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Practices, techniques and technologies for restoring degraded landscapes in the sahel

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Acronyms and abbreviations

ADB	African Development Bank
AFD	Agence Française de Développement (French Development Agency)
AFF	African Forest Forum
AFF-CCP	African Forest Forum Climate Change Programme
ANCAR	Agence Nationale de Conseil Agricole et Rural (National Agency for Agriculture and Rural Counselling)
ANR	Assisted Natural Regeneration
CEN-SAD	Community of Sahel-Saharan States
CILSS	Inter-State Committee on Drought Control in the Sahel
CAADP	Comprehensive African Agricultural Development Program
CBD	Convention on Biological Diversity
CCD	Conventions for Combating Desertification
CONSERE	National Framework Partnership to fight against desertification and poverty
CPS	Country Partnership Strategy
CST	Comité de Suivi Technique (Technical Monitoring Committee for Environment and Nature Protection)
CSE	Centre de Suivi Ecologique (Ecological Monitoring Centre)
CSLP	Cadre Stratégique de Lutte Contre la Pauvreté/ Strategic Framework for Poverty Alleviation
CNCASP	National Council for Agro-forestry-pasture
DANIDA	Danish Development Agency
DOS	Document d'Orientation Stratégique (Strategic Orientation Document)
DNCN	Direction Nationale de la Conservation de la Nature
ECOWAS	Economic Community for West African States
FAO	Food and Agricultural Organisation
FDF	Federal Department of Forestry
FMNR	Farmer Managed Natural Regeneration
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Green House Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
IDA	International Development Agency
IFAD	International Fund for Agricultural Development
INP	Institut National de Pédologie (National Soil Institute)
IPCC	International Panel on Climate Change
LADA	Land Degradation Assessment in Drylands
MDG	Millennium Development Goals
MEA	Multilateral Environmental Agreements
NAPA	National Action Plan for climate Change Adaptation
NEAP	National Environmental Action Plan

NPEP	National Policy on Environmental Protection
PAC1	Plan d'Action Communautaire (Community Action Plan) Phase 1
PDA	Projet de Développement Agricole (Agricultural Development Project)
PAN/LCD	Plan d'Action National de Lutte Contre la Désertification (National Action Plan for Desertification Control)
PANE	Plan d'Action National de l'Environnement (National Environmental Action Plan)
PAFN	Project d'Aménagement des Forêts Naturelles (Forests Management Project)
PAF	Plan d'Amenagement Forestier (Forestry Management Plan)
PAPIL	Small Scale Irrigation Support Project
PAPEL	Small Scale Livestock Support Project
PASF	Forestry Sector Support Project
PASP	Projet Agrosylvopastoral (Agrosilvopastoral Support Project)
PATECORE	Projet d'Aménagement des Terroirs et de Conservation des Ressources
PDRT	Projet de Développement Rural de Tahoua
PGRNG	Programme de gestion de ressources naturelles par aménagement des bassins versants dans la wilaya de Guidimakha
PLECO	Projet de Lutte Contre l'Ensablement des Cuvettes Oasiennes
PMN	Programme Mali Nord
PNISA	Programme National d'Investissement au Secteur Agricole (National Programme for Agricultural Sector Investment)
PRBP	Projet de Réhabilitation de Barrage et de Pistes
PSAOP2	Projet d'appui aux Services Agricoles et des Organisations des Producteurs, phase 2
PVAF	Plan Villageois d'Aménagement Forestier (Village Forestry Management Plan)
REDD	Reduction of Emission caused by Deforestation and forest Degradation
RDS	Rural Development Strategy
SED	Stratégie Energie Domestique (Domestic Energy Strategy)
SLM	Sustainable Land Management
SIF-SLM	Sustainable Investment Framework for the Sustainable Land Management
SLG	Structure Local de Gestion (Local Management Structure)
SDDSR	Schéma Directeur du Développement du Secteur Rural (Rural Sector Development Master Plan)
SNRASP	Système National de Recherche et d'Appui au Secteur Pastoral (National Research System on the Agro-silvo-pastoral sector)
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention for Climate Change
WOACAT	World Overview on Conservation and Technology

Executive summary

The different agro-ecological zones of Sahelian countries have experienced continuous degradation for the last four decades due to the combined effects of drought, increasing anthropogenic pressure on the limited natural resources available, deforestation and degradation of wood resources, reduced fallow period, intensification of cropping, overexploitation of water and pasture resources, etc. These malpractices have resulted in a decrease in the productivity of the prevailing Sahelian agro-silvo-pastoral land use systems.

In response to this crisis, many international agencies and donor organisations have provided support to Governments and people in the Sahel aiming at developing technical, environmental and agricultural strategies and approaches for achieving sustainable and productive management of the environment and improving the quality of the different land resources. This support, mainly in response to the humanitarian and environmental crises that brought severe famine and resulted in the loss of large areas of cropland, rangeland and forestland, has focused on soil and water conservation and restoration techniques. Thus, many projects in these decades of recurrent droughts have developed activities related to land improvement and development practices and to natural resources conservation.

After these decades of drought and famine, and following the Earth Summit in Rio de Janeiro in 1992, most Sahelian countries have developed strategies and national action plans and programmes for combating desertification and for improved management of natural resources in order to meet the commitments undertaken by signing and ratifying the Post-Rio international conventions, i.e. the Conventions for Combating Desertification (CCD), for Conserving Biological Diversity (CBD) and for mitigating Climate Change (UNFCCC). As a result, issues of environmental degradation, including desertification and degradation of natural resources such as forests, woodlands and trees, have received increased international attention.

In their efforts to implement these Multilateral Environmental Agreements (MEAs), most Sahelian countries have made significant progress in the fight against desertification, and for environmental protection and the rehabilitation of degraded lands, forests and woodlands. Much efforts has also been directed by countries towards technical, financial and institutional matters through implementation of several projects and programmes for desertification control, management of natural resources and improvement of income and living conditions of rural people. Various sustainable management techniques and practices, including farmer assisted natural regeneration, soil protection and conservation, and water conservation, have been implemented in the field. At the institutional level,

policies and strategies have been elaborated to strengthen countries' commitment to implementing regional and international initiatives.

Restoration of degraded land is increasingly a key requirement in a context where food security is one of the main objectives for sustainable development of the countries. Many policies and strategies that were developed, and the action plans and programmes that are in place; focus on micro-economic interventions. These are are heavily subsidised and unfortunately, do not consider the broader policies.

With the launching of the TerrAfrica process, Sustainable Land Management (SLM) is considered in most Sahelian countries as an imperative development tool for harmonising interventions within and between the major sub-sectors, such as agriculture, livestock, forestry, water resources and environment. It has been widely accepted that SLM can promote cross-sector integration, as recommended in the Agenda 21 and the Poverty Reduction Strategies elaborated and adopted by most Sahelian countries for achieving the Millennium Development Goals (MDGs). In fact, most Sahelian countries have elaborated and adopted sustainable investment frameworks for sustainable land management (SIF-SLM) for scaling up and mainstreaming best practices, techniques and technologies in this domain.

The main components of the SIF-SLM include:

1) providing adequate funding for scaling up SLM practices, techniques and technologies in the field, such as farmer managed natural regeneration, water harvesting technologies, soil fertility improvement techniques, afforestation, bush fire control measures, management of forests and protected areas, establishing flora and fauna reserves, elaboration and implementation of forest and woodland management plans, etc.;
2) strengthening the enabling environment for SLM practices, including improving institutional, political and financial support to SLM through: i) the implementation of a support programme for improving the institutional and financial capacities required for implementing SIF-SLM as a framework for National Strategies and Programmes for Food Security; ii) strengthening national mechanisms for SLM financial resource mobilisation from the coalition of financial and technical partners and others, mobilising relevant innovative funding sources, and increasing the national SLM budget; and, iii) enhancing the legislative and regulatory environment for SLM by integratiing SLM into policies, strategies, projects and cross-sector programmes at all administrative levels;
3) enhancing the advisory roles of the technical services and improving the participation of the private sector in the implementation of best SLM practices, techniques and technologies through the development of harmonised planning and the promotion of marketable goods and services from SLM practices;
4) developing necessary tools for data collection, analysis and information dissemination to all local users and decision makers;

5) formulating and implementing sound and appropriate communication strategy supporting the application of the SLM approaches and the adoption of best practices;
6) strengthening the capacities of all stakeholders in using SLM approaches, strategies, practices and techniques, and promote the implementation of SIF-SLM through various training sessions of all actors (civil society, private sector, local authorities, and public sector organisations of producers, etc.) involved in SLM;
7) providing adequate funding for the development and application of monitoring tools and SLM information systems, and building capacity for implementing them in order to allow stakeholders to better monitor land resource uses and changes and to transfer knowledge necessary for sustaining post-project impact, thereby contributing to greater adoption of climate-smart land, water and forest management.

CHAPTER 1 Introduction

BACKGROUND

The African continent is vulnerable to climate change. Desertification, drought, degradation of natural resources, flooding and poverty are the most important environmental and social challenges of Africa in general and the Sahelian countries in particular. A large proportion of the population depends on natural resources and agriculture for their livelihoods and governments are faced with limited financial resources and an array of challenges, such as maintaining the existing social and economic infrastructures for health care, education, transport and communication, etc. Africa is facing a potentially worrisome situation during this 21st century.

Africa's contribution to the global anthropogenic emissions of greenhouse gases is relatively small, amounting to about 7% in 1990, land use changes included. The emissions caused by the burning of fossil fuels, including transportation, are even smaller and represent only c. 4% of the world's total. Approximately 70% of the principal emission source on the African continent is land-use change, which essentially means deforestation. The remaining 30% can be attributed to industrial emissions and transportation (FAO, 2003 cited in FPA/NEPAD, 2007).

In this context, climate change is recognised as a major threat to achieving the poverty reduction aspirations of many African countries as well as achieving the Millennium Development Goals (MDGs). Climate changes already appear to affect rainfall patterns, water availability and sea levels, causing increased incidences of droughts, floods and bushfires, which in turn impact human health, agricultural productivity and biodiversity. In this way, climate change will adversely affect the livelihoods of many people, incomes of nations and the environmental resources on which people depend, including forests, trees and woodlands. While forests may be affected by climate change, they also play a key role in adaptation to such change, e.g. by increasing the resilience of rural communities. Forests may also support the adaptation of other species, e.g. mammals, birds and insects, to changing climate patterns and sudden climate events by providing refuge and migration corridors.

Forests and woodlands also indirectly support economies to adapt to climate change by reducing the costs of climate-related negative impacts. Forest ecosystems may also provide goods and services during extreme events (droughts and floods) and by reducing vulnerability to the effects of climate change. Most poor people in Sahelian countries depend directly or indirectly on forests and trees for their food security and livelihoods. With populations increasing by 2 to 3.5% per annum, more pressure is put on natural resources with a constantly increased demand for forest products and other natural resources.

An estimated 17.4% of global greenhouse gases (GHG) emissions are derived from deforestation. Forests also have considerable potential for carbon sequestration through afforestation, reforestation, degraded forest restoration and changes in forest management practices, as well as through substitution of forest products for fossil fuels or products requiring fossil fuels in their production.

These contributions of forests and vegetation cover to climate change mitigation have been recognised as a cornerstone of the post-2012 climate change agenda with the adoption of the “reduction of emissions from deforestation and forest degradation” (REDD+) approach at COP-16 in Cancun. The objectives of REDD+ include policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries and recognises the contribution of conservation, sustainable management of forests and enhancement of forest carbon stocks. Developing appropriate adaptation and mitigation actions include the improvement of forest management to reduce vulnerability and to mitigate GHG emissions through REDD+.

To reverse the trend of land degradation and climate change, several efforts have been made by countries at the technical, financial and institutional levels, by implementing several projects and programmes in the context of desertification control, management of natural resources and the improvement of living conditions and income of people, particularly in rural areas. At the technical and institutional levels, policies and strategies have been elaborated to strengthen their commitment to implementing regional and global initiatives, such as the United Nations Convention on Combatting Desertification (UNCCD), the United Nations Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (CBD), and the Comprehensive African Agricultural Development Programme (CAADP) of the African Union.

Unfortunately, much in these policies and strategies, plans and programmes focus on heavily subsidised microeconomic interventions, hence limiting the need to consider broader policies which are potentially more relevant to the development of Africa, i.e. reduction of poverty, increasing economic growth and protection of the environment.

METHODOLOGY

The methods employed to effectively address the overall objectives of this study and meet the specific tasks assigned include:

- visits to the countries of West Africa for data collection of major country political and strategic documents dealing with forests, forest management and restoration of degraded lands and woodlands, and to regions where farmer assisted natural regeneration is carried out, i.e. Maradi, Tahoua and Zinder in Niger.

- meetings with the different national and regional institutions (when applicable) dealing with issues related to sustainable management of forests and woodlands (with the support of an interview guide);
- meetings with some Coordination Units of Projects and Programmes dealing with rural development and sustainable land management issues to get information on their experiences, successes and difficulties encountered during the implementation of activities. These meetings also included discussions on the potentials of the techniques and technologies for restoring degraded forests and woodlands, and getting ideas and suggestions for mainstreaming and scaling up the most widely accepted SLM practices, techniques and technologies.

CHAPTER 2 Techniques and technologies for sustainable land and forest management in the Sahel

The Sahel is a region that has always been characterised by a high degree of climate variability, both in time (great variation between years, unexpected dry spells during the rainy season) and in space (rainfall can vary greatly from one area to another). Over the last two decades, the effects of climate change have exacerbated the already difficult conditions of the Sahelian populations. Crises that affect the Sahel are due to a combination of human and natural factors and dynamics, and political changes, and are mainly:

- periods of very low rainfall from 1970 to 1990;
- population growth rate of over 3% in most Sahelian countries, putting great pressure on natural resources (shortened or no fallow, decline in yields and migration to less drier areas);
- increase in the area of land cleared for farming, resulting in the disappearance of tree and grass cover and soil degradation caused by water and wind erosion;
- farming practices that in some locations have failed to adapt to changing environmental conditions and accelerated processes of erosion;
- increase in the area of denuded land with a hardened soil crust in uncultivated areas, resulting in a decline in the production of wood (firewood) and forage;
- loss of local know-how about soil conservation practices;
- disappearance of services provided by the government, such as animal healthcare, agricultural extension, supply of inputs and plant protection, as a result of structural adjustments.

As a result of these crises, it is estimated that about 25% of families left their villages between 1975 and 1985 because of the droughts in the area covered by PATECORE, the German programme in Burkina Faso. In the 1980s and 1990s, therefore, many international co-operation agencies, especially GIZ (earlier GTZ), provided supports to people in the Sahel for the development of technical, environmental and agricultural strategies and approaches for achieving sustainable and improved management of the environment and different types of land units. These supports, mainly in response to the humanitarian and environmental crises that brought severe famine and resulted in the loss of large areas of cropland, rangeland and forestland, focused on soil and water conservation (SWC) and soil protection and restoration (SPR) techniques (GIZ, 2012).

Thus, some of the most important projects implemented in Sahelian countries since 1980 have developed land improvement practices on a wide scale, e.g. in Burkina Faso and Niger. The project for land development and resource conservation in Burkina Faso (PATECORE) has improved a total of 100 000 ha of land, mostly farmland, with contour stone bunds and permeable rock dikes and dams. The Tahoua Rural Development Project (PDRT) in Niger focused on improving community land on plateau, slopes and farmland, using contour stone bunds, zai planting pits, Nardi/Vallerani and hand dug trenches, semi-circular bunds and other techniques on 125 000 ha and the Agrosilvopastoral Support Project (PASP) did the same on 500 000 ha in Niger. The Acacia Operation projects have improved the productivity of 4 000 ha of degraded agrosilvopastoral land (MAISHAROU, 2007) using the Vallerani technology. Hundreds of thousands of ha were rehabilitated by the Keita Integrated Project. The project for the rehabilitation of dams and tracks (PRBP) in Mali constructed around 80 small-scale dams, and the Mali North Programme (PMN) improved around 13 000 ha of land with village irrigation schemes and measures for developing seasonally flooded slope areas (GIZ, 2012).

After these decades of drought and famine, and following the 1992 Earth Summit in Rio de Janeiro, most Sahelian countries have developed strategies and national action plans and programmes for combating desertification and for the sustainable management of natural resources in order to meet the commitments undertaken by signing and ratifying the Post-Rio international conventions, i.e. CCD, CBD and UNFCCC. Since then, issues of environment degradation, including desertification and degradation of natural resources, such as forests, woodlands and trees, have attracted special international attention.

The implementation of the Multilateral Environmental Agreements (MEAs) has enabled most Sahelian countries to make significant progress in the fight against desertification, for environment protection and in the rehabilitation of degraded forests and woodlands through various practices, techniques and technologies, including farmer assisted natural regeneration, and soil and water protection and conservation. Unfortunately, the results obtained so far remain insufficient given the magnitude of the problems, partly as a result of the sectoral approaches that dominated the implementation of plans and programmes.

With the launching of the TerrAfrica process, the concept of Sustainable Land Management (SLM) was introduced and defined in 2005 as *"the adoption of systems of land use, which, through appropriate management practices, enables land users to maximize economic and social benefits of the land while maintaining and improving the ecological support functions of land resources"*. Since then, the SLM concept is considered in Sahelian countries as an imperative for sustainable development and a tool for harmonising interventions between the major sub-sectors of agriculture, livestock, water resources and the environment. It was unanimously accepted that SLM can promote cross-sectoral integration, as aimed for in the Agenda 21 and the Poverty Reduction Strategies elaborated and adopted by most Sahelian countries for achieving the MDGs.

Within the framework of implementing the new concept of SLM, many African countries have conducted a major exercise of diagnosing and evaluating the practices, techniques and technologies for the management of degraded forests, lands and woodlands in order to identify the best practices that could be applied on a large scale for meeting the needs of environmental protection, poverty alleviation and the improvement of rural livelihoods.

CHAPTER 3 Land resources in Sahelian countries

Countries in the Sahel and Sahara regions are characterised by low and erratic rainfall. In combination with some human influences, such as deforestation, over-grazing, bush fires, intensive monocropping with no use of fertilisers and organic material, etc. These have seriously affected the ecological equilibrium, resulting in the degradation of natural soil and vegetation resources, and a decline in agricultural production, all indicators of a process of desertification. Thus, in the four countries, i.e. Burkina Faso, Mali, Niger and Senegal, with an ever increasing population, not less than 629 000 hectares of forest disappear annually (UA/CENSAD, 2009) as shown in Table 1 below. The strong aridity experienced in most of these countries has induced a precarious situation of food security, energy supply and poverty (UA/CENSAD, 2009).

This predominantly rural population (50% to 80%) is characterised by a high growth rate (2.5 - 3.5%) and depends to a significant degree on forest and woodland resources for their livelihoods. These resources contribute substantially to meeting the food and feed needs in the Sahel, as well as also providing raw materials for crafting and roofing, and an array of non-wood forest products for medicines and other uses. Forest resources, in the broader sense, contribute significantly to the Gross Domestic Product (GDP) of some Sahelian countries, e.g. 9.5% in Niger. The economy of most countries relies largely on agro-sylvo-pastoral production systems, contributing to c. 40% of GDP in Niger (SDR, 2003). Crop production, livestock raising and forest exploitation are the main activities of rural people, who still rely mainly on extensive management systems with low yields leading to forest and woodlands areas reduction, loss of biodiversity, land degradation, poverty and food insecurity. Deforestation – mainly through conversion of forest and woodlands to agricultural land and exploitation for wood energy – accounts for more than 600 000 hectares each year in these countries (Table 1). Nigeria and Mali have the highest rates of deforestation, while Mauritania has the lowest rate.

Table 1. Population and GDP characteristics of six Sahelian countries (a), and forest and woodland statistics of the same (b)

County	Area (Km²)	Population 2012				GDP 2008	
		Total[1]	Density (inh/ km²)	Annual growth (%)	Rural (%)	Per capita (USD)	Annual growth (%)
Burkina Faso	274 200	15 275 115	56	2.6	81	1 160	4.5
Mali	1 240 192	15 494 466	13	2.4	68	1 129	5.0
Mauritania	1 030 700	3 359 185	3	3.1	59	2 100	2.2
Niger	1 267 000	16 344 687	13	3.4	84	683	9.5
Nigeria	923 768	170 123 740	184	2.6	52	2 099	6.0
Senegal	196 722	12 969 606	66	2.5	58	1 793	3.3
Total	4 932 582	233 566 799	47	-	-	-	-

Country	Extent of forests and other wooded areas[2]						Deforestation rate[3] (ha/year)
	Forest		Other wooded land		Other land		
	1 000 ha	% of land	1 000 ha	% of land	1 000ha	% of land	
Burkina Faso	5 649	21	5 009	18	16 702	5 902	-15 000
Mali	12 490	10	8 227	7	101 302	-	-99 000
Mauritania	242	n.s.	3 060	3	99 768	-	-10 000
Niger	1 204	1	3 440	3	122 026	8 000	-62 000
Nigeria	9 041	10	4 088	4	77 948	245	-398 000
Senegal	8 473	44	4 911	26	5 869	1 174	-45 000
Total	37 100	7.5	28 690	5.8	423 590	15 321	-629 000

To address the environmental challenges, efforts have been made at technical, financial and institutional levels to reduce the negative trends and improve the livelihoods of people by implementing development projects, e.g. hydro-agricultural and reforestation actions to combat desertification, water management improvement and introducing national and sub-

[1] CIA, 2012 (estimate)
[2] FRA, 2010
[3] FRA, 2005, cited in GGWI (2009)

regional coordination. The table 2 below shows some afforestation efforts carried out in Sahelian countries. However, despite some successes and good practices that should also be capitalised and developed, it must be recognised that the results remain much below expectations and the productive base has continued to deteriorate.

Afforestation and natural regeneration of forests and woodlands in some countries have significantly reduced the net total loss of forest area (Table 2). These efforts are certainly in part due to the application of Soil and Water Conservation practices carried out in most Sahelian countries and in part due to the application of sustainable management of forest and woodlands advocated by some development projects in the 1980s and 1990s.

Table 2. Afforestation/reforestation efforts of Sahelian countries (FRA, 2010)

Country	Other naturally regenerated forest			Planted forest		
	1 000 ha	% of forest area	introduced species (%)	1 000 ha	% of forest area	introduced species (%)
Burkina Faso	5 540	98	-	109	2	80
Mauritania	221	91	-	21	9	-
Mali	11 960	96	0	530	4	90
Niger	836	69	17	148	12	-
Nigeria	8 659	96	0	382	4	44
Senegal	6 456	76	-	464	5	53
Total	33 672	-	-	1 654	-	-

CHAPTER 4 Common SLM practices/ techniques/technologies in the Sahel

Sustainable management practices, techniques and technologies aim at achieving various goals, including:

i) improve water management,
ii) increase the productivity of cropland, forestland and rangeland, and,
iii) ensure sustainable management at the environmental, social and economic levels.

With regard to beneficiaries, the goal is to improve food security by ensuring, increasing and diversifying production to enable them to cope better in the lean season. Their income increases and comes from more diversified sources, which contributes to reducing poverty. In social terms, the goal is to improve the organisation and capacities of rural communities, promote the sustainable use of natural resources and prevent conflicts over them. These measures also contribute to raising the water table and making water more readily available to people and livestock. In environmental terms, they improve the ecology by protecting the land against erosion, increasing soil fertility and conserving biodiversity. They therefore provide people living in these areas with a more stable livelihood, reduce their vulnerability to external factors, such as climate change, and contribute to increasing their resilience. The most commonly used SLM practices, techniques and technologies in the Sahelian countries are summarised in Table 3 below.

Table 3 shows that Burkina Faso, Mali and Niger apply more or less the same practices/techniques/ technologies/approaches for SLM, viz. water harvesting, soil conservation, sand dune stabilisation and soil fertility improvement, probably because of the lower annual rainfall in these countries and intense sand storms that wipe away the fertile topsoil at the onset of every rainy season, creating large tracks of hardpans and sand dunes.

In Nigeria and, to a less extent, in Senegal, the application of SLM practices related to soil fertility and pH management is mainly due to the high rainfall received in these countries which washes away many important soil nutrients. The situation in Mauritania is relatively unique, because of its position at the ocean and its soils which are mainly sandy. The most important SLM applied there includes a combination of water harvesting techniques, sand dunes stabilisation, pasture management and gully plugging.

Table 3. Common SLM practices in Sahelian countries

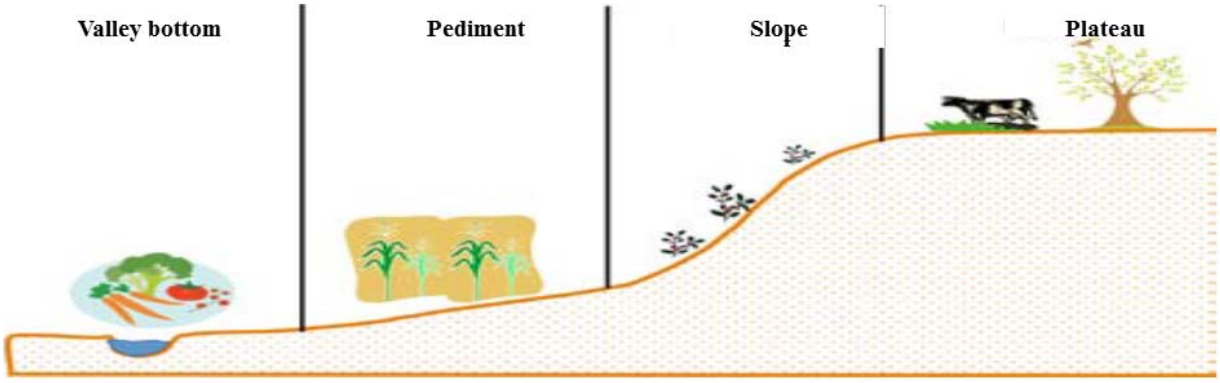
Common SLM practice	Country					
	Niger	Burkina Faso	Mali	Mauritania	Senegal	Nigeria
Semi-circular bunds/half moon	X	X	X	X	X	X
Zai/Tassa	X	X	X	O	X	X
Stony /vegetation bunds	X	X	X	X	X	X
Benches/banquettes	X	X	X	O	X	
Trenches	X	X	X	O	X	
Sub-soiling		X	X	O	X	X
Mulching	X	X	X	X	X	X
Composting	X	X	X	X	X	X
River banks stabilisation (dikes, gully plugging)	X	X	X	X	X	X
FMNR/RNA	X	X	X	X	X	X
Vallerani trenches	X	X	X	X	X	x
Windbreaks/hedgerows	X			X		X
Intercropping/Mixed cropping		X	X	X	X	X
Rural territory management approach	X	X		O	O	O
Rural wood market approach	X	X	X	O	O	X
Sand dune stabilisation	X		X	X	X	X
Fire breaks	X	X	X	X	X	X
Direct seeding	X	X	X	X	X	X
Aerial seeding	O	O	O	X	O	x
Liming	O	O	O	O	X	X
Minimum/zero tillage	O	O	O	O	O	X
Cover cropping	O	O	O	O	O	X
Improved fallow	O	O	O	O	O	X
Contour ploughing	O	O	O	O	O	X
Terracing	O	O	O	O	O	X

The best SLM practices identified by the Sahelian countries can be grouped into the following categories according to the objective for which they are implemented:

- *Biological farming practices or crop management techniques,* such as conservation agriculture with crop rotation and intercropping, integrated pest management, tree planting and agroforestry, mulching and crop residue management;
- *Improved pastures and rangeland techniques,* including planned grazing combined with water holes establishment, seeding grasses and woody species, control of invasive non-palatable plant species, and control of bush fires through establishment of fire breaks;
- *Improved forest management,* with practices such as afforestation and reforestation, farmer assisted natural regeneration, shelter belts, protection against wild fires, and conservation of plant diversity;
- *Improved soil fertility management,* including utilisation of crop residues, organic and humus amendment (compost, brown and green manure), integrated management of soil nutrients, and environmentally friendly farming techniques;
- *Water harvesting techniques* for recharge of groundwater or improved rain water management, through techniques such as zai (tassa), half-moon, stony bunds, ripping and sub-soiling, grass strip establishment, rehabilitating wasteland with benches and trenches, and drainage techniques;
- *Erosion control,* using mechanical methods or structures which serve as barriers of stones or vegetation along contour lines, ridging/ridge tying, minimum tillage for the management of water erosion, and sand dune stabilisation/fixation for the control of wind erosion.

These practices, techniques and technologies could also be further classified according to the objective of the activities and the position in the topographical sequence (Figure 1) in which they are applied for maximum impact. This grouping includes:

- improvement of *plateaux*: semi-circular and contour bunds, Nardi/Vallerani trenches, fire breaks;
- improvement of *slopes:* hand-dug trenches, permeable rock dams, dune stabilisation;
- improvement of *pediments:* contour stone bunds, permeable rock dikes, Zai planting pits, use of manure and compost, mulching, farmer assisted natural regeneration; sand dunes stabilisation, firebreaks; and,
- improvement of *valley bottoms*: water-spreading weirs, small-scale dams, village irrigation schemes.



Soil	Fertile alluvial soil	Deep, fairly fertile colluvial soil	Shallow stony soil (or sandy soil in the case of dune stabilisation)	Shallow, infertile soil, duricrust outcrops, barren areas with hardened soil crust
Use	Individual plots with: irrigated crops, market gardens, Communal grazing and watering areas	Individual plots with rain-fed crops	Communal land with some grazing areas	Communal land for: grazing, collection of wood and other products (fruits, medicinal plants)
Risk	Gully erosion Siltation Flooding	Gully erosion Sheet erosion	Gully erosion Landslides	Sheet erosion Gully erosion Wind erosion
SLM Practices	Water-spreading weirs, Small-scale dams, Village irrigation schemes, Assisted natural regeneration, Permeable rock dams, Contour stone bunds	Contour stone bunds, Permeable rock dikes, Zai planting pits, Manure, compost, mulching, Grass strips, Permeable rock dams	Hand-dug trenches Permeable rock dams, Contour stone bunds, Dune stabilisation	Semi-circular bunds, Nardi/Vallerani trenches, Contour bunds (Firebreaks)

Figure 1. Schematic representation of the toposequence of a watershed and SLM practices

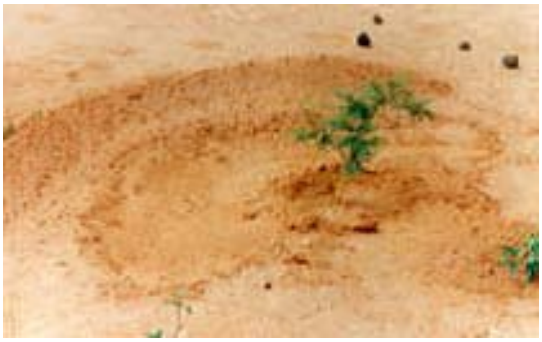
CHAPTER 5 Description of common SLM practices/techniques/approaches

SEMI-CIRCULAR BUNDS FOR CROPS AND FOREST/ RANGELAND

This technique involves building low embankments with compacted earth or stones in the form of a semi-circle (*demi-lune*) with the opening perpendicular to the runoff and arranged in staggered rows. They are used to rehabilitate degraded, denuded and hardened land for crop growing, grazing or forestry. Depending on their purpose, the areas inside the bunds could be enriched with manure or organic fertiliser for growing cereals, or not amended at all, for planting trees, shrubs and/or grasses for forestry and pastoral purposes.

Staggered semi-circular bunds for growing crops

Semi-circular bunds with millet growing in them



Forest/rangeland semi-circular bund

Forest/rangeland semi-circular bund with vegetation

Figure 2. Semi-circular bunds on cropland and forest/rangeland (pasp, 2003)

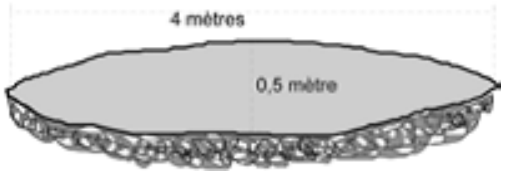
Like other erosion control practices, the semi-circular bunds slow down runoff and enable the harvested water to be used to good effect. This is particularly beneficial when rain is scarce, as the semi-circular bunds channel water towards the plants, increasing the moisture available to them. When they are used for reforestation, they increase the rate of

survival of the seedlings planted in them. In the case of agriculture, the semi-circular bunds enable crops to withstand dry spells.

Earthen semi-circular bunds are not, however, suitable in case of heavy rainfall. As they are not permeable, they could be flooded and the plants or crops waterlogged, leading to lower yields or mortality in the case of agricultural or tree crops that do not tolerate excess water. In such conditions, stone bunds are more preferable.

NARDI/VALLERANI TRENCHES

The Nardi/Vallerani trenches are micro catchments, 4 m long and 0.5 m wide. They are made using a tractor-pulled plough specifically designed for this purpose called Delfino. The Nardi plough cuts a furrow perpendicular to the slope, throwing up a ridge on the downhill side and thereby creating a barrier on that side of the furrow.



Construction of Nardi/Vallerani trenches

Plateau with trenches recently dug using a Nardi plough

Plateau with Nardi/Vallerani trenches, which has been scarified and planted with grass and trees (age: 2 years)

Plateau with Nardi/Vallerani trenches, planted with grass and trees (age: 5 years)

Figure 3. Nardi/Vallerani trenches: Establishment and impacts (pasp, 2003)

The number of trenches varies according to the gradient of the terrain and the type of soil: the recommended number of micro catchments for flat or gently sloping terrain is between 250 and 400 per ha, with the rows spaced 5 to 7 m apart. For steeper slopes, the rows

should be spaced 3 to 4 m apart, with a density of up to 600 micro catchments per ha. In each Nardi/Vallerani micro catchment, two or three seedlings are planted or seeds directly sown. Perennial grasses are sown a year later to allow the trees to become established first. The choice of species largely depends on the purpose of the rehabilitation and the priorities of the beneficiaries. It is recommended that the improved site is protected from grazing for at least three years to give the trees time to grow up and the grass time to reproduce naturally.

Nardi/Vallerani trenches are generally combined with scarification, which is carried out using a tractor-pulled rake. The strips between the trenches are scarified a year after they have been dug. These scarified strips are sown with perennial grasses at the same time as the trenches. The trees planted the year before are a year old, and the risk of the saplings being dominated by grass is minimal.

This technique is particularly effective in low rainfall situations, as the micro catchments collect the little rainfall water making it available to the plants growing in them. Like all reforestation techniques or practices, the Nardi/Vallerani trenches are effective in the control of water and wind erosion and for the rehabilitation of barren land. In wet years, the micro-catchments protect the land downhill from excessive runoff by retaining part of the water on the plateau.

Once implemented on a wide scale, this technique can extend and improve the quality of forest and rangeland and the quantity of pasture during years of droughts. In the medium and long-term, the technique can increase the supply of firewood, timber and other wood products. In the short term, the technique increases the production of herbaceous species used for many purposes such as fodder, roof and mat making materials or sold to generate extra income.

CONTOUR BUNDS FOR CROPS AND FOREST/ RANGELAND

Contour bunds are established for two purposes: crop production and forest or rangeland protection:

- *crop production* contour bunds are rectangular structures consisting of bunds built with earth or stone or a combination of both, which can be permeable or impermeable. The bund could be up to 80 m long with wings extend up to 15 m upslope. The contour bunds are built in staggered rows along the natural contour of the land with the open end facing uphill. The bunds are spaced 10 m apart, and the rows are positioned about 25 m apart, depending of the gradient of the slope.
- in the down slope face of the bund, a water collection ditch 1.0 m wide and 0.5 m deep is dug. The earth excavated from the ditch is piled up and compacted to construct the main bund. When used for growing crops, one-third of the total surface area inside the

contour bunds is loosened by sub-soiling. The remaining two-thirds of the surface are left untouched and serve as a catchment for runoff collection. The volume of water available to crops in the bund is about ten-times the amount of rain that falls in the area. Trees, shrubs and herbs are planted along the main body of the bund for stabilising the structure.

- *forest or rangeland protection* contour bunds. The technique is as described above, except that the dimensions are slightly different. In the case of contours bunds for forest and rangeland management, the bund could be up 100 m long, wings 15 m and spaced 30 m apart. The structure retains a lot of rain water on the plateau and effectively reduces runoff downstream, even in case of heavy rainfall.

Construction of contour bunds (CILSS)

Rows of contour bunds (FAO)

Figure 4. Contour bunds capture water and contribute to rehabilitating degraded land

Contour bunds are very effective technique in areas of low rainfall, as they increase the amount of water available to crops and vegetation. In case of areas of heavy rainfall, the number of bunds per hectare could be increased to retain the maximum of runoff and avoid the destruction of bunds. In this case, the crops and vegetation that do not tolerate stagnant water could be damaged because of water logging.

FIREBREAKS

Firebreaks are precautionary measures designed to protect pasture on rangelands during the dry season when winds are very frequent. Bushfires occur frequently on good quality rangeland with over 1t/ha of biomass. Firebreaks could be created manually or mechanically. In both cases, 10 to 15 m wide pathways are cleared perpendicular to the prevailing wind direction after the rainy season. These corridors or pathways are manually cleared from any herbaceous vegetation, using tools such as rakes, shovels and axes, or mechanically using a tractor pulling a large harrow, a four-wheel-drive vehicle pulling the blades behind it or graders. Trees are pruned and left in place.

Creating a firebreak using a tractor.

Creating a firebreak using a land grader.

Figure 5. Making firebreak using a tractor or land grader (PASF, Senegal)

This technique is particularly important as a precautionary measure in areas with high rainfall where pasture is very important and bushfire poses a great threat during the dry season following a good rainy season. Firebreaks should be maintained every year after a rainy season with abundant rainfall.

HAND-DUG TRENCHES

The technique involves manually excavating trenches of 3 to 3.5 m long and 0.6 m deep, spaced 4 m apart in staggered rows, giving an average number of 625 trenches per ha. The excavated earth is piled downhill of the trenches, which are aligned perpendicular to the slope. In the middle of each trench, a hole of 0.4 m deep is dug to plant a tree seedling. The seedlings planted receive the amount of water needed from that collected by the trench. The main purpose of this technique is to restore tree cover and prevent water erosion on slopes by reducing the flow of water that threatens land downstream.

Row of hand-dug trenches

Slope with hand-dug trenches

Figure 6. Design of hand-dug trenches (pasp, 2003)

The trenches reduce gully erosion and sedimentation of areas with a fragile soil structure. The young trees must be monitored for several years to ensure that they are not damaged

by grazing animals, and any dead trees must be replaced. Hand-dug trenches are beneficial regardless of the amount of rainfall received in the area. They are particularly useful in areas or in years where rainfall is minimal as they retain much rainfall and make it available to the trees growing in them. In years when rainfall is abundant or there are violent downpours, the young trees are protected, as they are planted on a raised step within the trench to avoid flooding and water logging. As an afforestation technique, the hand-dug trenches are effective in protecting the land against water and wind erosion. The shade provided by the trees' cover lowers the soil temperature and increases the soil biological activities.

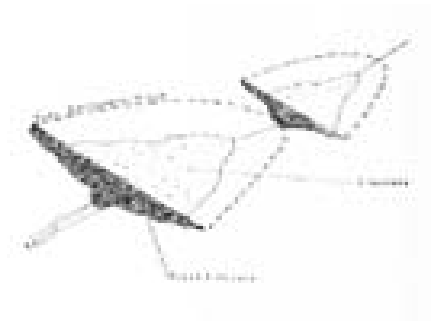
PERMEABLE ROCK DAMS

A permeable rock dam is a structure built in gullies using loose rocks and stones and sometimes reinforced with gabions. A filtering layer (blanket of gravel or small stones) is laid in a foundation trench. Further layers of medium-sized and large stones and rocks are laid on top. They are between 0.5 and 3 meters high, and the width of the foundation and the crest depends on the estimated volume of water flow. The structure built across the gully is extended to the sides with the construction of wing walls that spread the water over a larger area to the sides of the dam. The total width of the structure is generally at least three times its height. The dams can be constructed with or without a spillway. A spillway is required when floodwater flow is strong. It costs less to construct this type of structure with loose stones and rocks than with gabions.

Permeable rock dams can be used in periods of both low and high rainfall. By dissipating the flow of floodwaters, they ensure better use of rainwater and are therefore important in dry periods. By slowing the flow of rain water, the permeable rock dams also contribute to reducing gully erosion in wet periods when there are violent downpours. They also protect the land around water ways, restore and increase the area of land that can be cultivated.

The slowing of water running and the conservation of water for longer periods and the fine particles of earth trapped by the structure favour the establishment of natural vegetation along it, which helps to stabilise the dam. Seeds are also trapped, favouring the spontaneous growth of grass and trees upstream and downstream, contributing to restoring and conserving biodiversity. By dissipating rain water flow, they also contribute to reducing sand filling in the valleys further downstream.

As these dams are used in valley bottoms in the beds of seasonal streams, they increase infiltration and contribute to raising the water table. The valley bottom sites are particularly suitable for horticulture and vegetable production during the off-season, which is important for supplementary food production and an extra source of income.



Permeable rock dam without spillway (PATECORE)

Closing off a gully with a permeable rock dam (PGRNG, Mauritania).

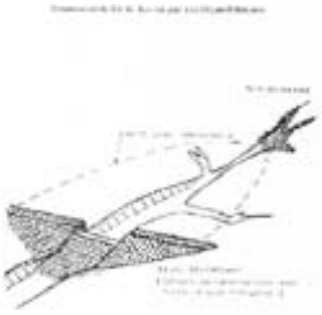


Figure 7. Construction of permeable rock dams

SAND DUNE STABILISATION

Dune stabilisation is achieved by setting up windbreaks arranged in a checkerboard pattern, with each side measuring between 10 and 15 m. In figures 8 and 9 below, dune stabilisation techniques using hedges and palisades are shown.

Euphorbia balsamifera hedge (PASP, 2003).

Dune stabilisation using palisades (CARITAS).

Figure 8. Dune stabilisation using hedges and palisades

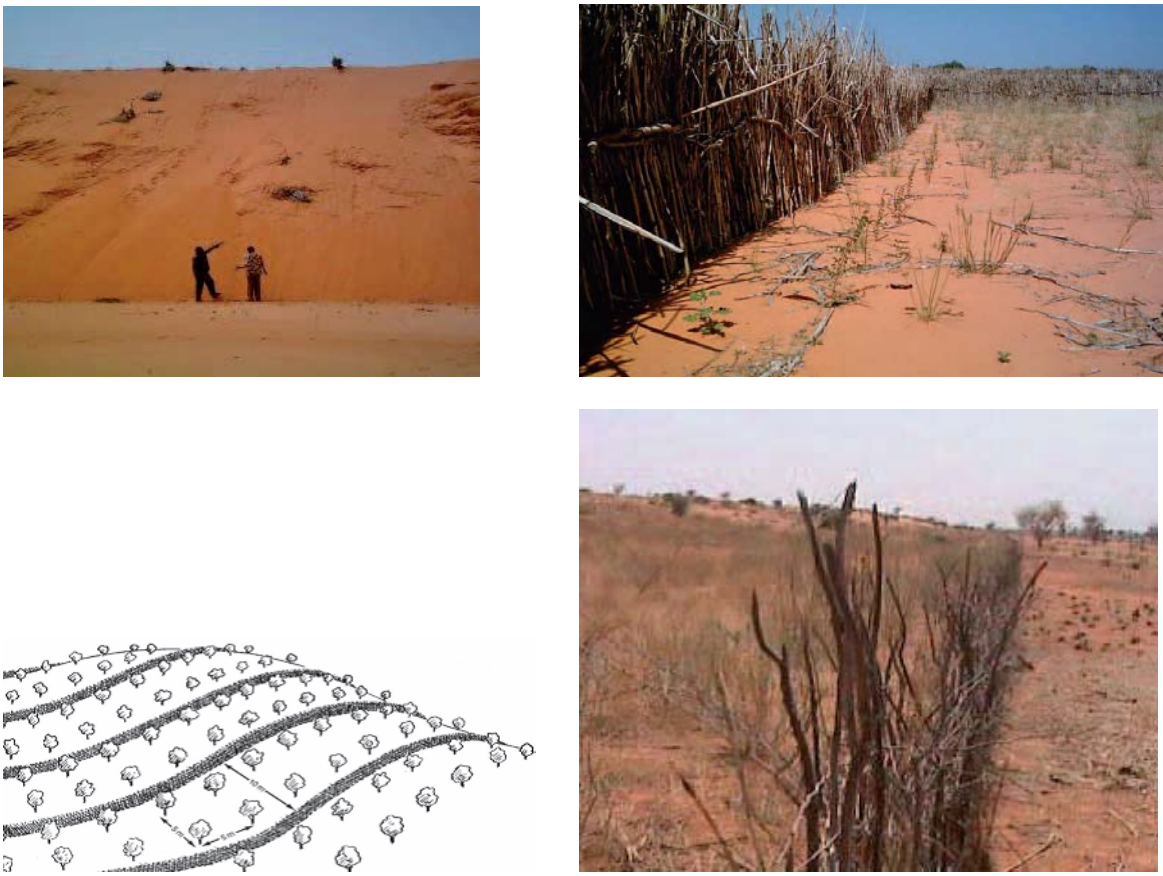


Figure 9. Dune stabilisation using hedges and palisades, Niger (wocat/fao, 2011)

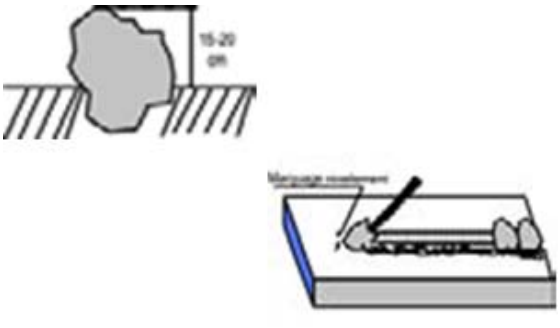
The windbreaks are formed by palisades made from millet stalks or other plant or tree material or by hedges and trees such as *Leptadenia pyrotechnica*, *Euphorbia balsamifera*, *Acacia raddiana*, *Acacia senegal*, *Balanites aegyptiaca*, *Prosopis juliflora*, etc. They provide protection from wind erosion and reduce the amount of sand blown onto cropland, dwellings and other infrastructure. Grass and shrubs are planted in strips in the fenced areas which must be protected for at least three years prohibiting all forms of uses.

With increasing wind velocity and accelerated degradation of the natural vegetation growing on sand dunes, it is very likely that problems caused by shifting dunes will worsen in the future. Techniques for sand dune stabilisation will therefore become more important for the protection of farmlands, dwellings and other infrastructures.

CONTOUR STONE BUNDS

Contour stone bunds are erosion control techniques built with stones in lines along the contour of the land after 10-15 cm of the soil has been removed from the line where they

are to be built. They should be built to a height of 20-30 cm from the ground and spaced 20 to 50 m apart depending on the inclination of the terrain. The best results are achieved when contour stone bunds are used in combination with biological measures (planting of grass, trees and hedges) and the use of organic fertiliser and mulching.



Stone bund with plants (pasp, 2003).

Installation of the stone bund

Water-tube level used to establish contour lines. /PDA/GIZ/Burkina Faso).

Stone bund with vegetation (A. Yeye

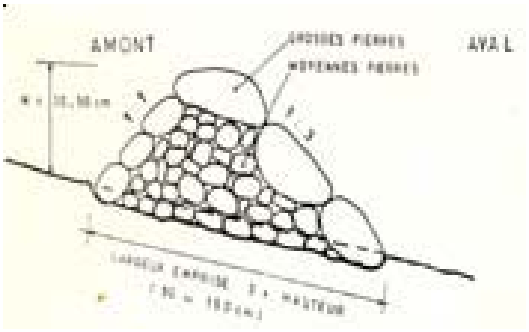
Figure 10. Construction of contour stone bunds

Contour stone bunds are useful from the perspective of climate change adaptation for a number of reasons. Under high rainfall, contour bunds protect the land in case of heavy rain, a phenomenon that tends to increase with climate change. In periods of low rainfall, contour bunds contribute to effective harvest of rainwater. They improve water retention and infiltration into the soil, increasing the amount of water available to plants and ensuring good harvest. Contour bunds also provide protection against wind erosion in case of good growth of vegetation cover.

PERMEABLE ROCK DIKES

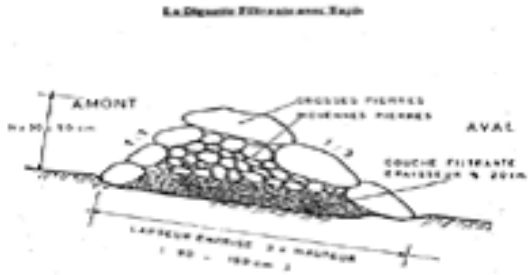
Permeable rock dikes are erosion control technologies built along the contour. They are built 30 to 50 cm high and 60 to 100 cm wide and made with different-sized stones and

rocks. There are two main types of permeable rock dikes: without filter layer established on more flat land with no gully erosion and with filter layer suited for land with heavy runoff.



Permeable rock dike with filter layer.

Rock dike installed



Permeable rock dike without filter layer

Series of dikes in a field

Figure 11. Permeable rock dikes (PATECORE)

The permeable rock dikes differ from contour stoned bunds in that they are bigger and constructed with various layers of stones, designed to control stronger water flows. For this reason, such dikes are often constructed upstream of stoned bunds to dissipate the power of the water flowing from the plateaux and slopes.

From the point of view of climate change adaptation, the permeable rock dikes could mitigate the effects of variations in rainfall. They are appropriate in the following scenarios:

- wet periods with heavy rains and violent downpours: permeable rock dikes constructed on the upper edge of the plot as a protective measure and a means of improving infiltration, protect land at risk from erosion;
- dry periods with little or no rainfall: as they stop or slow down the flow of water, permeable rock dikes improve infiltration and therefore increase the availability of water for crops.

Good tree and grass cover developed along the dikes contributes to lowering soil temperature and reducing wind erosion along the entire length of the structure.

ZAI/TASSA PLANTING PITS

Zai, or tassa, planting pits are an old farming technique rediscovered after the great drought of 1973/74 and later perfected by development partners working with farmers. It involves digging planting pits with a diameter of at least 30 to 40 cm and 10 to 15 cm deep. They are spaced 70 to 80 cm apart, resulting in around 10 000 pits per ha. Staggered rows of holes are dug perpendicularly to the slope. The excavated earth is formed into a small ridge down slope of the pit for maximum back capture of rainfall and runoff. Manure is added to each pit, though its availability is sometimes a problem. The improved infiltration and increased nutrient availability brings degraded land into cultivation.

Tassa planting pits are used for the rehabilitation of degraded and crusted land. This technology is mainly applied in semi-arid areas on sandy/loamy plains, often covered with hard pans, and with slopes below 5%. Common crops produced in this water harvesting system are millet and sorghum. At the start of the rainy season, seeds are sown directly into the pits. Silt and sand are removed annually. Normally the highest crop production is during the second year after manure application. The technology does not require external inputs or heavy machinery and is therefore favourable to spontaneous adoption. *Tassa* are often combined with stone bunds along the contour line to enhance water infiltration, reduce soil erosion and siltation of the pits. Grass growing between the stones helps increase infiltration and accelerates the accumulation of fertile sediment.

Figure 12. Zai technology for agricultural production (Wocat/FAO, 2011)

The Zai or Tassa technologies allow for collection and storage of rainfall in fields. The collected water amount to about the quantity rain that falls in the area. In case of little rain, Zai or Tassa improve soil moisture, soil fertility, soil organic matter, and improve crop yield

and grain quality, especially so when pits are opened long before the onset of the rains and manure is added.

ASSISTED NATURAL REGENERATION OF DEGRADED LAND

Two types of assisted natural regeneration can be distinguished, viz.: farmer managed natural regeneration and “fencing” assisted natural regeneration (ANR). These are described below.

Farmer managed natural regeneration

According to RINAUDO (2008), farmer managed natural regeneration (FMNR) is a simple method of reforestation that consists of coppicing and pollarding the trees on farm. While engaged in FMNR, the farmer selects the stumps he wants to leave in his farm and decides how many shoots are wanted per stump. Excess shoots are then cut and side branches trimmed half way to the stems.

The technique of farmer managed natural regeneration is a cheap and rapid method of re-vegetation, which can be applied over large areas of land and can be adapted to a range of land use systems. It is simple and can be adapted to each individual farmer’s unique requirements, providing multiple benefits to people, livestock, crops and the environment, including physical, economic and social benefits to humans. Through managing natural regeneration, farmers can control their own resources without depending on externally funded projects or needing to buy expensive inputs (seed, fertilisers, nursery supplies) from suppliers.

Children helping to source firewood

Harvesting millet amidst naturally regenerated trees, Niger

Figure 13. Farm land with FMNR (Source: Cortesy of Tony Rinaudo)

In disseminating the technique, farmers are given guidelines and left free to choose the number of shoots per stump, the number of stumps per ha that they will leave in their farms, the time span between subsequent pruning and harvest of stems, and the method of pruning used. FMNR can directly alleviate poverty, rural migration, chronic hunger and even famine in a wide range of rural settings. It contributes to stress reduction and nutrition of livestock, and contributes directly and indirectly to both the availability and quality of fodder. Crops benefit directly through modification of microclimate (greater organic matter build up, reduced wind speed, lower temperatures, higher humidity, and greater water infiltration into the soil), and indirectly through manure dropped by livestock, which spend more time in fields with trees during the dry season. The environment in general benefits as biodiversity increases and natural processes begin to function again.

With appropriate promotion, FMNR can reduce conflicts between competing interests for land based resources. For example, as natural regeneration increases fodder availability (tree pods and leaves), farmers are in a better position to leave crop residues on their fields and are less likely to take offence when nomadic herders want to graze their livestock in the dry season. Depending upon the site, it has the potential to:

- involve local people in developing a forest that meets their needs, and motivating them to conserve it;
- reduce total reforestation costs, because there is less site preparation, nursery establishment, and enrichment planting;
- fit well with farmers' cropping schedules, because ANR concentrates on maintenance instead of planting;
- provide local employment if there is outside funding, most expenses are for local labour;
- include species chosen by villagers, through enrichment planting or saving natural seedlings.

Assisted Natural Regeneration

As promoted by *NewTree* in Burkina Faso (see Figure 14 below), the fenced assisted natural regeneration starts with enclosing 3 ha of degraded land with a solid fence. Fencing material, such as iron posts and galvanic wire, are externally sponsored and locally assembled and installed. Along the fence a dense living hedge of thorny local tree species, such as *Acacia nilotica*, *A. senegal*, *Prosopis sp*, *Ziziphus mauritania*, etc., is established. A strip of 10 m width along the hedge is dedicated to agricultural production, i.e. on c. 10% of the protected area. The rest of the enclosed land is dedicated to natural regeneration of the local forest.

Figure 14. The NewTree technique (Burkina Faso)

Once barren and degraded land is protected, natural vegetation rich in endogenous species can actively regenerate. Annual inventories are made to monitor the species composition, biomass, biodiversity and the growth rate of the trees. The forest reaches a tree density of approximately 500 trees per ha and consists of mainly local species. Enrichment planting of rare important species enhances site biodiversity. The technique is of very important for biodiversity conservation.

The management activities in the protected area include (WOCAT/FAO, 2011):

i) seeding/planting of improved fodder species;
ii) establishing stone lines and half-moons for erosion control and water harvesting;
iii) installing beehives for honey production; and
iv) fodder production: the grass is cut, tied and carried to feed livestock outside the regeneration area.

The property rights of this type of protected areas are clearly established through a contractual agreement concluded at the beginning of the establishment, which include the respect of 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 such as beekeeping, the production of high-value vegetable crops, and non-wood forest products. Other incentives, including promoting the use of fuel-efficient cooking stoves, are also provided.

DOMESTIC ENERGY STRATEGY APPROACH

The Domestic Energy Strategy (DES) approach aims at sustainable management of forest resources by delegating responsibility to communities and increasing their sense of ownership. The approach was developed by the Domestic Energy Project in the 1990's and widely spread in Niger by PAFN (*Natural Forests Management Project*) for the management of natural dry-land forests.

In this approach, local people are organised to manage and protect forest resources in their areas for meeting the wood demand of urban centres. Communities are committed to sustainably manage the forests by using SLM technologies that ensure long term preservation and regeneration of forest resources and maintaining ecosystem services. The operational units of the approach are:

- the Local Management Structures (SLG), a committee at community level, is responsible for resource management, execution of development activities, monitoring and evaluation, and sustainability of investments. Creating these organisational structures, as well as training and capacity building of its members, is carried out by the project. Once SLGs are established, planning of development activities and elaboration of forest (PAF) and village forest management plans (PVAF) are conducted. Then, concrete activities are implemented, e.g. establishment of rural wood markets, commercialisation of wood and forest products, establishment of village development funds, and implementation of SLM activities. Local people implement project activities at field level. Wood exploitation is conducted by trained villagers using an agreed exploitation quota under the supervision of local forestry personnel and a Technical Monitoring Committee (CST) with experts from CIRAD in France and the University of Niamey.
- rural wood markets created by the project facilitate wood supply for urban centres and generate permanent income for the rural communities, thus improving their livelihoods. Part of the income is reinvested in sustainable forest management practices. The main aims of the approach are to simultaneously expand woodland areas, enhance controlled logging, assure provision of wood for urban centres, and ensure a permanent source of income for rural communities living near the forests. The approach is based on participatory methods, involving local actors at all stages of the project and handing over of major responsibilities for forest management to local communities.

The SLGs are the main institutional beneficiaries of the approach. They participate in the management of incomes generated from taxes on wood sold as set out in Government of Niger legislation – Ordinance No. 92-037 of August 21, 1992, regulating the transportation and marketing of wood in big cities and tax applied. The collected revenues are divided in three parts with percentages varying according to the operating mode of the forest area as shown in Table 4 below. The Treasury share is further reinvested in the management of

forest and the village share serves as the village development funds for socioeconomic infrastructures.

Table 4. Distribution of revenues between different levels of responsibility according to the operating mode

Beneficiaries	Operating modes		
	Uncontrolled exploitation	Oriented exploitation	Controlled exploitation
Management structure	0%	30%	50%
Communities	10%	20%	40%
National Treasury	90%	50%	10%

The objectives of Domestic Energy Strategy are:

- stop uncontrolled exploitation of forest resources and increase the population's stewardship of their land;
- ensure fuel wood supply for the large population centres of Niamey, Maradi, Tahoua and Zinder;
- combat rural poverty by providing additional sources of income in the form of new rural wood markets.

Decisions regarding choice of SLM technologies for the rehabilitation of the exploited forest areas were taken by specialists, after consultations with communities and land users. The implementation of the agreed activities was done by the SLG with support from the forestry field technicians.

CHAPTER 6 Main drawbacks to SLM practices amplification and drivers of land degradation

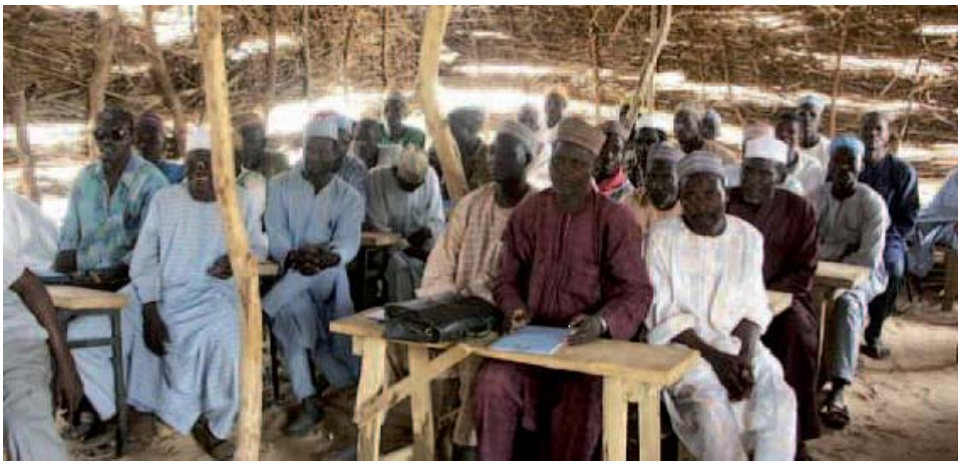
The main drivers of land degradation identified in most Sahelian countries include:

- predominantly *rural populations*, ranging from 84% in Niger, 81% in Burkina Faso to 52% in Nigeria, with *high growth rates:* Niger (3.36%), Burkina Faso (2.61%) and Nigeria (2.55%);
- the high *poverty rates* in most Sahelian countries necessitate rapid economic development, which is dependent on exploitation of *natural resources*. To date, agriculture and, particularly, livestock herding are still the main driving contributors to the economy, providing the main source of income for a majority of people; for instance, the number of cattle, goats and sheep has increased in the past 30 years, from around 2 million in 1970 to around 8 million in 2012 in Burkina Faso; also, the area planted with cotton, the main cash crop, increased from 80 000 ha in 1970 to around 500 000 in 2005;
- *climate:* rainfall in the Sahelian zone is erratic, with large differences between years. Rainfall patterns have been dominated by sequences of drier and wetter years; for instance, the 1970s and 1980s experienced particularly severe droughts in the Sahel, with rainfall in the years 1983 and 1984 showing the lowest figure in the century. Since the mid-1980s, overall rainfall has gradually increased;
- *land ownership:* for a very long time land has been managed by customary authorities; the recently introduced Agrarian and Land Reform Law largely rejected this role of customary authorities; instead, the government was vested with the authority of attribution and retrieval of any piece of land; however, because of its complexity, this law was increasingly considered inappropriate with regard to customary rights and was strongly rejected by traditional leaders; in Burkina Faso, for example, successive revisions of the legislation in 1991 and 1996 introduced privatisation of agricultural land under customary land tenure systems, stating that this would strengthen security of resource tenure and increase agricultural productivity; while customary rights are formally recognised, no legal safeguards are provided for tenure security for most rural people and farmers who are reluctant to take responsibility for the long term maintenance of soil fertility;
- *traditional management systems of pastoral areas: they* are characterised, to a large extent, by open access and common property resources, of which the common management is guided by local traditions; this enhances the efficiency of the sahelian pastoral system, as there is a strong spatial variability in annual rainfall, which allows

pastoralists to lead their herds to areas with the most abundant feed resources; however, the system also stimulates pastoralists to use as much grass as possible for their own herds, and this leads to overgrazing which hits the society as a whole;

- *traditional management systems of forest resources* are also characterised by open access and common property resources; local stakeholders have few incentives to reduce harversting of fuelwood to a sustainable level in a state-owned forest. Recently, the introduction of forest and woodland resources management by local communities to satisfy the demand of urban centres, has introduced a monetary value to wood, and thereby a commercial resource managed by local people based on sustainable management norms via rural wood markets. However, because of the monetary value attached to the business, the assigned wood harvesters do not always follow the norms for exploitation, which has led to unsustainable management of the already scarce woodlands resources, especially in Niger.

The various land degradation drivers and drawbacks of SLM application often lead to the application of generally unsustainable and sometimes inefficient land management practices.



Overview of management meeting session

A wood market area in Illéla

Figure 15. Meeting sessions and wood market (Source: Cortesy of Hamadou Mamoudou)

CHAPTER 7 Conditions and prerequisites for up-scaling best practices, techniques and technologies in the Sahel

SLM practices and techniques are implemented in the field taking into account the objectives of the management and the topography of the watershed units, which generally include plateau, slopes, pediments and valley bottoms (Figure 1). These topographical units have different types of soil, vegetation and uses and are often exploited by different user groups under different land tenure:

- the *plateau* areas are community lands with shallow, infertile, stony soils. Uses include grazing for livestock and collection of wood, straw, fruits, bark and other secondary products; the land and vegetation on the plateau are often severely degraded due to overuse;
- the *slopes* also have shallow, stony soils with some grass and bush cover. Runoff water flowing over the plateau and steeper slopes creates gullies and causes landslides, which leads to serious degradation of the hillsides. These areas are of limited use as community rangeland for livestock;
- the *pediments* are located in the lower, more gently sloping areas with deeper, more fertile soils; these are the main areas used for growing rain-fed crops; plots are cultivated by individual farmers who grow food crops; the straw is used as forage for livestock in the dry season; this type of land is prone to sheet and gully erosion caused by surface runoff flowing over the plateau and down the slopes;
- the *valley bottoms* have deep, more fertile soils enriched by fertilising elements from upstream areas. Bottomlands are used to grow rain fed subsistence crops during the rainy season. During the dry season, the shallow water tables are used to irrigate off-season cash crops. Plots of land in the valley bottoms are cultivated by individual farmers, although there are also sometimes community grazing areas for livestock. The concentrated flow of water from upstream areas can lead to serious threat to bottom lands. Although it carries fertilising sediment with it, it can also cause severe gully erosion and the siltation of land and hydro-agricultural infrastructures.

There is no one-size-fits-all technical solution for the application of SLM practices and techniques. It is necessary to determine the most suitable ones in each case, taking into account the topography of land to be improved and the subsequent land uses. Therefore,

an assessment of the watershed as a whole is made to choose a combination of techniques and practices adapted to the area's specific agro-ecological conditions (rainfall, topography, soil properties and structure, type of degradation, vegetation cover, etc.), which must also feasibly be within the means of the farmers.

The most widely used SLM practices in the Sahel were described by PAC1 (in Niger Republic) and by WOCAT/FAO (2011) and GIZ (2012) in the majority of the Sahelian countries. The practices, techniques and technologies described above were mainly drawn from these references and the personal experience of the author accumulated for more than ten (10) years of field experience in matters related to the rehabilitation of degraded land in Niger Republic.

The historical successes of many projects of the 1980's and 1990's in the various countries of the Sahel were achieved mainly as a result of, among other things:

- *sound organisation:* the projects were initially organised in the form of 'autonomous' undertakings in collaboration with government bodies and the cooperation agencies; most of the activities were carried out by project personnel who had sizeable logistics units at their disposal and their own equipment and means of transport;
- *clearly identified intervention units:* the village land area was the basic unit for interventions, which were based on a simplified spatial planning approach and land management organisations; as time went on, the projects worked increasingly with local providers (carriers, consultancy firms, NGOs) to carry out part of the work and involved the community authorities in planning and monitoring the measures implemented;
- *participatory approaches*: involvement of beneficiaries after intense awareness campaigns and training of the local people;
- *substantial financial support:* a lot of money and time are needed to achieve successful impacts of SLM practices; the Keita Integrated Project in the Republic of Niger, financed by the Italian Government, has achieved tremendous outputs, as a result of many phases from 1984 to 1998 in the same areas and has spent billions of FCFA.

In order to consolidate these achievements as a result of sustained efforts of over 40 years of degraded land rehabilitation, sand dune stabilisation, and the management of scarce forest and woodland resources, most Sahelian countries have joined the international platform of TerrAfrica. With the support of TerrAfrica Platform coalition partners, such as UNDP, World Bank, IFAD, FAO, NEPAD, UNCCD-Secretariat, UNEP, ADB, GEF, etc., most countries have established a programmatic approach to the sustainable management of land, forests and woodlands and agreed on roadmaps for formulating Strategic Investment Frameworks for Sustainable Land Management (SIF-SLM).

As a platform for dialogue and consultation, TerrAfrica has since its launching supported SSA countries to achieve their goals through an open and inclusive partnership. Up to date,

most Sahelian countries have elaborated their SIF-SLMs. The opportunities and the conditions for scaling up and mainstreaming the best SLM practices, which differ from one country to another, are also identified by most countries. The results of these large national consultations among the stakeholders from various countries of the Sahel are summarised in Table 5.

Table 5. Requirements for scaling up SLM practices in Sahelian countries

Country	Major issues	Barriers to SLM up-scaling	Requirements for up-scaling
Burkina Faso	▸ High population growth ▸ High demand for natural resources ▸ Insecure land tenure ▸ Increased degradation of agricultural land ▸ Degradation of pasture lands ▸ High deforestation rate	▸ Increase in population growth ▸ Expansion of economic activities depending on natural resources ▸ High degradation of natural resources due to climate change ▸ Insecure land tenure ▸ Traditional systems of pasture and forest resources management ▸ Insufficient resources allocation/funding	▸ Mainstreaming SLM practices in all developmental sectors ▸ Train and support local population ▸ Capitalise past experiences of community land management ▸ Support agricultural diversification ▸ Train farmers through Farmer Field Schools ▸ Secure land tenure arrangements ▸ Enhance institutional support ▸ Enhance micro-credit support for economic activities ▸ Enhance monitoring the use of natural resources ▸ Enhance capacity building for local populations ▸ Enhance afforestation/reforestation through mobilisation of CDM finances
Mali	▸ Land degradation ▸ Loss of biodiversity ▸ Degradation of agro-ecosystems ▸ Siltation of rivers ▸ Encroachment of sand dunes on farms and infrastructure ▸ Frequent bush fires ▸ Depletion of surface and ground water	▸ Sectoral approaches to SLM applications ▸ Insecure land tenure ▸ Lack of financial resources ▸ Lack of technological knowhow ▸ High population growth rates ▸ High pressure on natural resources	▸ Mainstreaming SLM practices in all developmental sectors ▸ Mobilisation of adequate financial resources ▸ Improve institutional capacities of the National Council for Environment ▸ Enhancing the legislative and regulatory environment for SLM applications ▸ Enhancing the advisory role of technical services ▸ Improving the participation of the private sector in SLM practices ▸ Harmonisation of planning ▸ Development of data collection and decision making tools ▸ Implementation of sound strategies for communication ▸ Capacity building of all stakeholders

Country	Major issues	Barriers to SLM up-scaling	Requirements for up-scaling
Mauritania	▸ Promote growth of production sectors ▸ Ensure equitable land resources access ▸ Increase supply and availability of goods and services for sustainable develop-ment ▸ Development of stake-holders' management capacities	▸ Lack of knowledge of land degradation ▸ Plurality of those whose activities impact SLM ▸ Plurality of institutions in charge of coordinating SLM practices ▸ Insufficient financial resource allocation	▸ Improve quality of information on SLM ▸ Capitalisation of the existing knowledge ▸ Improvement of knowledge on land resources ▸ Strengthen capacities of SLM multi-sector actors and improve synergies ▸ Mainstream SLM practices in all sectors of development ▸ Integrate SLM teaching in higher education ▸ Mobilise adequate financial resources for SLM amplification ▸ Improvement of SLM monitoring and coordination of SIF-SLM ▸ Improvement of pasture through aerial seeding ▸ Control of agricultural land salinity ▸ Control sand encroachment on infrastructures ▸ Development of wetlands
Niger	▸ Soil infertility in crop lands ▸ Degradation of farm land through hardpans ▸ Degradation of pasture lands: proliferation of non-palatable species ▸ Biodiversity loss ▸ Degradation of forests and woodlands ▸ Silting of water bodies ▸ Encroachment of sand dunes	▸ Insecure land tenure ▸ Lack of financial resources ▸ Lack of technological knowhow ▸ Sectoral approaches to SLM application	▸ Harmonisation of field interventions ▸ Mainstreaming SLM practices in all sectors ▸ Development of advocacy and information on SLM ▸ Increase experience sharing among farmers ▸ Development of decision making tools ▸ Strengthening of political dialogue ▸ Improvement of coordination ▸ Improvement of monitoring and evaluation ▸ Provision and mobilisation of adequate national financial resources ▸ Improved planning and coordination in the external financial assistance

Country	Major issues	Barriers to SLM up-scaling	Requirements for up-scaling
Nigeria	▸ Overgrazing ▸ Overexploitation of natural resources ▸ Food insecurity ▸ Irrigation malpractices ▸ Intensive exploitation of forest resources ▸ Loss of biodiversity ▸ Land use conflicts	▸ Lack of knowledge on SLM practices ▸ Fragmented institutional coordination capacities, mandates and policy ▸ Inadequate access to information and knowledge to producers	▸ Mainstreaming SLM practices in all sectors ▸ Capacity building, communication and information dissemination ▸ Monitoring, evaluation, coordination, knowledge and information management
Senegal	▸ Increased degradation of land ▸ Loss of biodiversity ▸ Increased flooding ▸ Reduction of forest resources ▸ Degradation of wild-life habitat ▸ Increase poaching and reduction of wild animal ▸ Invasion of water bodies with unwanted species ▸ Reduction of fish production ▸ Lack of specific legal framework for risk management	▸ Inadequate resource allocation ▸ Weak scientific result application ▸ Lack of advocacy and sensitisation ▸ Weak institutional framework ▸ Various institutions in charge of SLM with different views	▸ Mainstreaming SLM practices in all sectors ▸ Amplification of identified best SLM practices ▸ Strengthening agricultural advisory services ▸ Support to producer organisations and their functioning ▸ Strengthening the inter-sectoral coordination of SLM implementation ▸ Strengthening the technical and financial coordination of application of SLM practices ▸ Strengthening monitoring and evaluation of SLM projects

CHAPTER 8 Key observations and recommendations

It is now widely accepted that SLM practices provide an effective way of improving the management of water resources and of reducing soil erosion, vegetation and biodiversity, thereby helping to increase and maintain crop, forest and forage yields. Application of SLM practices could contribute to mitigating the effects of climate change and significantly improve food security and the resilience of the rural population to external shocks. The implementation of SLM practices, techniques and technologies is therefore a promising solution for Sahelian countries. However, their wide scale implementation requires long-term commitment and huge financial resources in order to achieve significant impacts.

Large scale implementation of SLM practices also requires sustained national and international technical and financial efforts from governments to effectively organise and oversee the efforts of communities to implement, operate and maintain these practices. Without the sustained technical oversight and guidance, the implementation of SLM techniques and practices will lose momentum, because in most cases traditional short-term projects can only contribute to a specific investment in the broader land improvement framework, with no significant results.

Although there exists simple and low or no cost SLM practices and techniques, such as Zai, semi-circular bunds and Farmer Managed Natural Regeneration, which could easily be replicated by farmers, their large scale application has been hindered by the failure of farmers to take the initiative and replicate them on their own, not because of lack of knowledge and expertise, but due to lack of incentives.

Hence, to achieve the objectives of large scale implementation of best SLM practices, techniques and technologies, several hypotheses could be considered in the formulation of sound recommendations, viz.:

- the use of the *food for work* approach by some of the projects provides an incentive by enabling people to generate income while implementing the SLM practices, but it also has a demobilising effect when the farmers have to continue the activities on their own after external funding has come to an end;
- farmers may be deterred from making long-term investments in such practices due to the fact that they have other immediate needs to meet and that land rights are not guaranteed;
- the technical complexity of some SLM practices and techniques are beyond the capacities of the users and require external support for their application; these include permeable rock dams, water-spreading weirs and small-scale dams;

- large scale application of SLM practices requires major logistic and financial resources, which are not easy to mobilise without the support of a project or external partner; this is the case of practices involving the transportation of large blocks of stone from quarries located at a distance from the site or the purchase of cement such as water-spreading weirs;
- the complexity of social relations can hinder the implementation of SLM practices: working together to improve community sites is not easy undertaking; community organisation entails the risk of disputes and conflicts and requires capable local leadership; experience has shown that practices implemented on individually owned land are more sustainable and more easily replicable than those implemented on community land;
- the allocation of limited resources, such as family labour to carry out the work, is another factor to be taken into account; using family members to implement SLM practices in the villages may be less profitable than allowing them to emigrate to work in urban centres;
- in view of the rapid and relentless pace of land degradation and the fact that most farmers cannot afford to invest in SLM practices by themselves, provision should be made to make funding available from the government and the international community for this purpose. This would allow the implementation of SLM practices on a wider scale. Private Service providers and NGOs could be commissioned to implement SLM practices under the technical supervision of governments.

Taking into account all these considerations, the following recommendations could be formulated to the countries and donors:

1) to strengthen the enabling environment for scaling up SLM practices, including improvement of institutional, political and financial capacities for wide application of SLM techniques through: i) enhancing the legislative and regulatory environment for integrating SLM practices into policies, strategies, and cross-sectoral projects/programmes at all administrative levels; ii) strengthening national mechanisms for internal and external financial resource mobilisation and coordination of the implementation of SIF-SLM; and, iii) formulating and financing support projects/programmes for the implementation of SIF-SLM;
2) to formulate and implement sound communication and awareness strategies for supporting the appropriation of SLM approaches and adoption and application by local farmers of simple and low cost SLM practices, such as farmer managed natural regeneration and zai, using appropriate communication supports and channels;
3) to strengthen the capacities of all stakeholders in SLM approaches and strategies, practices and techniques through various training sessions of all actors (civil society, private sector, local authorities, and public sector producer organisations, etc.) at all levels;

4) to provide adequate funding through mobilisation of internal and external resources for scaling up SLM practices, techniques and technologies, which are beyond the capacities of local communities, e.g. water harvesting, soil fertility improvement, afforestation, bush fire control measures, management of forests and protected areas, establishment of flora and fauna reserves, elaboration and implementation of forest and woodland management plans, etc.;
5) to enhance the advisory roles of technical services and improve the participation of the private sector in the implementation of best SLM practices, techniques and technologies through development of harmonised planning and promoting marketable goods and services from the implementation of SLM practices;
6) to provide adequate funding for: i) the development and application of necessary implementation and monitoring tools (data collection, analysis and information dissemination); ii) information systems on SLM practices; and, iii) capacity building for all stakeholders in order to enable them to better monitor land resource uses and changes and acquire the necessary knowledge for sustaining post-project impact, thereby contributing to greater adoption of climate-smart land, water and forest management.

References

FPA/NEPAD, 2007. Les changements climatiques et l'Afrique. Document préparé conjointement par l'Unité de soutien du FPA et le Secrétariat du NEPAD et présenté à la 8e réunion du Forum pour le Partenariat avec l'Afrique à Berlin, Allemagne, les 22 et 23 mai 2007. www.forumpartenariatafrique.org

GIZ, 2012.Good Practices in Soil and Water Conservation. A contribution to adaptation and farmers´ resilience towards climate change in the Sahel. 60 p.

Maisharou, A., 2007. Rapport final de mise en œuvre de la phase pilote du projet Opération Acacia, 24 p. + annexes.

PASP, 2003. Référentiel des mesures techniques de récupération, de protection et d'exploitation durable des terres. Niamey, Niger.

République du Sénégal, 2007. Plan Cadre des Nations Unies pour l'Aide au Développement (UNDAF) – Sénégal 2007–2011, 52 p.

Rinaudo, T., 2008. The Development of Farmer Managed Natural Regeneration. World Vision, Australia.

SDR, 2003. Stratégie de Développement Rural. République du Niger. 93 p. + annexes

UA/CENSAD, 2009. The Great Green Wall: Implementation Operational Procedures of Conceptual Design. 35 p.

WOCAT/FAO, 2011. Sustainable Land Management in Practice. Guidelines and Best Practices for Sub-Saharan Africa Field application. 245 p.

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