A PLATFORM FOR STAKEHOLDERS IN AFRICAN FORESTRY

RESTORATION PRACTICES IN DEGRADED LANDSCAPES OF SOUTHERN AFRICA



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Restoration practices in degraded landscapes of Southern Africa

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Table of contents

List of tables

List of figures

Acronyms and abbreviations

AFF	African Forest Forum
AFOLU	Agriculture, Forest and Land Use
CAADP	Comprehensive Africa Agriculture Development Programme
CAMPFIRE	Community Area Management Programme for Indigenous Resources
CBNRM	Community Based Natural Resource Management
CCARDESA	Centre for Coordination of Agricultural Research and Development in Southern Africa
CCP	Climate Change Programme
CDM	Carbon Development Mechanisms
CIFOR	Centre for International Forest Research
COMESA	Common Market for East and Southern Africa
DANCED	Danish Cooperation for Environment And Development
DFID	Department for International Development
EAC	East African Community
ENSO	El Niño–Southern Oscillation
FAO	Food and Agriculture Organization
FRIM	Forest Research Institute of Malawi
Ha	Hectare
ICRAF	World Agroforestry Centre
IFA	Individual Forest Areas
IGA	Income Generating Activities
JFM	Joint Forest Management
Mg	Mega grammes
NAP	National Action Programme

NAPA	National Adaptation Programme of Action
NGO	Non-Governmental Organizations
PFM	Participatory Forest Management
REDD	Reduced Emissions from Deforestation and Forest Degradation
SADC	South African Development Community
SRAP	Sub Regional Action Programme
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
VFAs	Village Forest Areas
WB	World Bank

Executive summary

The highest deforestation and forest degradation rates in Africa occur in the dry forests and woodlands where the pressure for land is continuously increasing, poverty is rampant, livelihood options are few, and climate change effects are severe and expected to become even more severe. In addition, land and forest tenure and rights of access to forest and woodland resources are either not clearly defined or non-existent to many people. Restoration of degraded forest and tree resources as well as woodland areas, therefore, may contribute to both peoples' livelihoods and environmental quality. An assessment was conducted in some countries in Southern Africa in order to document local experiences in restoring degraded lands, forest and tree resources as well as woodland areas. The specific objectives of the study were to:

a) assess ways and experiences farmers and other stakeholders have and are using to rehabilitate degraded lands and forest and tree resources in woodlands and savannahs in Southern Africa;

b) identify and describe the technologies and practices that have been very successful in rehabilitating degraded lands as well as forest and tree resources in Southern Africa and the conditions for their success;

c) evaluate the extent to which such successful technologies and practices and their prerequisite conditions can be up-scaled in woodlands and savannahs of Southern Africa.

Both published and grey literature was accessed to source data and/or information on land degradation and technologies used for rehabilitation/restoration in countries of Southern Africa. Literature review was supplemented by field visits in Malawi, a country deemed to have serious land degradation due to high population pressure with limited land for agricultural expansion.

Successful practices

Natural regeneration

- Most of the rehabilitation and/or establishment of natural woodlands rely on natural regeneration through either coppicing, promotion of wildings and, presently, seedlings with support from some development projects.

- A coppice with standards system of management is preferred over complete coppice because it ensures a permanent woodland cover. This system also guarantees a source of supplementary regeneration through seeds provided by the standards. In woodlands

where rate and vigour of coppicing is low, soil scarification would encourage root suckering and the new regenerants should be protected from fires through ‘controlled early burning fire’ management regime.

- The advantage of coppice regeneration is that most species produce more than one shoot, which offers opportunities for multiple uses. However, the slow growth may be of concern, especially, where complete coppice cutting is advocated.
- In general, natural regeneration is still ideal in areas needing land rehabilitation where there are still large tracts of land, for example in Mozambique, Zambia, Zimbabwe, etc. However, the issue of land and tree tenure rights, though clearly recognized in the policies of SA, needs to be implemented on the ground.

Artificial regeneration

This is, currently, the most common form of tree planting used for woodlots and commercial forest plantations. This has been promoted, exclusively, through the use of exotic species, such as species of *Eucalyptus* and *Pinus*. This has also seen the promotion of multipurpose tree species used in new agroforestry technologies, such as improved fallows, mixed intercropping, etc. While this has been, to some extent, successful in tree planting programmes, mostly for energy, the adoption of tree planting for other uses, such as environmental services is not common except in donor-driven projects.

Traditional systems

Traditional systems are mostly associated with conservation of trees known to be beneficiary through soil amelioration or provision of other multipurpose uses, such as fuelwood, fruits and wood for construction. Their management are governed by the targeted end products. However, for agricultural production, this is now being replaced more by improved agroforestry technologies, such as improved fallows and/or mixed intercropping with trees or woodlots.

Pre-conditions for up-scaling the practices in Southern Africa

Natural regeneration

There are very few areas of the natural forests and woodlands in the SADC sub-region that could be described as pristine woodlands or forests. In fact, most of the forest areas have been associated with human activities and have been transformed to secondary forests. The forest policies and their related policies have been revised in most countries of SA and are in line with the SADC forestry protocol. These have incorporated the participation of local communities in the management of the natural resources. However, there is still a problem of full scale implementation due to issues of land and/or tree tenure and, in cases of joint/co-management, the benefit sharing mechanisms are still not satisfactory to the communities.

The success of this practice is, therefore, very much dependent on the commitment of the governments in the region to implement associated forestry and decentralization policies, which would in turn address issues of rights, access and benefits by the local communities involved in the management of the resources. For example, in Zimbabwe, the adoption of the CAMPFIRE and in Malawi the CBNRM approaches have been advocated with alternative sources of income as a priority.

Artificial regeneration (tree planting) and agroforestry

All countries in the SADC have identified different types and causes of land degradation. Malawi, Mozambique, South Africa and Zimbabwe have identified tree planting as a source of renewable energy. This form of tree planting is mostly through the use of fast growing trees, which are usually exotic species. There is, therefore, a potential for using tree planting for rural development through income generation by supplying the biomass resources to energy generation companies and formalizing fuelwood and charcoal market supply chains to suburban areas in the region.

Addressing the linkages between Agriculture, Forest and Land Use (AFOLU) and Reduced Emissions from Deforestation and Degradation (REDD) is being advanced under the African Climate Solution. Carbon sequestration through the increase of carbon stocks and, particularly, the conversion of unproductive croplands and grasslands to agroforestry, has the highest potential to soak up atmospheric carbon (Syampungani et al. 2010). The promotion of and/or up-scaling of Climate-Smart Agriculture through conservation agriculture fits into both the AFOLU agenda as it is fully incorporated in national development plans and/or strategic agricultural programmes for Malawi, Mozambique, Zambia and Zimbabwe. In fact, the promotion of conservation agriculture with trees (agroforestry) has actually been shown to sequester more carbon in the soil than just conservation agriculture. Hence, the promotion of agroforestry and renewable energy sources are already well supported by both the national policies, and national adaptation and mitigation strategies to climate change in the region.

Conclusions

- It is clear from the study that natural regeneration of different forms, especially, through coppicing is the predominant form of restoration in dry forests and woodlands of SA. This may carry different forms of silvicultural management practices (complete coppice, coppice with standards and selective cutting, as well as pollarding, pruning and lopping) depending on the targeted end products.

- While the policies promoting participatory natural resource management are in place in most countries of the region, their implementation has mostly taken pilot project-based approach with no strategies for up-scaling by the governments. In this regard, the CBMNR projects managed by NGOs in Malawi, CAMPFIRE (the only notable project) in Zimbabwe and the participatory programme supported by DANCED/DFID in South Africa are some examples. Similar donor funded projects were initiated in Zambia by the Forestry Department.

- Opportunities exist where dry forests and woodlands can be sustainably managed provided tenure and benefits are clearly outlined and through promotion of IGAs that are beyond tree utilization/harvesting. For example, Namibia has promoted community conservancy management with trophy hunting in the Caprivi while Zambia has well established Game Management Authority that seems to have some form of positive sharing of benefits. In addition, there is a potential in the future through payment for environmental services (PES) when some of the natural forests and woodlands are assessed, e.g. for carbon markets.

- There is also need to take cognisance of the linkage of the livelihoods needs of local people and global environmental requirements. The multifunctional approach to land use management augers well with the current agro-ecosystems practiced in SA. In addition, most of the development policies highlight the need for sustainable management of the land resource. Thus, climate-smart agriculture, such as conservation agriculture, agroforestry and, indeed, reforestation, have been highlighted as the way of addressing climate change by agricultural sector plans in most countries in the region.

Recommendations

- African Forest Forum should facilitate development of projects through either governments or SADC/CARDESA to promote up-scaling of community-based management of natural resource. This would include capacity building of policy makers and natural resource managers on best practices for rehabilitation/restoration of dry forest and tree resources as well as woodlands.

- Through SADC/CARDESA, AFF should facilitate the development of guidelines for assessing and managing dry forest and tree resources as well as woodlands for REDD+, PES and procedures for community-based carbon markets. This can also be extended to multifunctional land use practices, such as agroforestry and traditional agro-ecosystems in collaboration with ICRAF and CIFOR.

In summary, AFF should develop mechanisms for championing the work of The Forest Carbon Partnership Facility (FCPF) of the World Bank and UN-REDD Program (FAO, UNDP and UNEP), which seem to exhibit limited success so far.

CHAPTER 1 Background

INTRODUCTION

In Southern Africa, land degradation, which is defined in general terms as a temporary or permanent decline in the productive capacity of the land (Stocking and Murnaghan, 2001), is a result of habitat change largely driven by anthropogenic factors involving low input agriculture practices, including shifting cultivation and the subsequent encroachment into forest and woodland areas, pastoralist practices, indiscriminate exploitation of timber, fire wood and non-timber forest resources, bush fires and others. Southern Africa has a range of forest and woodland types that provide key goods and services, especially for the local livelihoods of rural communities. Chidumayo (2011) has defined the term woodland in the broadest sense as a variety of wooded vegetation formations in which the woody canopy covers more than 10% of the ground surface, under climatic conditions with a dry season of three months or more. This definition incorporates vegetation types commonly termed woodland, shrubland, thicket, savannah, wooded grassland and dry forest in its strict sense. The dry forests and woodlands of Southern Africa, largely, consist of the Miombo, Zambezi Teak and Mopane woodlands.

With the exception of South Africa, fuelwood is the primary source of energy in countries of Southern Africa. This has contributed greatly to the loss of forest cover in the region. In addition, traditional farming systems characterized by shifting cultivation are no longer sustainable due to human population dynamics. This is also associated with soil erosion, which is the most widespread form of land degradation and one of the biggest threats to agricultural productivity in Southern Africa. It is estimated that about 15% of the land is degraded through erosion (UNEP, 2007). Additionally, land tenure arrangements and associated equity issues are a major threat to the sustainable use of land resources. The communal land tenure system, in which individual property rights are weak, is the most widespread. This has also contributed greatly to the loss of the forest resources as there is no perceived need to manage the resources sustainably because of lack of ownership.

Notwithstanding, there are recognized traditional forest management practices and new tree planting opportunities with associated socio-economic benefits that have the potential to promote restoration of degraded landscapes as well as forest and tree resources provided proper policies and institutional frameworks are in place that address the problems highlighted. Forest and other related policies in most countries in Southern Africa have been revised to address access of the local communities to the resources with the hope that it will result in their sustainable use and management. However, there is still a need to address benefit sharing, especially between the states and communities.

Most of the member states of South African Development Community (SADC) have signed the SADC Forestry Protocol whose main objectives include the: (i) promotion of the development, conservation, sustainable management and utilization of all types of forests and trees, (ii) promotion of trade in forest products in order to alleviate poverty and generate economic opportunities and (iii) achievement of the effective protection of the environment and safeguard the interests of both present and future generations. Furthermore, the region has demonstrated strong commitment to ratify and implement the United Nations Convention to Combat Desertification (UNCCD) through developing national and sub-regional programmes to combat desertification with collective response to problems of land degradation, drought and desertification, thereby, directly facilitating the rehabilitation of land, forest and tree resources.

The contribution of forests to climate change has been recognized as a cornerstone of the post-2012 climate change agenda with the decision to promote the reduction of emissions from deforestation and forest degradation (REDD+) in tropical countries during COP-16 in Cancun (IPCC 2007). Reduction of emissions from deforestation and forest degradation includes policy approaches and positive incentives on issues related to reducing emissions of greenhouse gases (GHGs) from deforestation and forest degradation in developing countries and recognizes the contribution of conservation, sustainable management of forests and enhancement of forest carbon stocks in achieving REDD+ objectives. Developing appropriate adaptation and mitigation actions include the improvement of forest management to reduce vulnerability to climate change and mitigate GHGs through REDD+.

The "*Africa forests, people and climate change project*" supports the emerging Climate Change Program (CCP) of the African Forest Forum (AFF) (www.afforum.org, accessed on 01 February 2014) to further develop the forest-climate change nexus considered key for Africa's future development. The purpose of the AFF-CCP is to better understand how forests and trees, and the people who depend on them in the various African landscapes, respond to climate change and variability. The emphasis of the project is on the development of the forest-climate change nexus in semi-arid areas (Sahel Belt), the woodlands of West, Eastern and Southern Africa and moist forests in Central and West Africa. As an overall strategy, the three working areas of policy and advocacy, capacity building and skills development and learning and knowledge management are closely interlinked.

The highest deforestation and forest degradation rates in Africa occur in the dry forests and woodlands where the pressure for land is continuously increasing, poverty is rampant, livelihood options are few, and climate change effects are severe and expected to become even more severe. Also, many of the countries have weak institutional structures for forest governance. In addition, land and forest tenure and rights of access to forest and woodland resources are either not clearly defined or non-existent to many people. Within such an environment, it becomes very difficult to implement policies that will not allow or seriously restrict people from, for example:

- cutting trees and clearing forests for cropland;
- collecting fodder for livestock or grazing livestock in the forests and woodlands;
- collecting firewood and making charcoal;
- harvesting timber and poles for domestic housing needs;
- collecting a myriad of non-forest products that support their livelihoods.

These are the activities that are prevalent in African dry forests and woodlands, activities which hold potential to reduce poverty. Restoration of degraded forest and tree resources as well as woodland areas, therefore, may contribute to both peoples' livelihoods and environmental quality.

OBJECTIVES OF THE STUDY

The objectives of this study were to:

- assess ways and experiences farmers and other stakeholders have and are using to rehabilitate degraded lands and forest and tree resources in woodlands and savannahs in Southern Africa, namely Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe;
- identify and describe the technologies and practices that have been very successful in rehabilitating degraded lands and forest and tree resources in Southern Africa and the conditions for their success; and
- evaluate the extent to which such successful technologies and practices and their prerequisite conditions can be up-scaled in woodlands and savannahs of Southern Africa.

METHODOLOGY

Both published and grey literature was accessed from different sources to obtain data and/or information on degradation of land, forest and tree resources and technologies used for rehabilitation/restoration in countries of Southern Africa. Literature review was supplemented by field visits in Malawi, a country known to have serious land degradation due to high population pressure with limited land for agricultural expansion. The technologies used in Malawi were evaluated for their suitability and up-scaling to other parts of that country and other countries in Southern Africa. Field visits were conducted in

Blantyre, Machinga, Mwanza, Neno, Ntcheu and Zomba districts with known high rates of deforestation and having ongoing pilot projects on forest restoration and/or rehabilitation. During field visits, main stakeholder interviews were conducted with professionals at the Forest Research Institute of Malawi (FRIM), District Forest Offices and NGOs involved in forest rehabilitation programmes.

CHAPTER 2 State of land, forest and tree resources in Southern Africa

OVERVIEW OF DEGRADATION IN SOUTHERN AFRICA

Globally, direct drivers of change encompass habitat change and degradation, climate change and extreme weather events, over-exploitation of natural resources and invasive species. Similar drivers are experienced in dry land forest ecosystems in Southern Africa, and they are mostly driven by population growth, agricultural expansion and energy needs (Table 1). These direct activities are closely linked to policy, market and institutional failures that undervalue forests and woodlands, and overvalue the benefits of destroying them to make way for other forms of land use. Land tenure arrangements and associated equity issues are major threats to the sustainable use of land resources. As stated above, the communal land tenure system, in which individual property rights are weak, is the most widespread. Hence, the poor land and tree tenure system in Southern Africa is likely to have encouraged their over-exploitation. Consequently, the remaining forested areas face increasing pressure, particularly, in response to high population growth rates and increasing poverty.

Table 1. Some causes of land degradation in Southern Africa. Source: Tarr and Tarr (2002)

Immediate causes	Ultimate causes
Frame conditions ▸ Rapid population growth ▸ Poverty: impoverished subsistent-farming communities have little option but to 'live off the land	▸ Lack of incentives that encourage or facilitate sustainable land management, e.g. lack of land tenure system ▸ Inequitable land distribution ▸ Poorly designed agricultural and other land-use projects that show little understanding of the socio-economic circumstances of the population and the dynamics of the natural resource base
Climatic factors ▸ Persistent drought ▸ Variable rainfall patterns	
Agricultural practices ▸ Overgrazing ▸ Deforestation ▸ Excessive vegetation burning ▸ Poorly managed irrigation ▸ Farming methods that are inappropriate for African conditions	▸ Inappropriate drought relief and settlement policies, e.g. establishing permanent water-points and settlements for livestock farmers on arid, semi-arid or sub-humid drylands ▸ Inappropriate production incentives, e.g. government subsidies for pesticides, fertilisers and water, which encourage overuse and wastage
Other human impacts ▸ Soil pollution ▸ Air pollution (acid rain?)	▸ Production of cash crops, forcing traditional farmers and herders onto marginal land that is vulnerable to degradation

Land use conversion, habitat change and degradation

In Southern Africa, the main human-induced habitat change includes inappropriate agricultural activities, including shifting cultivation and slash-and-burn activities that are still practised in many parts of the region. These practices are no longer sustainable and responsible for vast amounts of forest clearing and declining soil fertility. An annual loss of about 1.7% of forest land attributed to unsustainable harvesting practices, including expansion of agricultural land and use of fire for land clearing, as well as the change in forest condition and/or status has been reported in the region. In addition, impoverished subsistent communities, often, have no choice but to rely heavily on wood (for fuel), wild plants, animals and other resources that natural forests and woodlands provide. For example, charcoal production and trade provide income generating opportunities for both the rural and urban communities of Southern Africa. In Zambia alone, the charcoal industry has been reported to generate about US$30 million per annum and support 60,000 Zambians (Kalumiana and Shakachite, 2003). According to Falcão (2008), 150,000 families are employed in charcoal production in Mozambique and, on average; the annual income generated is about US$ 250-300 per family. In Malawi, estimates show that 92,800 people owe their livelihood to the charcoal industry (Kambewa et al., 2007). Among the countries within the dry woodlands and forests, Zimbabwe has the highest rate of deforestation (1.7%) while Angola (0.2%) and Mozambique (0.3%) have the lowest rates (Table 2).

Table 2. Deforestation rates in woodlands of Southern Africa. Source: FAO (2007)

Country	Total forest cover (2005) (1 000ha)	Annual change (1990-2000)		Annual Change (2000-2005)	
		(1 000 ha)	Proportion (%)	(1 000 ha)	Proportion (%)
Angola	59,104	-125	-0.2	-125	-0.2
Botswana	11,943	-118	-0.9	-118	-1.0
Lesotho	8	NS	3.4	NS	2.7
Malawi	3,402	-33	-0.9	-33	-0.9
Mozambique	19,262	-50	-0.3	-50	-0.3
Namibia	7,661	-73	-0.9	-73	-0.9
South Africa	9,203	0	0	0	0.9
Swaziland	541	5	0.9	5	0
Zambia	42,452	-445	-0.9	-445	-1.0

Zimbabwe	17,540	-313	-1.5	-313	-1.7

NS = not significant

Climate change and extreme weather events

Forests may contribute to global carbon emissions when cleared, but also have a potential to absorb carbon emissions if managed in a sustainable manner. Biome sensitivity assessments in Africa show that deciduous and semi-deciduous closed canopy forests may be very sensitive to small decreases in the amount of precipitation that plants receive during the growing season, illustrating that deciduous forests may be more sensitive than grasslands or savannahs to reduced precipitation (He´ly et al. 2006). Chidumayo (2008) showed that dry tropical trees in the savannahs of Zambia suffer severe water stress at the beginning of the growing season and that a warmer climate may accelerate the depletion of deep-soil water that tree species depend on for survival.

Associated with climate change is an increased incidence of extreme weather events that lead to massive local suffering for people and increased environmental impacts. Droughts and floods related to El Niño Southern Oscillation (ENSO) have had major human and economic and environmental costs in Southern Africa (e.g. The Floods in Mozambique in 2000). The natural resources in many instances come under more pressure as a natural coping strategy by the local communities.

One of the main challenges facing Africa is desertification. Both the global community and Africa have specifically recognized the need to address this issue. The UNCCD is the key global instrument addressing this. The UNCCD has been ratified by Lesotho and Zimbabwe in 2000 followed by Botswana, Malawi and Swaziland in 2001, Mozambique and Zambia in 2002 and South Africa in 2004.

Biodiversity

Southern Africa is globally recognized as a centre of biodiversity richness and endemism (Table 3). The Western Cape, Karoo and Miombo woodlands are of particular significance (Burgess et al., 2004). However, there is threat to biodiversity through land use transformation in some areas, such as Malawi, South Africa and Zimbabwe (Table 3). The various species of fauna and flora found in these ecosystems are also an important source of livelihoods and income for communities through Community-Based Natural Resource Management (CBNRM) programmes. Southern Africa has placed increasing importance on conservation and sustainable use of biodiversity resources and invested in several initiatives in support of those objectives, notably the transfer of ownership of biodiversity from the state to the private and community sectors, and the development of trans-boundary parks. In addition, most natural resources and environmental policies in the region recognize user rights and participatory management of the resource, including the SADC

Forestry Protocol (Saundry, 2007; Ham and Chirwa, 2011). Climate change is also emerging as a major threat to biodiversity in Southern Africa with some symptoms already manifested (Rutherford et al., 1999). It has been claimed that the highly diverse and unique succulent flora of the winter-rainfall regions in the Southwest Africa (Fynbos) is projected to be particularly threatened (Rutherford et al., 1999; Foden et al., 2003; UNEP, 2007).

Table 3. Biodiversity richness and endemism in Southern Africa. Source: Adopted from UNEP (2007)

Country	Area (km^2)	Biodiversity opportunity Plants		Threat [Proportion of land transformed (%)]	Response [Proportion of land Protected (%)]
		Endemic	Total		
Angola	1,246,700	1,260	5,185	4	4
Botswana	581,730	17	2,151	9	18
Lesotho	30,350	2	1,591	16	0
Malawi	118,480	49	3,765	29	9
Mozambique	801,590	219	5,692	11	4
Namibia	824,290	687	3,174	2	4
South Africa	1,221,040		23,420	22	5
Swaziland	17,360	4	2,715	0	2
Zambia	752,610	211	4,747	9	8
Zimbabwe	390,760	95	4,440	32	8

DESCRIPTION AND IMPORTANCE OF FOREST AND TREE RESOURCES

The vegetation in Southern Africa is generally referred to as the Zambezian Phytoregion (White, 1983). The region covers over ten countries in Central and Southern Africa lying between 3 and 26° South with a total area of 377 million ha. Miombo woodland is a significant biome covering about 10% of the African land masses (White, 1983). The dry miombo woodland occurs in Southern Malawi, Mozambique and Zimbabwe (White, 1983; Frost, 1996). The other woodland types in Southern Africa are the undifferentiated woodlands of teak and acacia woodlands. The Zambezi teak woodland is dominated by the *Baikiaea plurijuga* Harms that occurs in the Kalahari sands, especially associated with head waters of the Upper Zambezi and Okavango Delta (Timberlake et al., 2010). Other species associated with *B. plurijuga* include *Pterocarpus angolensis* DC., *Guibourtia coleosperma* (Benth.) J. Léonard and *Schinziophyton rautanenii* (Schinz) Radcl.-Sm. The third type of woodland is the Mopane woodland and semi-arid shrubland, which have *Colophospermum mopane* (J. Kirk ex Benth.) J. Kirk ex J. Léonard as the dominant tree species (Timberlake et al., 2010).

Woodlands in Southern Africa support the livelihoods of millions of both rural and urban dwellers through the provision of non-wood products, which include bees wax, honey, edible fruits, edible insects, mushrooms and traditional medicines (Bradley and Dewees, 1993). They are also a source of agricultural land, firewood, charcoal and timber (Luoga et al., 2000).The rural economy in Southern Africa is mainly based on the premises of slash and burn agriculture and wood extraction for charcoal production (Syampungani, 2008), which has greatly contributed to the degradation of woodlands and forests in the region. The woodlands in Southern Africa are, therefore, heavily disturbed, with very little old regrowth woodland remaining, while their cover continues to decline (Dewees et al., 2010), largely, driven by land clearing for agriculture and wood extraction for energy (Syampungani et al., 2009).

CHAPTER 3 Restoration approaches and practices

WOODLAND MANAGEMENT

The management practices for the woodlands in Southern Africa are designed to meet specific tangible products (Chidumayo et al., 1996; Chirwa et al., 2008; Dewees et al., 2011). Wood production, for example, in the miombo woodlands is also affected by the way miombo trees respond to harvesting. Responses depend on the phenological state, degree of resistance to fire, ability to re-sprout, seeding patterns, seed germination characteristics and seedling development (Chidumayo et al., 1996). Miombo woodlands usually respond to wood harvesting by coppice regeneration, but the rate of regeneration is affected by human activities (Chirwa et al., 2008). The best harvesting techniques and management practices are those that promote regeneration in the post-harvest era. Employing either of these systems requires that some management mechanisms are put in place to ensure high productivity. For example, adhering to optimum diameter classes, within which particular species have high coppicing effectiveness, would provide for enhanced coppicing ability for many woodland species.

Traditional management systems

Clarke et al. (1996) provided a review of some of the traditional practices and emphasized the inextricable link of the trees/woodlands, and agricultural and livestock management systems in Africa. In some areas, local leaders control the felling of trees for small-scale use. Traditionally, women would only be permitted to collect dead wood to be used as firewood. Certain trees are only permitted to be used for certain purposes and the quantity harvested is also monitored. In some places, the bark may only be harvested on the west and east facing sides of the trunk, because it is believed that those are the locations where the most potent medicines are found. This was a way of preventing “ring barking”. Control of use was also sometimes governed by traditional cultural practices. In Mozambique, Tanzania, Zambia and Zimbabwe, trees growing around sacred water sources may not be felled for fear of the water drying up (van Rijsoort, 2000). Individual large trees are normally used for traditional ceremonies and, therefore, not felled as they are thought to have ties to the spirits (van Rijsoort, 2000). Clarke et al. (1996) highlighted the widespread importance of sacred groves as dwelling places for ancestral spirits, burial grounds, protection of springs and sites for rainmaking ceremonies in Mozambique, Zambia and Zimbabwe. Sacred groves are protected using religious sanction and/or through fines imposed on violators by the chief.

Chidumayo et al. (1996) have provided an extensive review of the harvesting practices in Southern Africa, which are usually dependent on end uses. Pollarding is practised throughout the miombo region to a greater or lesser extent. In Zambia, mature woodlands are still pollarded and lopped in the preparation of ash gardens in the traditional *chitemene* shifting cultivation system. In Zimbabwe, branches are lopped for fuelwood, browse, fibre and fruit harvesting, and Mopane worms in areas where trees are scarce and felling of whole trees is prohibited (Chidumayo et al., 1996). In areas where clear cutting is for permanent agriculture, tree regeneration is through root suckers or coppices. Subsequent management would be through selective thinning for poles and timber in the long-term. The 'nicking' of the cut edge will encourage sprouting from the stump (Lowore and Abbot, 1995), while deep ploughing is said to increase the stocking rate by causing root suckers to develop (Chidumayo et al., 1996).

Silvicultural systems

Three basic silvicultural systems have been employed in harvesting Miombo woodland products in Southern Africa, namely coppice with standards, selective cutting system, clear cutting, harvesting of non-timber forest products (NTFPs) and fire management.

Coppice with standards system

The system involves leaving behind few trees over a harvested area. The high value species are left until maturity whilst the other species are clear cut and the regeneration is managed to produce a range of small dimension wood products, such as firewood and poles (Shackleton and Clarke, 2007). The trees that are left may be important for timber, fruit or fodder. For example, in Zambia most of the trees that are left over a cut area are timber species (S. Syampungani, personal communication). However, the system has been proposed for use by small scale farmers in Malawi as a means of maximizing the production of firewood and poles whilst retaining high value species that produce NTFPs and other services, such as fruit trees with spiritual significance (Lowore and Abbot, 1995). The system has the advantage of retaining a portion of tree cover and protecting site from erosion and sun scorch.

Selective cutting system

Selective cutting is the cutting down of selected trees in a forest according to criteria regarding minimum tree size for harvesting so that growth of other trees is not affected. In Zambia, for example, as many trees as possible are cut for timber and poles, and the stumps are trimmed (Lees, 1962). The selection varied from tree to tree and species to species because it was dependent on size and suitability for intended product (Chidumayo et al., 1996). Branches are, then, piled away from live trees and stumps or sold as firewood or converted to charcoal. The cut-over area is burnt for up to 10 years in order to encourage and protect regeneration in groups occurring in canopy gaps. However, Hosier (1993) views selective harvesting negatively in that an increase in the net price of a wood product, improvement in the harvesting or processing technology or increased poverty among harvesters tend to reduce selectivity and may cause over exploitation of the harvested species. It has been suggested that shading by canopy trees contributes to slow shoot growth of suppressed saplings in Miombo woodlands (Werren et al., 1995).

Clear felling

Clear felling is appropriate when harvesting firewood for the charcoal industries (Shackleton and Clarke, 2007). Since a large area is cleared, the system results in the highest rate of regrowth of the three systems. This is because the stumps of most Miombo trees have the ability to produce coppice shoots once they are cut (Strang, 1974; Chidumayo, 1993). It tends to produce rapid regeneration, which can be managed according to the product requirement.

Harvesting of non-timber forest products

While traditionally emphasis of silvicultural systems was on wood products, such as timber, recently, this has been extended to incorporate other wood products, such as firewood and poles of various sizes (Lowore and Abbot, 1995). However, very little research has been carried out on harvesting rates and designing management systems for NTFPs. The argument has been that products, which are seasonally available, such as fruits do not require harvesting limits, and provided that no damage is done to the trees during harvesting, the impact of fruit removal is minimal (Shackleton and Clarke, 2007). For example, Emanuel et al. (2005) demonstrated that 92% of fruits of *Sclerocarya birrea* (A. Rich.) Hochst. subsp. *caffra* (Sond.) Kokwaro could be harvested without impacting the population’s size class profile. However, harvesting of the bark for various products, including medicine, rope fibre and making beehives, can be highly destructive and result in increased tree mortality (Chidumayo et al., 1996). A number of methods for reducing the negative impacts of bark harvesting have been proposed and tested, notably by using improved harvesting methods that prevent ring barking and reduce fungal infestation and the use of leaves to obtain medicinal products instead of bark (Geldenhuys et al., 2006).

Fire management

Much of the current knowledge of fire and its effects on Miombo woodland structure and functioning has come from general observation supplemented by information derived from a limited number of experiments. The interest of focus among the early researchers has been more on changes in species composition with emphasis on different ecological groups that tend to develop over time (Trapnell and Langdale-Brown, 1962; Lawton, 1978). However, several studies attempted to determine the effects of fire frequency and burning period on the structure and function of the Miombo woodlands in general (Trapnell, 1959; Kikula, 1986; Chidumayo, 1988; Zolho, 2005). These studies demonstrated that species dominance and coppice effectiveness can be influenced by the fire frequency and intensity. This is because different miombo species respond differently to fire attack (Lawton, 1978). But, high intensity fires on perennating organs and food reserves generally result in die-back of shoots as a result of depletion of root food reserve of parent plants due to the systematic and continuous effects of fire (Kennard et al., 2002). From a management perspective, fire management in extensively managed woodlands should take into account the age of the woodland, the phenology of the dominant and/or desirable species, the type of land use and the management objectives of the area.

RESTORATION OF FOREST AND TREE RESOURCES

The choice of techniques for rehabilitating specific degraded areas depends first on the priorities and management objectives of stakeholders followed by the costs and benefits associated with available rehabilitation techniques and the economic, social and environmental values of the land resources in their current and desired future states. While other interventions are not discussed specifically, it is important to look beyond the forest rehabilitation and consider other socio-economic and ecological interventions. Some of the rehabilitation techniques identified as playing a role in rehabilitation in Southern Africa include natural regeneration, assisted natural regeneration, fire, enrichment planting, plantations and agroforestry.

Natural regeneration

Most of the woodlands across Southern Africa are capable of recovering following disturbance cessation (Geldenhuys, 2005; Chirwa et al., 2008; Syampungani, 2008). The re-growth may be from either coppices of stumps or root origin or stunted seedlings present in the herbal layer at the time of clearing (Chidumayo and Frost, 1996). Savannah woodland species generally have both vertically and horizontally extensive root systems, which facilitate recuperation after cutting (Mistry, 2000). These extensive root systems tend to produce root suckers and coppices once the above-ground parts are removed. Syampungani (2008) observed that a number of species, namely *Brachystegia* spp., *Isoberlinia angolensis* (Benth.) Hoyle & Brenan, *Julbernadia paniculata* (Benth.) Troupin, *Pseudolachnostylis maprouneifolia* Pax, etc. tend to coppice in stands that were previously under charcoal production, and slash and burn agriculture. Natural regeneration associated with coppicing has been reported mostly in Malawi, Mozambique, Namibia, Zambia and Zimbabwe (Table 4). Assisted natural regeneration is also used in forest restoration in Malawi, South Africa, Swaziland, Zambia and Zimbabwe. Pollarding is also a common practice in most countries, especially for trees on the farmland. Although fire has been tried as a management tool in some countries (Namibia, Swaziland and Zambia), literature indicates that it has, mostly, been used in many areas to manage grazing areas.

Table 4. Some natural regeneration techniques practiced in some countries of Southern Africa

Country	Natural regeneration	Assisted Natural Regeneration	Coppice	Pollarding	Fire
Angola				√	
Botswana				√	
Lesotho				√	
Malawi	√	√	√	√	
Mozambique	√		√	√	
Namibia	√		√	√	√
South Africa		√			
Swaziland		√		√	√
Zambia	√	√	√	√	√
Zimbabwe	√	√	√	√	

The available literature on woodlands in Southern Africa indicates that stem densities vary significantly from one woodland type to another and also whether or not the woodland is a regrowth. Densities ranged from 837 to 1,131 stems.ha^{-1} in old growth Kalahari woodlands of the undifferentiated woodland while in the Miombo old growth, the stocking was, on average, 2,434 – 2,773 stems.ha^{-1} (Syampungani, 2008). Higher variations in stocking (stems.ha^{-1}) have also been observed in mesic, semi-arid and arid localities in central Lowveld of savannahs in Southern Africa. Shackleton and Scholes (2011) recorded higher values in mesic (18,530 stems.ha^{-1}) compared with semi-arid (3,996 stems.ha^{-1}) and arid (3,978 stems.ha^{-1}) localities. A comparison of regrowth stand densities between Kalahari woodlands and miombo woodlands indicated a significant variation from 1,131 to 6,685 stems.ha^{-1} in Miombo woodland to 7,264 to 9,700 stems.ha^{-1} in Kalahari woodlands (Table 5). A variation in stocking per recovery stage/disturbance factor was reported by Strang (1974) in the Zimbabwean Highveld, which was protected against fires. Initially, a steady increase in stocking from 925 – 5,810 stems.ha^{-1} was observed between 1.5 and 18 years after cutting. However, lower stocking levels were observed in the same locality, which was constantly experiencing fires (Strang, 1974).

Table 5. Growth parameters of some woodlands in Southern Africa

Range of variables		Vegetation type	Source
Density (stems.ha^{-1})	1121-6926	Re-growth (miombo)	Syampungani et al. (2010); Campbell et al. (1996); Strang (1974)
	2434-2773	Uneven-aged mature woodland (miombo)	Syampungani (2008)
	3978-18530	Uneven-aged mature woodland (South African central lowveld)	Shackleton and Scholes (2011)
	837-1131	Uneven-aged mature woodland (Kalahari)	Timberlake et al. (2010)
	7264-9700	Regrowth (Kalahari)	Timberlake et al. (2010)
Basal area (m^2)	7-22	Uneven-aged mature woodland (Miombo)	Lowore et al. (1994); Freson et al. (1974)
	7.12-12.44	Uneven-aged mature woodland (South African central lowveld)	Shackleton and Scholes (2011)
Mean biomass (Mg.ha^{-1})	1.5-90	Uneven-aged mature woodland (Miombo and Mopane woodlands)	Chidumayo (1991); Tietema (1993)
	22-44.47	Uneven aged mature woodland	Guys (1981); Martin (1974)
	18.41-37.9	Uneven aged mature woodland (South African central lowveld)	Shackleton and Scholes (2011)
Growth rate (Mean annual ring width in mm)	4.4-5.6	Regrowth (Miombo)	Syampungani et al. (2010)
	2.3-4.8	Uneven aged mature woodland (Miombo and South African savannahhs)	Shackleton (2002); von Maltitz and Rathogwa (1999); Chidumayo (1988)

The basal area ranged from 7 to 22 $m^2.ha^{-1}$ in old uneven aged stands of various woodland types (Table 4) with the lowest being recorded on lithosols in southern Malawi at about 650 mm mean annual precipitation and the highest being recorded in wet miombo woodland deep soils of the Democratic Republic of Congo at 1,270 mm rainfall (Lowore et al., 1994; Freson et al., 1974). Lower basal area (e.g. 9.81 $m^2.ha^{-1}$) was mostly associated with young regrowth stands of up to 20 years old since cutting (Chidumayo, 1987). However, higher values of stand basal areas of between 30 and 50 $m^2.ha^{-1}$ have been recorded in wet miombo and dry miombo of Zambia and Zimbabwe, respectively, in small sized plots (Chidumayo, 1985; Grundy, 1995).

Artificial regeneration

The success of seedling establishment in natural forests and woodlands is low due to moisture and heat stress. The majority of tree seedlings in miombo woodlands, notably those of *Brachystegia* and *Julbernardia* species, have non-foliaceous and non-chlorophyllous cotyledons with a short life span. In addition, Chidumayo et al. (1996) indicated that species of both *Brachystegia* and *Julbernardia* have ectomycorrhizae, and it is also possible that the early death of some seedlings may be because these seedlings fail to establish an association with mycorrhizae by the time they shed their cotyledons. Mortality of young seedlings is also due to uncontrolled fires and grazing by animals. Chidumayo et al. (1996) showed that stem mortality under late burning was 5 - 6 times higher than under early burning, but mortality varied among species.

On the other hand, tree planting through woodlots and/or plantations is a viable option to increasing woody biomass and tree products to meet the long-term needs of the people. Trees have also been planted to produce environmental services, such as soil stabilization and amelioration, windbreaks and shade and carbon sequestration (Chamshama et al., 2010).

Currently, Southern Africa has about 2,200,000 ha of forest plantations, which accounts for about 28% of the total African plantations (Table 6). Almost two thirds of this, about 1,500,000 ha, are in South Africa. The plantations consist of fast growing exotic species, such as *Pinus patula* Schiede ex Schltdl. & Cham., *Cupressus lusitanica* Mill. and *Eucalyptus* spp., which were established mainly for the production of industrial round wood for export and, in some cases, wood fuel. Only in the case of South Africa, Swaziland and Zimbabwe have plantation programmes been strongly linked to industrial utilisation. Limited markets and accessibility undermined the industrial use of Malawi’s plantations, while the civil wars in the past affected the management of plantations in Angola and Mozambique. However, there is a rapid expansion of forest plantations in Northern Mozambique (Landry and Chirwa, 2011).

Table 6. Extent of forest plantations in the SADC countries

Country	Land area (1 000 ha)	Total forest area (1 000 ha)	Plantation forest (1 000 ha)	Proportion of area of plantation forest area (%)
Botswana	56,673	12,427	1	0.01
Lesotho	3,035	14	14	100
Malawi	9,409	2,562	112	4.4
Mauritius	202	16	13	81.3
Mozambique	78,409	30,601	50	0.2
Namibia	82,329	8,040	0	0
South Africa	121,758	8,917	1,554	17.4
Swaziland	1,721	523	161	30.8
Tanzania	88,359	38,811	135	0.3
Zambia	74,339	31,246	75	0.2
Zimbabwe	38,685	19,040	141	0.7
SADC	554,919	152,195	2,256	1.5

Traditional agro-ecosystems

Farming systems in Southern Africa have, largely, been practiced for subsistence on ever-decreasing plots of lands with declining soil fertility. These farming systems have become inadequate to cope with population growth explosions that are experienced in the region. The general agro-ecosystem/farming system in Malawi and Zambia is the *maize mixed farming*, but Zambia has also the *forest-based and root crop farming systems* (Musinguzi, 2011). The *Forest-based farming* system is practiced characteristically in humid forests in the region, and farmers practice shifting cultivation by clearing a new plot in the forest every

3 - 5 years and, then, in the past allowed a fallow period of 7 - 20 years. This is the basis of the Chitemene system in Zambia and the Machambas that are used to cultivate crops, such as cassava, maize, beans and potatoes in Niassa Province of Mozambique (Chidumayo, 1987; Landry and Chirwa, 2011). In Mozambique, the fields are usually first planted with cereals or groundnuts followed, later, by cassava. Cassava is complemented by maize, sorghum, beans and cocoyam. In South Africa, the general agro-ecosystem is, mainly, composed of large commercial and smallholder farming system in semiarid and dry sub-humid zones. This system comprises of scattered smallholder farms in the former homelands and large commercial farms both with mixed cereal-livestock systems. In addition, maize mixed farming and agro-pastoral millet/sorghum farming systems are practiced in South Africa. Also, predominant in the commercial sector is the game farms, which typically comprise of private nature reserves that, somehow, contribute to in situ biodiversity conservation.

The traditional tree legume-based system [Faidherbia albida (Del.) A. Chev. Parklands]

For centuries, farmers have retained a low density of trees in the parkland or two-tiered systems in the tropics, especially, in the semi-arid areas in order to improve the yield of understorey crops (Akinnifesi et al., 2008). In Southern Africa, traditionally, farmers grow crops under scattered trees including the *F. albida*/maize system in Southern and Central Malawi. *Faidherbia albida* has a unique characteristic of shedding most of its leaves during the wet season and resuming leaf growth during the dry season. This makes it possible to cultivate under its canopy with minimum shading effect on the companion crop. Substantial benefits are realized from these practices as resource-use by trees and associated crop components rarely overlap. The cultivation of crops under canopies of *F. albida* is the most notable of such traditional agroforestry practices in Southern Africa (Table 7).

Table 7. Some agroforestry systems and technologies used in Southern Africa

Country	Agroforestry System/Technologies					
	Improved fallows	Contour hedgerows	Conservation agriculture	Boundary planting	Farm forestry/ woodlots	Traditional systems
Angola						
Botswana						
Lesotho						
Malawi		√	√	√	√	√
Mozambique						√
Namibia						
South Africa				√	√	
Swaziland						
Zambia	√		√	√		√
Zimbabwe			√	√		

Dambo land ecosystems (Dimba cultivation and pastures)

In Southern Africa, especially Malawi, Zambia and Mozambique, smallholder farmers cultivate uplands as well as wetlands (Khumalo et al., 2012). The dambo is cultivated in the dry season intensively utilising both mono-cropping system as well as mixed cropping patterns also known as intercropping dominated by maize, beans, sugarcane and green vegetables. Apart from such intensive dry-season cultivation, dambo are a source of green grazing pastures when the uplands have dry grass. Such practices of cultivation and grazing result in vegetation degradation as invaders such as *Cynodon*, *Urochloa* and *Sporobolus* grass species become dominant.

Transhumance grazing systems

Seasonality is considered to be an important factor in the agricultural systems of the agro-ecosystems of Southern Africa. It revolves around the very distinct wet and dry seasons. The availability of pasture in the late dry season is of particular importance in the management of the agro-ecosystems (Khumalo et al. 2012). In Zambia, transhumance grazing is still practised on the Kafue flats, where livestock graze in woodlands in the wet season and on the low-lying flood plains in the dry season (Sǿrensen, 1993). Scoones (1990) also reported this pattern of grazing in Zimbabwe. This is important in the restoration of degraded lands in that it allows the trees to recover through vegetative-coppice regrowth just before the start of the wet season.

Agroforestry

In Africa, and particularly Southern Africa, the main constraint to agricultural productivity is soil nutrient deficiency. For this reason, agroforestry research in the region has focused on soil fertility replenishment (SFR) technologies over the years and the adoption, and scaling-up of these practices is the main thrust of the ongoing on-farm research (Akinnifesi et al., 2008; Akinnifesi et al., 2010; Table 7). SFR encompasses a range of agroforestry practices aimed at increasing crop productivity through growing trees (usually nitrogen-fixing), popularized as *fertilizer* tree systems, directly on agricultural land. Fertiliser tree systems involve soil fertility replenishment through on-farm management of nitrogen-fixing trees (Mafongoya et al., 2006; Akinnifesi et al., 2010).

The different fertiliser tree systems that have been developed and promoted in Southern Africa (Akinnifesi et al., 2008, 2010) over the last two decades include:

- *Intercropping*: it is the simultaneous cultivation of two or more crops on the same field, usually, involving maize as the main crop in Southern Africa and other agronomic crops as risk crops. In agroforestry-based intercropping systems, species, such as pigeon pea [*Cajanus cajan* (L) Millsp.], *Tephrosia vogelii* Hook. f., *F. albida*, *Leucaena leucocephala* (Lam.) De Wit and *Gliricidia sepium* (Jacq.) Kunth ex Walp. are prominent. *Gliricidia sepium* is a coppicing exotic species that is being used in the intercropping technologies throughout Southern Africa (Chirwa et al., 2003).

- *Relay cropping*: it is a system whereby nitrogen-fixing trees, shrubs or legumes, such as *Sesbania sesban* (Jacq.) W. Wight, *S. macrantha* Welw. ex E. Phillips & Hutch, *T. vogelii* and *Crotalaria* spp. or perennial pigeon pea (*C. cajan*), are grown as annuals and planted 3 to 5 weeks after the food crop.

- *Improved fallow*: it has emerged as a promising alternative to traditional fallows. In an improved fallow, fast-growing, nitrogen-fixing species, such as *S. sesban*, *T. vogelii*, *G.*

sepium and *L. leucocephala* are grown for 2 to 3 years in the fallow plot after which, they are harvested.

The most widely tried system in Eastern Zambia is the improved fallow system while different forms of conservation agriculture are being promoted in Malawi, Zambia and Zimbabwe. Notable traditional systems as described above are common in Malawi, Mozambique and Zambia (Table 7)

CASE STUDY: LOCAL LEVEL PRACTICES IN MALAWI

Tree regeneration/planting

Most of the regeneration observed was around houses, especially for fruit trees and on arable agricultural land (Table 8; Figures 1 and 2). However, some development project areas encouraged natural regeneration by protecting important species, stimulating root sprouting and using seedlings in some degraded natural woodlands or farmers' fields. Planting of trees from seeds, seedlings, wildings, cuttings or truncheons is a very common practice in many parts of Malawi (Ngulube et al., 1999). Living fences were usually planted from cuttings and truncheons, especially around the homesteads and dry season vegetable gardens in the '*Dambos'*. While early burning in traditional practices is, usually, used to encourage growth of new pastures, it was noted that it stimulated sprouting of grasses and regeneration of certain tree species that require fire to germinate.

Agroforestry technologies, usually promoted by NGOs in Malawi include mostly intercropping and relay cropping systems in the Shire Highlands. Tree planting is promoted through different programmes by NGOs and the government.

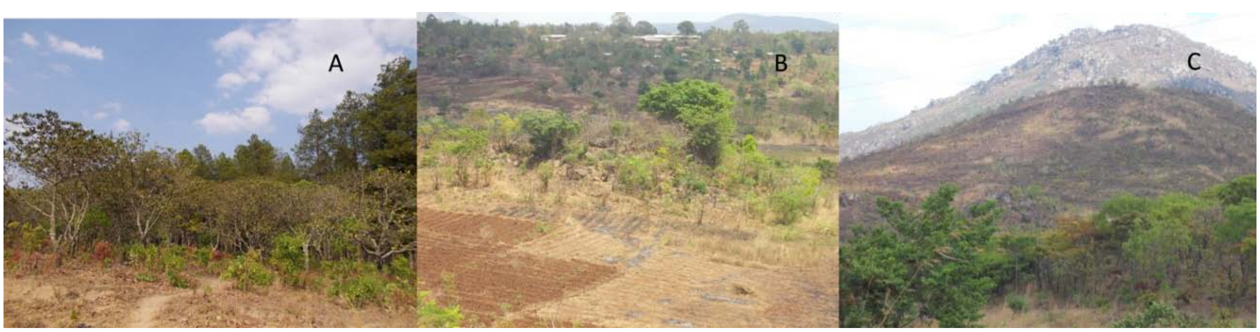

Figure 1. Regeneration - (A) Dedza-Miombo regeneration dominated by fully grown Uapaca in the background; (B) Zomba - completely cultivated fields with planted species in the farmers' fields; and (C) Ntcheu Hills: showing extent of degradation (Photo by Chirwa, 2012).

Figure 2. Machinga (Ntaja) Malawi - (A) Women's club tree nursery; (B) *Senna spectabilis* woodlot; and (C) Enrichment planting in a degraded site (Photo by Chirwa, 2012).

Table 8. Existing tree regeneration/planting practices in some part of Malawi

Practices	Species	Places
Artificial regeneration/tree planting **Seedling and subsequent transplanting of seedlings**	Exotic species: *Eucalyptus* species, *Citrus* species, e.g. *C. sinensis* (L.) Osbeck, *C. limonium* Risso and *C. reticulata* Blanco, *Gmelina arborea* Roxb., *Toona ciliate* M. Roem., Senna siamea (Lam.) Irwin & Barneby, *Mangifera indica* L., *Carica papaya* L., *Psidium guajava* L. and *Persea americana* Mill. Indigenous: *Parinari curatellifolia* Planch. ex Benth., *Uapaca kirkiana* Müll. Arg., *Vitex payos* (Lour) Merr., *Multidentia crassa* (Hiern) Bridson & Verdc., *Azanza garckeana* (F. Hoffm.) Exell & Hillc. and *Bauhinia thonningii* (Schumach.) Milne-Redh.	Homesteads and arable lands near homes, water catchments
Assisted natural regeneration **Wildling transplanting**	*Cussonia arborea* Hochst. ex A. Rich., *Diplorrchynchus condylocarpon* (Müll. Arg.) Pichon., *Burkea africana* Hook., *Pterocarpus angolensis* DC., *A. garkeana*, *Dalbergia melanoxylon* Guill. & Perr., *Afzelia quanzensis* Welw., *Julbernardia paniculata* (Benth.) Troupin, *P. angolensis*, *Annona senegalensis* Pers., *Cutunaregan spinosa* (Thunb.) Tirveng., *Brachystegia utilis* Burtt Davy & Hutch., *Commiphora mosambicensis* (Oliv.) Engl., *Ficus natalensis* Hochst., *P. guava*, *Syzygium* species – *P. curatellifolia* and *U. kirkiana*.	Homesteads and arable lands near homes, catchments etc.
Cuttings or truncheons	*Ficus capensis* Thunb., *Senna senguana* L., *Dalbergia nitidula* Welw. ex Baker., *Lannea discolour* (Sond.) Engl., *Erythrina abyssinica* Lam. ex DC., *C. arborea*, *F. natalensis*, *C. mosambicensis*, *C. spinosa*, *Albizzia antunnesiana* Harms. *Euphorbia tiruccali* L., *Ziziphus mucronata* Willd.	Homesteads, Living fences for cattle, bathrooms, homes and gardens.
Stimulation of regeneration/Coppice Regeneration	*Eucalyptus*, *Gmelina*, most indigenous spp	Homesteads, woodlands, live fences, etc.
Agroforestry	Most multipurpose tree species – *Gliricidia*, *Leucaena*, fruit trees.	

CBNRM: the Case of Community Project at Kamwamba, Neno

The Sustainable Management of Indigenous Forests (SMIF) project was a response to the vast reduction in forest cover due to unsustainable utilization of forest resources (FAO, 2009). It aimed at empowering rural forest users to manage their forest resources sustainably by promoting communal and individual forest management and introducing sustainable income generating activities (IGAs). The project was, thus, aimed at improving forest management while addressing livelihood needs of communities at the same time. The implementation of SMIF was preceded by baseline surveys to access forest resources, identify alternative income generating activities and institutional structures supportive of enterprise development and forest management.

Key activities implemented included forest management activities (seedling production, afforestation, seedling/coppice tending, fire protection and patrols for illegal forest activities) and income generating activities (guinea fowl rearing, fruit juice production from *Tamarindus indica* L. and *Adansonia digitata* L. fruits and honey production). Only the impact on the forest resource as a result of different forest management activities is reported here.

Forest inventory was undertaken 10 years after the inception of the project and the results were compared with forest inventory data at the beginning of the project (Mwalukomo, 2006).

Forest cover

The major gain was not in terms of increasing overall forest area, rather the gain was in terms of reduced forest degradation achieved through tree planting and improved management. The overall indigenous forest cover has increased by over 30% in stocking from 1998 to 2006. The forest cover of the Village Forest Areas (VFAs) increased by over 48%. The individual forest areas (IFA) under weak leaderships attained the lowest forest cover increase (24%) over the same period. However, forests were mostly comprised of young trees of less than 10 cm diameter at breast height (dbh) in a forest type, which can reach a diameter size of 42 cm. This has implication on the resource base for sustainable enterprises introduced in the area.

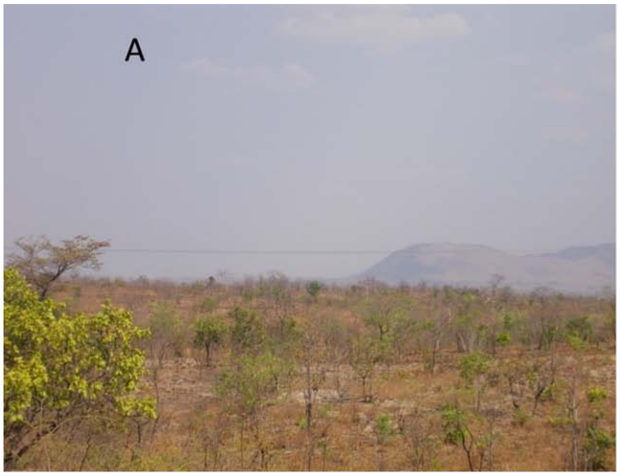

Figure 3. Kamwamba area, Neno - (A) Young regeneration and (B) Charcoal sale on the M1 Road from Blantyre to Lilongwe, Malawi (Photo by CHIRWA, 2012).

Species composition

The project area is now dominated by *Combretum fragrans* F. Hoffm. (292.74 stems.ha^{-1}), *Pterocarpus rotundifolius* (Sond.) Druce (259.42 stems.ha^{-1}), *Combretum zeyhri* Sond. (258.23 stems.ha^{-1}), *Diplorrhynchus condylocarpon* (Müll. Arg.) Pichon. (167.79 stems.ha^{-1}) and *Bauhinia petersiana* Bolle (165.41 stems.ha^{-1}). Compared to the 1996 situation, some trees have maintained their dominance, namely *C. fragrans* and *B. petersiana*, implying that there has been a shift in species dominance in the area.

A total of forty tree species were recorded in the VFA areas while 54 species were recorded in the IFAs (unregulated) under weak leadership and 33 species in IFAs under strong leadership. The variation in species diversity is associated with increasing forest disturbance (May, 1981). The IFAs (unregulated) are frequently disturbed by fire and harvesting activities, hence, the high species richness (54 species). The total control area was dominated by large diameter trees representing a fairly undisturbed forest, hence, the low species richness (24 species).

Stem diameter distribution

Most stems are found in the 1 - 4.9 cm diameter at breast height (dbh) category with the IFAs (regulated) recording the highest number of stems.ha^{-1} followed by the IFAs (unregulated). The areas under total control recorded the third highest and VFAs came last in this dbh class. Tree stocking increased over the project period, but was associated with lower diameter classes. However, the forest resource is still under severe stress due to harvesting for fuelwood and charcoal making, which is still prevalent in the area (Figure 3B). Considering that fuelwood and charcoal can use tree with diameter size of as small as 5 cm dbh, the forests of the area will continue to suffer further degradation if no better protection is instituted.

Tree planting

Tree planting, as an intervention to reduce deforestation and improve forest cover, resulted in a total of 242,021 trees being planted from 1996 to 2006. The largest number of trees (181,144 trees) was planted by individual villagers, signifying the high level of commitment from individual villagers planting on their own land. Over 31 different indigenous tree species were planted. Exotic tree species were also planted such as eucalypts species (65,529), seconded by *S. siamea* (44,298). The agroforestry species, such as *Albizzia lebbeck* (L.) Benth., *Delonix regia* (Boj. ex Hook.) Raf. and *Faidherbia albida*, were also widely planted in the area.

Most families own homestead woodlots or carried out enrichment plantings in their IFAs. Some of them have already started benefiting from the woodlots by harvesting the trees for domestic use or generating income from sales of poles, especially from *Eucalyptus* species. Tree planting and tending of natural regeneration has had a positive impact on the small diameter class, and the survival of young trees reflects the degree of protection from fire that the young tree received. However, there is a need for strong protection due to excessive over exploitation that is rampant in the area for tree as small as 5 cm diameter (Figure 3A).

CHAPTER 4 Successful practices and pre-conditions for up-scaling

EVALUATION OF RESTORATION PRACTICES

Natural regeneration

Most of the rehabilitation and/or establishment of natural woodlands has been through natural regeneration involving coppicing, promotion of wildings and, presently, seedlings through some development projects (refer to Table 4). Few studies have shown the response of natural woodland species to different forms of harvesting regimes. In a study across soil and climatic conditions where the natural woodlands were subjected to selective thinning (coppice with standards and complete coppicing with the exclusion of fire), it was shown that miombo can be regenerated and managed through coppice systems as long as the woodlands are kept in juvenile state through use of short rotations (Lowore, 1999; Mwabumba et al., 1999). The commonest type of regeneration was by underground rootstocks (suffrutices) (Table 9). A coppice with standards system of management is preferred over complete coppice because it ensures a permanent woodland cover. This system also guarantees a source of supplementary regeneration seeds provided by the standards. In addition, in woodlands where rate and vigour of coppicing is low, soil scarification would encourage root suckering, and the new regenerants should be protected from fires through '*controlled early burning fire*' management regime.

Table 9. Type and number of regenerants at Chimaliro, Dedza and Phuyu in Malawi. Source: Mwabumba et al. (1999)

Regeneration type	Phuyu		Dedza		Chimaliro	
	1997	1999	1997	1999	1997	1999
Suffrutices	35	43	26	34	39	48
Seedling	11	1	12	8	11	10
Root sucker	2	-	-	-	-	-

Abbot and Lowore (1999) compared the coppice regeneration of firewood species in Chimaliro in the forest reserve and the customary woodlands. The findings showed that customary land had a higher species diversity (66 species compared with the Reserve's 43 species) due, in part, to its more varied structure and age, which have allowed invasive and pioneer species to become established. The advantage of coppice regeneration is that most species produce more than one shoot, which offers opportunities for multiple uses (Table 10). However, the slow growth may be of concern, especially where complete coppice cutting is advocated. Notwithstanding, as regeneration of miombo woodlands through vegetative, as opposed to seedling, regrowth is more productive, in the short-term at least, management systems for wood products of small (non-timber) dimensions have historically been based on coppice or coppice with standard systems (Chidumayo, 1987; Lowore and Abbot, 1994; Abbot and Lowore, 1999). However, miombo provides much more than just firewood to local populations, and the management varies from one area to another to reflect the multiple utilities of the woodlands.

In general, natural regeneration is still ideal in areas needing land rehabilitation where there are still large tracts of land, for example in Mozambique, Zambia, Zimbabwe, etc. However, the issue of land and tree tenure rights, though clearly recognized in the policies of Southern Africa, need to be implemented on the ground. This would also be the case where Participatory Forest Management approaches are being promoted where benefit sharing is still a bottleneck in the success of some CBNRM programmes.

Table 10. Four-year coppice regeneration for selected species at Chimaliro Forest Reserve, Malawi

Species	Number of coppices		Coppice height		Coppice shoot	
	Mean	SE	Mean (m)	SE	Mean Basal diameter (cm)	SE
Acacia amythethophylla Steud. ex A. Rich.	3.6	0.566	3.44	0.128	4.67	0.383
Brachystegia boehmii Taub.	5.6	0.466	1.71	0.107	4.18	0.264
Brachystegia floribunda Benth.	8.1	0.605	2.38	0.099	4.55	0.219
Brachystegia longifolia Benth.	6.6	2.012	2.00	0.138	4.80	0.559
Brachystegia spiciformis Benth.	7.9	1.222	3.06	0.170	4.91	0.289
Brachystegia utilis	7.0	0.519	2.42	0.079	4.56	0.171
Combretum apiculatum Sond.	2.2	0.550	3.36	0.328	4.19	0.503
Combretum molle R.Br. ex G.Don	3.5	0.494	3.55	0.445	3.75	0.544
Jubernardia paniculata (Benth.) Troupin	6.5	0.357	1.62	0.044	3.27	0.096
Pericopsis angolensis (Baker) Meeuwen.	8.9	1.065	1.94	0.097	3.92	0.289
Piliostigma thonningii (Schum.) Milne-Redh.	11.0	8.100	3.10	0.106	5.66	0.384
Pseudolachnostylis maprouneifolia Pax	8.9	0.837	2.38	0.141	4.56	0.352
Uappaca kirkiana	6.8	0.493	1.74	0.053	4.60	0.141

Artificial regeneration

This is currently the most common form of tree planting used for woodlots and commercial forest plantations. This has been exclusively with use of exotic species such as those of *Eucalyptus* and *Pinus*. This has also seen the promotion of multipurpose tree species used in new agroforestry technologies, such as improved fallows, mixed intercropping, etc. While this has been, to some extent, successful in tree planting programmes, mostly for energy, the adoption of tree planting for other uses, such as environmental services is not common except in donor driven projects.

Traditional systems

This was also a common form in the traditional farming systems where trees on the farm land are a common feature. However, except in areas where the tree species, like in the case of the *F. albida* parkland systems, is directly associated with productivity, most trees on farm like in Malawi are being either cleared or pollarded as source of energy or for income generation. The traditional shifting cultivation system, like in Northern Zambia, is now being compromised due to the population pressure and improved systems need to be promoted as was the case with improved fallows using species of *Sesbania* in the Eastern Province of Zambia.

PRE-CONDITIONS FOR UP-SCALING THE PRACTICES

Natural regeneration

There are very few areas of the natural forests and woodlands in the SADC sub-region that could be described as pristine woodlands or forests. In fact, most of the forest areas have been associated with human activities and transformed to secondary forests. Hence, due to their degraded nature and high pressure to provide other important forest products, natural forests, especially, dry forests and woodlands in SADC countries only play a minor role in the provision of construction timber. However, where there is some form of harvesting for important species, the harvesting criteria in most of the countries is, usually, selective harvesting of large diameter timber species. As highlighted earlier, the forest policies and their related policies have been revised in most countries of Southern Africa and are in line with the SADC forestry protocol. These have incorporated the participation of local communities in the management of the natural resources. However, there is still a problem of full scale implementation due to questions of land and/or tree tenure issues, and in cases of joint/co-management, the benefit sharing mechanism are still not satisfactory to the communities. Notwithstanding, the main forest restoration practices advocated in natural forests and woodlands in all the countries of Southern Africa was mostly through coppice natural regeneration because of the associate benefits of better rates of growth due to the already established root system. However, other forms of natural regeneration, in the form of associated natural regeneration, have been advocated by some development projects in Malawi where the main objective was the rehabilitation of watershed management areas. In South Africa, removal of invasive alien species (Australian Acacias, Pines, etc.) is the main objective (Table 11).

Table 11. Regional and national approaches and programmes and the recommended practices for restoration

Country	Type and cause of degradation	Objectives and/or activities for restoration	Potential practices for restoration
South Africa	Veld degradation, including loss of cover, bush encroachment, alien plant invasion, change in composition of plant species, deforestation, clearing of veldt and loss of biodiversity.	Community planning package, afforestation and renewable energy.	▸ Tree planting ▸ Assisted natural regeneration
Zimbabwe	Land degradation as one of the main problems attributed to climatic change and human activities.	Provision of energy, alternative livelihoods and land rehabilitation with the adoption of a CAMPFIRE approach.	▸ Tree planting ▸ Natural regeneration
Malawi	High population pressure and a very high reliance of the population on the natural resource base as the main causes of desertification	Promotion of community-based forest/natural resource management activities and alternative sources of income activities, e.g. micro-projects in bee-keeping, tree seedling production, (fruit) tree planting, agroforestry, establishment of VFAs, woodlots, etc.	▸ Natural regeneration ▸ Agroforestry ▸ Tree planting
Zambia	Land degradation and drought.	Forest, ecosystems and species conservation.	▸ Natural regeneration ▸ Tree planting ▸ Agroforestry
Mozambique	Drought, flood and tropical cyclones.	Promote the use of renewable energies, encourage the use of conservation agriculture, promote community reforestation activities for energy consumption and forest conservation activities, community reforestation activities using native species and community activities for fire management.	▸ Natural regeneration ▸ Tree planting ▸ Agroforestry

The success of this practice is, therefore, very much dependent on the commitment of the governments in the region to implement associated forest and decentralization policies (Table 12), which would, in turn, address issues of rights, access and benefits by the local communities involved in the management of the resources. For example, in Zimbabwe, the adoption of the Community Area Management Programme for Indigenous Resources (CAMPFIRE), and in Malawi the CBNRM approaches have been advocated with alternative sources of income as a priority (Table 12).

Artificial regeneration (tree planting) and agroforestry

All countries in the SADC have identified different types and causes of land degradation (Table 11). Malawi, Mozambique, South Africa and Zimbabwe have identified tree planting as a source of renewable energy. This form of tree planting is mostly through the use of fast growing trees, which are usually exotic species. In South Africa, with high rural electrification and a more advanced energy policy, renewable form of energy is encouraged. There is, therefore, a potential for using tree planting for rural development through income generation by supplying the resource to energy generation companies. However, in most other countries of the SADC, tree planting is for fuelwood supply. This also has a potential to create opportunities, especially if clear mechanisms for REDD+ are in place in the region.

Addressing the linkages between Agriculture, Forest and Land Use (AFOLU) and Reduced Emissions from Deforestation and Degradation (REDD) is being advanced under the African Climate Solution (COMESA-EAC-SADC, 2011). Carbon sequestration through the increase of carbon stocks and, particularly, the conversion of unproductive croplands and grasslands to agroforestry, has the highest potential to soak up atmospheric carbon at rates of the order of three tonnes ha^{-1} $year^{-1}$ according to the IPPC (2007). The promotion of and/or up-scaling of Climate-Smart Agriculture through conservation agriculture fits into the AFOLU agenda as it is fully incorporated in national development plans and/or strategic agricultural programmes for Malawi, Mozambique, Zambia and Zimbabwe (Table 11). In fact, the promotion of conservation agriculture with trees (agroforestry) has actually been shown to sequester more carbon in the soil than just conservation agriculture. Hence, the promotion of agroforestry and renewable energy sources are already well supported by both the national policies and national adaptation and mitigation strategies to climate change in the region.

Table 12. Factors influencing the rehabilitation and/or restoration of dry forests and woodlands in Southern Africa. Source: Adopted from Dewees et al. (2011)

Factor	Malawi	Mozambique	Zambia	Zimbabwe
Relevant Policies	• Forest Act No. 11 (1997) • National Forestry Policy (1996)	• Forest and Wildlife Act (1999) • Reform Land Law No. 19 (1997) • National Forestry Policy (1997)	• The Forests Act (1999) • Lands Act (1995) • National Forestry Policy (1998)	• Forest Act (Chapter 19:05 revised in 1996) and Communal Land Forest Produce Act (1987) • Communal Land Act (Chapter 20:04), Natural Resources Act (Chapter 20:13), National Parks and Wildlife Act (Chapter 20:14), Land Acquisition Act (1992) • Draft National Forestry Policy (2001)
Forestry and decentralization	Decentralization not adequately addressed in the forest policy.	Forestry policy (1998) and Act (2002) call for delegation of responsibility to the lowest level. Land and wildlife/forestry laws contradictory with respect to tenure.	Forestry Policy (1998) and Forest Act (1999) allow for community involvement only in local forests (not national).	Policies for local control in place for wildlife but not forestry.
Commitment to implementation	Few practical results (Blaikie, 2006). Devolution in forest sector less successful than other sectors. Forest administration slow to	Commitment at policy level, but many implementation problems. Devolution fragmented and limited by sector related barriers and lack of procedural guidelines.	Implementation mechanisms vague.	Decentralization to district councils only. Committees often collapse when projects end. More successes for wildlife than forestry.

	approve local forest management plans.	More successes for wildlife than forestry.		
Benefit sharing	Government retains powers to define the type and location of resources that communities may manage.	Very restricted benefits from concessions and often benefits do not reach communities.	Limited benefits to local communities. Elite capture by traditional leaders.	Benefits end with the district council. Elite capture by traditional leaders.
Land tenure	Not clear-cut in communal areas.	Not clear-cut in communal areas.	Not clear-cut in communal areas.	Not clear-cut in communal areas.
National Development Plans and Strategic Agricultural Programmes	*Sustainable management of natural resources*: conservation farming, afforestation, protection of fragile land and catchment areas, and rehabilitation of degraded agricultural land.	Plano Estratégico de Desenvolvimento do Sector Agrário (Strategic Plan for Agricultural development) (2010) (PEDSA) - Specific strategic objectives. Land, water, forest and wildlife resources used sustainably.	National Agricultural Policy: Sustainable Land Management Programme: Promote appropriate conservation farming methods; promote appropriate agro-forestry packages and technologies.	The Zimbabwe Medium Term Plan Agriculture Sector. Completion and rationalization of the land reform programme, which includes: (i) establishment of secure tenure systems; and (ii) land use planning.

CHAPTER 5 Conclusions and recommendations

CONCLUSIONS

Southern Africa is globally recognized as a centre of biodiversity richness and endemism with the Western Cape, Karoo and Miombo woodlands being of particular significance. However, there is a threat to biodiversity through land use transformation in some areas such as Malawi, South Africa and Zimbabwe. Human-induced habitat change, including inappropriate agricultural activities, continues to be practised in many parts of the region, resulting in an annual loss of about 1.7% of forest land. Among the countries within the dry woodlands and forests, Zimbabwe has the highest rate of deforestation (1.7%) while Angola (0.2%) and Mozambique (0.3%) have the lowest rates. However, there is a need to recognize the importance of the forest resource for the livelihoods and income of communities in the region. Hence, Southern Africa has placed increasing importance on conservation and sustainable use of the forest resource with supportive national and regional policies that promote community participation. The participation of the communities has the added benefit of using their traditional and/or local knowledge in resource use and management.

It is clear from the study that natural regeneration of different forms, especially, through coppicing is the predominant form of restoration in dry forests and woodlands of Southern Africa. This may carry different forms of silvicultural management practices (complete coppice, coppice with standards and selective cutting, pollarding, pruning and lopping) depending on the targeted end products.

While the policies promoting participatory natural resource management are in place in most countries of the region, their implementation has, mostly, taken pilot project-based approach with no strategies for up-scaling by the governments. For example, in Malawi (most of the CBNRM projects are managed by NGOs), in Zimbabwe, CAMPFIRE is the only notable project while in South Africa the Danish Cooperation for Environment And Development/ Department for International Development (DANCED/DFID) participatory programme was the case in point. Similar projects were initiated in Zambia by the Forestry Department, but were also donor funded.

Opportunities exist where dry forests and woodlands can be sustainably managed provided tenure and benefits are clearly outlined and through promotion of IGAs that are beyond tree utilization/harvesting. For example, Namibia has promoted community conservancy management with trophy hunting in the Caprivi while Zambia has well established Game Management Authority that seems to have some form of positive sharing of benefits. In addition, there is potential in the future through payment for environmental services (PES) when some of the natural forests and woodlands are assessed for carbon markets.

There is also a need to take cognisance of the linkage of the livelihoods needs of local people and global environmental requirements. The multifunctional approach to land use management augers well with the current agro-ecosystems of Southern Africa. In addition, most of the development policies highlight the need for sustainable management of the land resource. Thus, climate-smart agriculture, such as conservation agriculture, agroforestry and, indeed, reforestation have been highlighted as the way of addressing climate change by agricultural sector plans in most countries in the region.

RECOMMENDATIONS

African Forest Forum should facilitate development projects through either governments or SADC/CARDESA (Centre for Coordination of Agricultural Research and Development in Southern Africa) to promote up-scaling of community-based management of natural resources. This would include capacity building of policy makers and natural resource managers on best practices for rehabilitation/restoration of dry forests and woodlands.

Through SADC/CARDESA, AFF should facilitate the development of guidelines for assessing and managing dry forests and woodlands for REDD+, PES and procedures for community-based carbon markets. This can also be extended to multifunctional land use practices, such as agroforestry and traditional agro-ecosystems in collaboration with World Agroforestry Centre (ICRAF) and Center for International Forest Research (CIFOR).

In summary, AFF should develop mechanism for championing the work of The Forest Carbon Partnership Facility (FCPF) of the World Bank and UN-REDD Program (FAO, UNDP and UNEP), which seem to exhibit limited success so far.

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