (weekly or monthly) checking of hive conditions to ensure that the colony is not disturbed by pests or damaged through wind / rain. In drought periods a shallow bucket of water is provided to the bees. Reparation activities if needed.
3. Harvest honey (as soon as sufficient is available), wax and propolis, using a ‘smoker’ and clean bucket, leaving brood combs to maintain the colony (usually annually at end of rainy and / or flowering season; depends on location). Harvesting of honey combs often done at night to minimise disturbance of the bees.
4. Filter honey from combs to separate honey and wax; then bottle and pack.
5. Process wax (e.g. washing comb and boiling in water or solar melting box) and melt into moulds, using a press or centrifuge. Comb washing water can be used in honey beer or wine in lidded buckets / basins or bottles or using as fermentation airlock.

Labour requirements

For establishment: low
For maintenance: low

Knowledge requirements

For advisors: medium to high
For land users: low

Photo 1: View of the case study area: mountainous forests in Mount Oku region, Northwest Cameroon.

Photo 2: Women carrying harvested wax.

Photo 3: Modern bee hive.

Photo 4: Traditional bee hive. (All photos by Ingram Verina)

Case study area: Mount Oku region, North-west Cameroon



Establishment inputs and costs per beehive

Inputs	Costs (US\$)
Labour: 10 person-days	40
Equipment / tools:	
bee suit	10
smoker	15
4 buckets	12
filtering materials	10
bottles for honey	5
Construction material	2-15
TOTAL	94-107
% of costs borne by land users	100%

Remarks: For a start up, 5 beehives are needed. Labour includes collection / purchase of materials. Hives can be made from local materials (e.g. raffia palm, mud, rattan, lianas, grasses, wood, or sawn planks for top bar hives) and by using available tools (machete, axe, knife; lifespan 2-5 years).

Maintenance inputs and costs per beehive per year

Inputs	Costs (US\$)
Labour: 15 person-days (US\$ 4/day)	60
Construction materials for: replacement / repair hive materials, filtering / harvesting	5
TOTAL	65
% of costs borne by land users	100%

Remarks: Labour costs depend on number of hives and distance from household. Costs vary with production level and availability of equipment (knife, mesh filter, buckets). Harvest equipment can be basic and includes smokers (bunch of grass / metal smoker) and bee suits (also made locally).

Benefit-cost ratio

Inputs	short term	long term
Establishment	slightly negative	positive
Maintenance	neutral	positive

Remarks: Initial investment in hives often recouped in 2-5 years, depending on level of production.

Ecological conditions

- Climate: subhumid
- Average annual rainfall: 2,000-2,400 mm
- Soil parameters: lateritic clay
- Landform: plateau, valleys, mountain slopes
- Altitude: mountain forests
- Each forest type produces its own honey, with a specific taste, colour, consistency and moisture content determined by the pollen and nectar from the forest plants.

Socio-economic conditions

- Type of land user: small to medium scale, very poor to average level of wealth; individuals or groups; cooperatives are mainly used for marketing products and / or buying material
- Population density: 70-100 persons/km²
- Land ownership: community forest or individual (titled and not titled)
- Land use rights: legal form of community management; many people keep bees by the forest edge on their farms, usually on privately owned land
- Market orientation: mixed (subsistence and commercial)
- Level of mechanisation: manual labour

Production / economic benefits

- +++ Subsistence use and sales of apiculture products e.g. wax / honey / propolis soaps, cosmetic, creams, wine, candles etc.
- +++ Increased income
- ++ Own consumption of honey for food and medicinal use

Ecological benefits

- +++ Conservation of forests and particularly melliferous trees
- +++ Pollination of forests and crops

Off-site benefits

- +++ Pollination in area approx 4-6 km from hive

Weaknesses → and how to overcome

- Pests destroy hives / eat honey (e.g. honey badgers, ants, termites, civets) → relocate hives, stronger / different hive construction, regular checks.
- Theft of hives → patrol forest, make agreements in community, locate hives near farms / houses, chain or lock hive.
- Low production → relocate hives to more forested areas, ensure hive located with < 2 km from water source in dry season.
- Bush fires can destroy hive → agreements with farmers / pastoralists about bush fire patrols in dry season, create fire breaks around hive and support trees.
- Rain can destroy hive → use of metal, sheet, grass, raffia or wood as protective 'roof', place in a 'bee house' of locally constructed materials, or under a simple shelter, and experiment with different designs.

Adoption

Established and knowledgeable beekeepers in a community aid dissemination of technology and spontaneous adoption. The technology of hive building needs to be learned but there are many low-tech, local material designs known, as well as simple designs for 'modern' hives. In the mountainous forests of Northwest Cameroon, both traditional practices are passed on around Mt. Oku as well as being stimulated through cooperatives, associations and business groups, covering some 4,500 beekeepers mainly in Bui, Boyo, Mezam and Donga Mantung divisions.

Main contributors: Ingram Verina, CIFOR-Cameroon; Yaounde, Cameroon; v.ingram@cgiar.org
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COMMUNITY FORESTS - CAMEROON

The 1994, Cameroon forestry law introduced the concept of community forests (CF), which gives communities the right to access forest resources in or around their villages, for an area up to 5,000 ha, over a period of up to 25 years. Villagers are allowed to manage, conserve and exploit the products of their CFs in a participatory manner. A manual of procedures guides the process of creating and managing a CF. Basic stages include:

- (1) Inform the community of their rights, obligations and procedures;
- (2) Select / create a suitable, legal community entity to manage the forest;
- (3) Mark the boundaries and agree forest use zones;
- (4) Inventorise the forest resources, such as timber species and NTFP;
- (5) Hold consultation meetings to agree on forest use, zones and plans;
- (6) Complete application file by the community and send to government;
- (7) Draw up a management plan for a 5-year period, including the distribution of revenues in the community;
- (8) Obtain the necessary felling permit for timber;
- (9) Exploit forest and implement activities according to the management plan;
- (10) Carry out annual review of logging exploits by ministry;
- (11) Monitor revision of, and approve, the management plan (5-yearly).

Once the exploitation permit based on the management plan has been obtained, communities can start to exploit on an annual basis. Often small logging enterprises are contracted for timber extraction. Where the focus is on non-timber resources - e.g. *Prunus africana* in the Northwest and Southwest - these may be exploited collectively or individually. Activities also include hunting, farming, and management of the forest to secure environmental services. Revenues from forest resources should be distributed according to the management plan, involving payments for extraction and control services (patrolling for checking on fires, etc.), as well as contributions to the forest management institution and to community development projects (e.g. schools).

Results in Cameroon are mixed: Over 400 CFs have been requested since 1996, of which 174 are operating while the rest are still waiting to be approved. In 40% of the operating CFs timber is exploited. Issues of concern however include: (1) inequitable distribution of benefits and 'capture' by elites, contractors and NGOs; (2) low profits resulting from artisanal extraction methods and scale, and (3) the long and difficult process to obtain the permission. Determinants of CFs' success include: (1) communities' technical and managerial capacities; (2) access to market information about timber and non-timber prices and buyers; (3) access to finance and equipment.

**Type of approach**

Project / programme based innovation, incorporated into legal framework

Problems / constraints addressed

- Often low level of management and administration skills to obtain and then manage a CF
- Overcoming competing interests in forest use by communities
- Ensuring that all forest users benefit equitably from their community forest

Aims and objectives

- Devolve forest management and exploitation rights to local communities adjacent to forests
- Communities benefit from exploitation of forest resources
- Forest conservation

Target groups

Local communities

Participation and decision-making

All stakeholders / users in a community should be represented in the local institution set up to demarcate, apply for, managing and exploit a community forest, implemented through a management committee, often incorporates traditional authorities in a community, and in collaboration with local Ministry of Forests and Wildlife.

Implemented SLM / other activities

- SLM measures: participatory demarcation and landuse and forest use planning
- Other activities: sometimes community group work e.g. negotiation and conflict resolution, management and book-keeping skills

Implementing bodies

International institutions and NGOs with national government and national NGOs and local communities

Land users' motivation for implementing SLM

Profitability: harvest of timber

Prestige: social pressure to manage their own forest

Improved livelihood: by conserving forest values e.g. water source protection, sacred areas

Rules / regulations: agree on farm and forest land, hunting zones

Photo 1: Communities placing a boundary marker at the edge of a forest. (Verina Ingram)

Photo 2: People with their beehives, in a community forest. (Verina Ingram)

Case study area: mainly southern part of Cameroon in the humid and mountain forest areas; 100,000 ha for 404 community forests



Costs and subsidies

Budget: Large set-up costs: average 2,600-32,000 US\$/ha (max. 59'000 US\$) over 2-4 years; operating costs: average 2,000 US\$/ha/year over the 25 year period of a CF.

Approach costs were met by the following contributors / donors:

National government	5%
International NGO	20%
National NGO	20%
Local government	5%
Local community, land users	50%
Total	100%

Subsidies financed under the approach:

Externally financed inputs

Labour	not financed (in kind)
Equipment / tools	Differs by CF: financed by project, leased, owned by a timber contractor
Agricultural inputs	not financed
Construction material	not financed
Infrastructure	not financed

Access to credits

In most cases no credit was provided. If a CF was supported by a programme / project, some receive financial credit to commence logging operations.

Training and awareness rising

- Form of training: on-the-job; forest visits, public meetings, training courses, exchange visits
- Topics: community group management, participative planning, financial management, timber exploitation, forest inventory. Training was provided to villagers and selected community representatives.

Advisory service

The communities have been made aware of the possibility to manage their forests and exploit timber. They were assisted to set up CF's, by projects / programmes, and sometimes also in the operation of the forests.

Method and key elements: advice (by NGOs, government, village elites) on group management, participative planning, financial management, contract negotiation, timber and non timber exploitation, inventories.

Research

Research has been conducted on successes, failures and contentious issues of CF in Cameroon; does it work? Is it really participative? Who benefits and how much? How can governance arrangements be reformed to create impacts intended in the forestry law?

Organisation / capacity development

Most CF's start with a capacity building and awareness raising phase by informing the communities of the CF concept, followed by on-the-job capacity building to set up a suitable functioning community organisation, inventorying forest resources, holding consultation meetings, and how to draw up and implement a management plan.

Benefits of SLM Approach

- ++ Improved sustainable land management: cost-benefit analysis indicate there are slightly more environmental and economic benefits than costs from CF than not having a CF
- ++ Adoption of Approach by other land users / projects: multiplier effect to other communities in Cameroon - also across Central African region
- ++ Improved livelihoods and human well-being: revenues for community from legal timber exploitation, conservation of forest environmental services

Strengths

- Offers legal, long term route for communities to zone and exploit forests, particularly for timber but also non timber products and environmental services.
- Devolves responsibility for forest management and conservation from national government to community level.
- Gives priority to communities to extract timber, rather than to logging companies.

Weaknesses → and how to overcome

- Implementation costs and time can be higher and take longer than revenues → good initial inventory needed to assess revenues.
- Usually external assistance or informed local community members needed for implementation, is a long and complicated process.
- Requirement only to use artisanal logging methods mean profits can be low and losses of timber high, due to wasteful artisanal methods → proposals to modify legislative framework are emerging that make it possible to use more mechanisation and export to more profitable overseas markets.
- Danger of capturing revenues by elites and / or inequitable distribution → support / needed to ensure equitable distribution of benefits.

Sustainability of activities

Once community forestry is up a running and exploitation activities show profitably, communities do continue the approach, but few CFs in Cameroon have more than 3 to 4 years of experience.

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