Report:

Sustainable Land Management Practices of South Africa

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FOREWORD

In South Africa, sustainable land use and management is paramount as the country's agricultural natural resources are diverse, complex and vulnerable to degradation. To realise sustainable agricultural production and development, an agro-ecosystem-specific approach entailing soil, water and nutrient conservation agriculture practices is imperative. This LADA report provides a selection of successful soil and water conservation technologies and approaches collected as part of the World Overview of Conservation Approaches and Technologies (WOCAT) Programme in South Africa.

The Department of Agriculture, Forestry and Fisheries (DAFF), South Africa's LADA project coordinator, has been supporting WOCAT since 1998 as an effective method of collecting, documenting, analysing and distributing information on best management practices. With the initiation of the LADA project, WOCAT and LADA teams jointly adapted the WOCAT questionnaire now being used globally as WOCAT-LADA questionnaire.

Examples described in this report were selected from the vast South African WOCAT database and are by no means exhaustive. This report should be regarded as a dynamic document and as an important first step in the ongoing process of documenting sustainable land management practices.

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REPORT ON SUSTAINABLE LAND MANAGEMENT PRACTICES OF SOUTH AFRICA

INTRODUCTION

This report constitutes a range of technologies and approaches collected in South Africa that are aimed at reducing land degradation and promoting sustainable land management. South Africa constitutes a vast biodiversity and has a wide distribution of the natural resources of soil, climate, water and vegetation. Various practices have been developed and are being used to promote and improve the sustainable management of these natural resources. This report comprises of a summary of such practices that have been collected within South Africa as part of the World Overview of Conservation Approaches and Technologies (WOCAT) project and is a deliverable of the Land Degradation Assessment in Drylands (LADA) project.

WHAT ARE LADA AND WOCAT

South Africa is one of six pilot countries (together with Argentina, China, Cuba, Senegal and Tunisia) participating in the global LADA project with the general aim of creating a basis for informed policy advice on land degradation (LD). Land degradation assessments are conducted at a global (GLADA), national (LADA-N) and local (LADA-L) scale, using different methodologies for each scale. Included in the project is the development of tools and methods that enable users to assess and quantify the nature, extent, severity and impacts of LD on various dryland ecosystems.

The national assessment investigates both land degradation (LD) and sustainable land management (SLM) in agriculture at sub-national level. This is done using a mapping questionnaire that was prepared in collaboration with WOCAT which enables the mapping of LD and SLM extent and trends in South Africa. A participatory expert assessment approach is implemented and involves key stakeholders or experts who have a thorough understanding of land degradation and factors controlling it in the specific assessment areas.

At the local level, LADA assessments aim to characterize smallerl areas in terms of LD and SLM. It is used to determine the current status and circumstances of LD, as well as its historical development and the land users' perception of it. The same goes for SLM being practiced in the area in order to enhance recommendations of SLM practices available to improve the state of the natural resources. Both biophysical and socio-economic indicators are measured in order to reach these outcomes. Land degradation is a dynamic process with various causes and effects leading to the degradation and in the LADA context, the basic assumption is made that human activities on land are the main driver causing LD. For this reason, the human aspect is also included at the local level. The LADA website can be visited at www.fao.org/nr/lada for further information.

WOCAT has as its vision that land and livelihoods are improved through the sharing and enhancing of knowledge about SLM. It has developed a framework to document, monitor, evaluate and disseminate SLM knowledge worldwide, which includes the complete process from data collection to a database. The information generated is aimed at decision support. To this end, WOCAT has developed questionnaires to analyse and evaluate SLM practices at the local level in the form of Technologies (QT) and Approaches (QA). The Technologies address the specifications of that technology, as well as where it is used (natural and human environment) and what impact it has. In the case of Approaches, the questionnaire looks at how implementation was achieved and who achieved it. These questionnaires form the main pillar of the WOCAT study site documentation and the information is entered into the WOCAT databases for online retrieval. The WOCAT website can be visited at www.wocat.net to access these databases.

PURPOSE AND LAY-OUT OF THE BEST PRACTICES REPORT

In South Africa, WOCAT has been implemented for years with numerous Approaches and Technologies have been documented. Of these, a selection was made of quality checked documents to include in this report. The report is aimed at SLM specialists at the (sub-) national and field level, including planners, project designers, decision makers, researchers, agricultural advisors, project implementers, extension officers and land users.

The report is aimed at providing an entry point for users who need to identify appropriate SLM measures or practices for specific LD problems. A summary of the available SLM Approaches and Technologies documented in South Africa is provided in the form of case studies which provide basic information on where the case studies were conducted, as well as general information surrounding it. From this, users can decide whether an Approach or Technology may be a solution to their specific problems and consult more detailed publications or specialists regarding the execution of these measures. This is not a manual for the implementation of SLM practices and should not be used as such.

This report is not a complete compilation of SLM practices available or known in South Africa and is seen as a dynamic document to be supplemented as new questionnaires are completed and new information becomes available. The information in these case studies constitutes what was available and entered into the questionnaires at the time when they were completed for the WOCAT project and the levels of information may vary between the case studies. The case studies are grouped according to conservation groups as defined in the WOCAT mapping questionnaire and also correspond to the conservation groups used in the national LADA assessment. A brief description/introduction is given of each conservation group, with the appropriate QT and QA case studies listed thereafter.

Case Studies – titles and short descriptions			
	Technology	Approach	

Conservation Agriculture

Photo	Limpopo Province	Conservation Agriculture (QT RSA 43) Conservation agriculture included aspects such as crop rotation, mulching and no-tillage.	Farmers involved in own development QA RSA 43) Planting without ploughing in a crop rotation system to improve moisture management, reduce erosion and increase crop yield.	Mpumalanga Province
			No-till Crop Production (QA RSA 56) Introduction of No-Till crop production systems to rural small scale farmers.	Mpumalanga Province

Vegetation Strips

Photo	KwaZulu/Natal Province	Vetiver grass soil conservation system (QT RSA 04) Vetiver grass is planted as a vegetative barrier (hedge), on the contour at 5 m vertical intervals within fields of sugarcane.	Self teaching (QA RSA 04) Ideas from booklet and implemented the vetiver system.	KwaZulu/Natal Province
	Limpopo Province	Grass strips (QT RSA 35) Combination of field demarcation and erosion protection by grass strips.		

Grazing Land Management

Photo	North West Province	Rangeland rehabilitation (QT RSA 32) Rangeland rehabilitation where we use perennial grasses to rehabilitate the footslopes in a semi-arid region on a clay loam soil.		
	Mpumalanga Province	Veld restoration on degraded duplex soils (QT RSA 30) Restoration of degraded grazing land.		

	Free State Province and North West Province	**Chemical bush control (QT RSA 16)** To either clear or thin bush (trees) in encroached areas by chemical means.	**Participatory rural approach (QA RSA 39)** Participatory Rural Approach including a partly holistic approach; between social and environmental sciences.	North West Province
	North West Province	**Rip-ploughing, oversowing (QT RSA 07)** Rip-ploughing and over-sowing (sod-sowing) of extensive grazing land in order to improve productivity of a semi-arid rangeland.		
	Gauteng Province	**Combating of invader plants and push packing (QT RSA 09)** The combating of invaders to preserve water resources and the rehabilitation of the bare ground by means of brush packing to prevent soil erosion.	**Technical and scientific support and job creation in community sector (poorest of the poor) (QA RSA 09)** To make the community aware of precious resources like water and the preservation of it, the control of alien encroachment, creation of job opportunities and the training of undeveloped communities.	Gauteng Province
			Awareness raising (QA RSA 19) To make the people aware of veld degradation, rehabilitation and the participation of the people.	Northern Cape Province
	North West Province	**Agronomic and vegetative rehabilitation (QT RSA 33)** Combinations; cultivation and vegetative.	**Land user participation with research (QA RSA 33)** Land user participation with researchers to improve existing and develop new technologies.	North West Province
	Limpopo Province	**Revegetation and re-seeding (QT RSA 37)** Re-vegetation of old degraded land. Restoring area to increase grazing capacity and production.	**Government funded demonstrations (QA RSA 37)** Government-funded restoration demonstration site to restore degraded land – by community participation. Community becoming the key stakeholders – capacity building.	North West Province
	North West Province	**Communal grazing management (QT RSA 41)** Rangeland management of communal grazing land, to improve grazing capacity by applying rotation.	**Communal stakeholders (QA RSA 41)** Government funded project aimed at rangeland management to enhance natural resource management, the community being the key stakeholders.	North West Province

	Gauteng Province	Restoration of degraded rangeland (QT RSA 42) Research investigation into alternative treatments for eradicating invasive species and revegetating degraded rangelands with palatable herbaceous species.		
			Working for Water (QA RSA 42) Government-funded restoration/rehabilitation initiative as part of Working for Water project. Aim was to eradicate alien invasives.	Gauteng Province
			Rehabilitation techniques in southern Kalahari – Vegetative and Management (QA RSA 55) Shared interest by Mier Management Council and Provincial Department of Agriculture.	Northern Cape Province

Gully Control/Rehabilitation

Photo				
	Limpopo Province	Old motor tyre contours (QT RSA 01) Old motor tyres and/or vegetation along contours.	Assistance to community (QA RSA 01) Community requested assistance to combat soil erosion, only possible when 'Drought Relief Funds' became available.	Limpopo Province
	Limpopo Province	Gully control (gabions) at Maandagshoek (QT RSA 31) Stone walls and re-vegetation (planting of indigenous trees) = Rehabilitation.	Interactive community approach, biodiversity increase (QA RSA 31) Community involvement.	Limpopo Province
	North West Province	Gravity type inverted tyre structure (QT RSA 14) Stabilising of gully erosion by means of gravity type inverted tyre structures filled with stone.	Community driven protection of the Molatedi Dam catchment area (QA RSA 14) Development and Capacity building in participating communities through the implementation of measures to prevent topsoil losses through erosion in the Molatedi dam catchment area.	North West Province

Terraces

Photo	Limpopo Province	Traditional stone terrace walls (QT RSA 03) Stone terrace walls (or bunds) on sloping along the (approximate) contour.	Community tradition (QA RSA 03) Inherited, and still practiced tradition of stone terracing - passed down from generation to generation.	Limpopo Province

Water Harvesting

Photo			Water harvesting and basin tillage (WHB) through demonstrations (QA RSA 45) Optimising rainwater use, reduce runoff by use of basins and reduce evaporation losses by applying mulch (stones/reeds) on the runoff strip and in the basins.	Free State Province

Ground Water/Salinity Regulation/Water Use Efficiency

Photo	Western Province	Sub-surface drainage on irrigated lands (QT RSA 10) Drainage of saturated and salinised soils by means of sub-soil drainage pipes.		

Storm Water Control/Road Runoff

Photo	North West Province	Water run-off control plan on cultivated land (QT RSA 11) Artificially built watercourses with contour banks with a specific gradient.	All participants – Law enforcement (QA RSA 11) Ordering a land user through the act to implement the SWC.	North West Province

Other

Photo	Mpumalanga Province	Wetland rehabilitation (QT RSA 27) To rehabilitate/stabilise distorted wetland as close as possible to its original state/function.	Working for Water Wetland rehabilitation (QA RSA 27) To improve the quality and quantity of water production and biodiversity in the Blyde River catchment area.	Mpumalanga Province

	Western Cape Province	**Strip mine rehabilitation by plant translocation (QT RSA 47)** Rehabilitation of areas degraded by strip mining, through the translocation of indigenous plants in arid areas of the Namaqualand coast.		
			Extension officer approach by Commercial farmers (QA RSA 21) Farmer approached extension officer (acquire free service) for technical advice and subsidy.	Eastern Cape Province
			Inter departmental approach (QA RSA 34) Eradication of invasive alien plants to enhance water sustainability by increasing runoff into dams and rivers.	All 9 Provinces

CONSERVATION AGRICULTURE

Conservation agriculture (CA) systems, as defined by FAO (2001), includes the following principles:

- **Minimum tillage using specialised implements**

Minimum or reduced tillage manipulates the soil as little as possible as it minimizes the frequency of the use of tillage equipment. Innovative combination equipment units are used and in the field of engineering exciting adaptations have been made to existing farm machinery, as well as the development of new equipment. Zero, or no-tillage, is a planting method that involves no seedbed preparation other than opening the soil for placing seed at the intended depth. No cultivation is performed during the growing season. Weed control is accomplished through using appropriate herbicides.

- **Multiple-cropping**

Mixed species cropping/multi-cropping/intercropping/crop rotation are synonymous in that they imply the growing of two or more plant species in the same field in the same year and at least, in part, at the same time. For the purpose of this document, the term multiple cropping systems is used, covering all the individual approaches. Multiple cropping systems permit the intensification of the farm system, which results in increased overall productivity and biodiversity; the recycling of organic material; water management; soil erosion protection; and pest and disease suppression.

These systems ensure the incorporation of natural processes conducive to the recycling of nutrients; the maximization of biological N fixation; and the minimization of nutrient losses. Multiple cropping systems are conducive to improving soil health and quality and to breaking the pest and disease cycle. These systems require little if any inorganic fertilizer; they mitigate weeds, disease, insects and other pest problems and therefore the frequent use synthetic control products. These systems reduce soil erosion as there is no or little incidence of bare soil areas for extended periods of time. As synthetic nutrients and control products are minimized, the risk of the contamination of water sources and C release (as CO_2) is nullified or at least minimized.

- **Mulching**

It is well-known that mulching, or crop residue retention, in reduced or no-till systems can increase soil organic carbon, leading to improved soil structure, water regimes, fertility, soil biology, and, hence, soil productivity. Residue retention significantly reduces the effects of wind and water erosion, organic carbon build-up is enhanced, soil nutritional status is supplemented through residue breakdown. Evaporative water loss from the surface layers, as well as the risk of potential compaction of the topsoil, are largely reduced. A residue cover could be a potential source of disease build-up, especially in a monoculture system. In view of sustainable agricultural production systems and other pest and disease considerations, crop rotation and mixed cropping systems are essential. The other alternative is to select more disease resistant cultivars.

Other principles used in the design of CA systems are:

- **Integrated soil fertility and acidity management:**

A direct impact on soil fertility due to CA is increased soil organic C and N, as well as mineral N (NO_3-N + NH_4-N) because of N fixation, higher N contents of legume residues and N mineralization. Furthermore, the improved soil biological properties will greatly enhance organic matter, nutrient and mineral transformations, thereby greatly affecting soil organic compounds and soil nutrient availability. Soil physical properties like aggregate stability, bulk density and total porosity are beneficially influenced by residue retention and can indirectly contribute to increased soil biological activity and, consequently, increased soil fertility. It should be emphasized that soil fertility properties like pH, phosphorus and basic cation contents are not directly influenced by a CA practise like crop rotation.

- **Integrated pest management (IPM)**

Integrated pest management is an ecologically-based approach to pest control combining biological, chemical and other regulatory means. IPM utilizes a multi-disciplinary knowledge of crop and pest relationships, the establishment of acceptable economic thresholds for pest populations and constant field monitoring to detect potential problems. It is therefore a strategy to contain pests by biological and cultural control factors, minimizing or avoiding chemical control.

IPM methods could include the use of resistant crop varieties, certified seed, protective seed treatments, disease-free transplants or rootstock, crop rotation, push-and-pull systems, cultural practices, removal of infested plant material, and the optimal use of biological control organisms. There is no natural pest control programme. The farmer has to observe the pest status of the crop and base control decisions on these observations to maintain the delicate balance between pest build up and natural enemies.

- **Integrated weed management (IWM)**

IWM is normally a combination of practices such as crop rotation and long-term conservation tillage. IWM is a combination of weed control practices, thus reducing dependence on any one type of weed control. Such practices include cultural (crop rotations, intercropping and the use of mulch), mechanical (conservation tillage) supplemented by chemical herbicides (such as Glyphosate).

Conservation Agriculture in South Africa

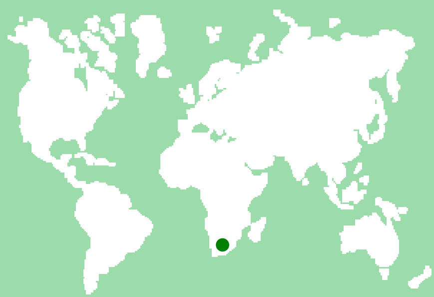
The relative success of CA in Brazil and elsewhere, and the regime shift it has caused has aroused the interest of various institutions and agencies in South Africa. Frequent exchange visits to and from Brazil, has created an atmosphere of Brazil as a main source of inspiration for CA technologies, practices and machineries. As early as 1977, CEDARA (the research arm of the Department of Agriculture in KwaZulu-Natal) began on-station no-till experiments (Derpsch, 2003). Many provincial Departments of Agriculture (notably in KwaZulu-Natal, Eastern Cape, Limpopo) in South Africa are now pushing for the wider spread and use of CA. In some cases CA has become part and parcel of attempts to revitalise agriculture (e.g. The Massive Food Production programme of the Eastern Cape provincial Department of Agriculture). State support for agriculture is made dependent of whether CA is applied or not. Support agencies such as ARC, CIMMYT and NGO's are engaged in many projects. CA has become part of an institutionalised discourse of agricultural development expressed by both South African and international experts. In this way CA in South Africa appears as technology that is far from having emerged from a novelty as was the case in Brazil. However, most of the current attempts to spread and intensify CA have evolved into an ordinary Transfer-of-Technology matter (e.g. technology push) with perhaps similar outcomes: limited adoption, non-adoption and dis-adoption in the short and long run.

In contrast, in other grain producing provinces such as Free State, North-West and Mpumalanga there is, however, little evidence of broad state support to the spread and use of CA. The major thrust in Limpopo is realigning agricultural production with demands and priorities set by a revitalisation of irrigation and attempt to maintain high production levels despite changes in ownership because of the land reform programme. Next to labour and lack of commercial infrastructures for small scale agriculture, water is one of the main ecological constraints to expanding agriculture. The spread of CA among large-scale, commercial farmers in SA is also sporadic and based upon innovative individual farmers and/or groups. Although these farmers have contributed to the large pile of evidence proving the potential benefits of CA in South Africa, the adoption of CA is still slow.

right: Technology (Hester Jansen van Rensburg)
left: Mulching

Conservation Agriculture

Mpumalanga Province, South Africa



Location: Mlondozi
Technology area: 5.2 km²
Conservation measure(s): management measure, vegetative measure, agronomic measure, structural measure
Land use type: Cropland: annual cropping
Stage of intervention: prevention of land degradation, mitigation / reduction of land degradation
Origin: externally introduced through project, recently (< 10 years ago)
Climate: semi-arid
WOCAT database reference: QT RSA43
Related approach: Farmers involved in own development
Compiled by: Hester G. Jansen van Rensburg, ARC- Institute for Soil, Climate & Water, South Africa
Date: 26/11/2001, updated 12/12/2003 by Rinda van der Merwe

Conservation agriculture included aspects such as crop rotation, mulching and no-tillage.

The goal of conservation agriculture is to maintain and improve crop yields and at the same time protect and stimulate the biological binding functioning of the soil. The essential features of conservation agriculture are no-tillage, maintenance of cover (live or dead vegetal material) and crop rotation. Crops are planted through the cover with special equipment or (in the case of Mlondozi) by making holes in the ground with a hand hoe. Soil cover inhibits erosion and the germination of weed seeds; it improves soil water retention and reduces compaction. Crop seeds are planted without prior ploughing. If a plough sole exists, the soil has to be ripped, if not, crop seeds can be planted. It is advisable to move gradually from tillage to no-till over a period of 4-5 years, starting with a crop that produces enough organic material (2-3 ton dry material annually).

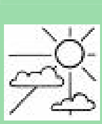
Classification

Land use problems: Soil compaction (plough layer). Reduced soil fertility. Soil acidity. Overgrazing. Lack of implements. Lack of land tenure. In land users' view: Lack of land tenure. Lack of money.

Land use

cropland: annual cropping

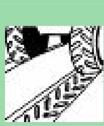
Climate



semi-arid

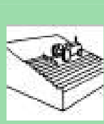
Degradation

erosion by water: loss of topsoil by water

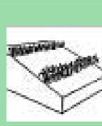


physical degradation:

Conservation measure(s)



agronomic



vegetative

management

Stage of intervention

Prevention
Mitigation/reduction
Rehabilitation

Origin

Land user's initiative:
Experiments/research:
Externally introduced: recent (<10years)
Other's (specify):

Level of technical knowledge

Low: land user
Medium: field staff/agricultural advisor
High:

Main causes of land degradation: Agricultural causes

Main technical functions: ·

- improvement of ground cover
- increase in organic matter
- increase/maintain water stored in soil
- increase of infiltration
- improvement of soil structure
- increase of surface roughness

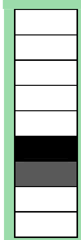
Secondary technical functions: ·

- increase in soil fertility
- control of concentrated runoff (drain/divert)
- control of concentrated runoff (impede/retard)
- control of concentrated runoff (retain/trap)
- control of dispersed runoff (impede/retard)
- control of dispersed runoff (retain/trap)
- reduction in wind speed
- sediment harvesting
- water harvesting
- control of raindrop splash

Environment

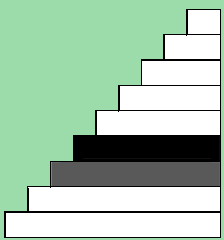
Natural Environment

Average annual rainfall (mm)



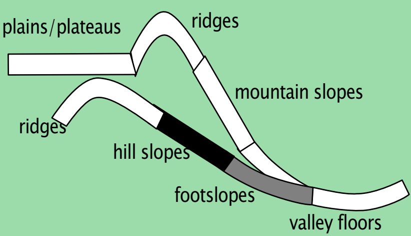
>4000
3000-4000
2000-3000
1500-2000
1000-1500
750-1000
500-750
250-500
<250

Altitude (m a.s.l.)

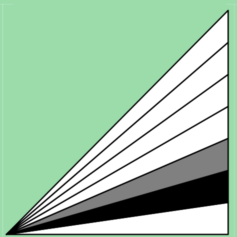


>4000
3000-4000
2500-3000
2000-2500
1500-2000
1000-1500
500-1000
100-500
<100

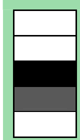
Landform



Slope (%)



Soil depth (cm)



0-20
20-50
50-80
80-120
<120

Growing season(s): 170 days (Nov to April)

Soil texture: Medium (loam): most common; fine (clay): common

Topsoil organic matter: Medium (<1-3%): most common; low (<1%): common

Soil drainage/infiltration: Medium: most common

Soil water storage capacity: Medium

Human environment

Cropland per household (ha)

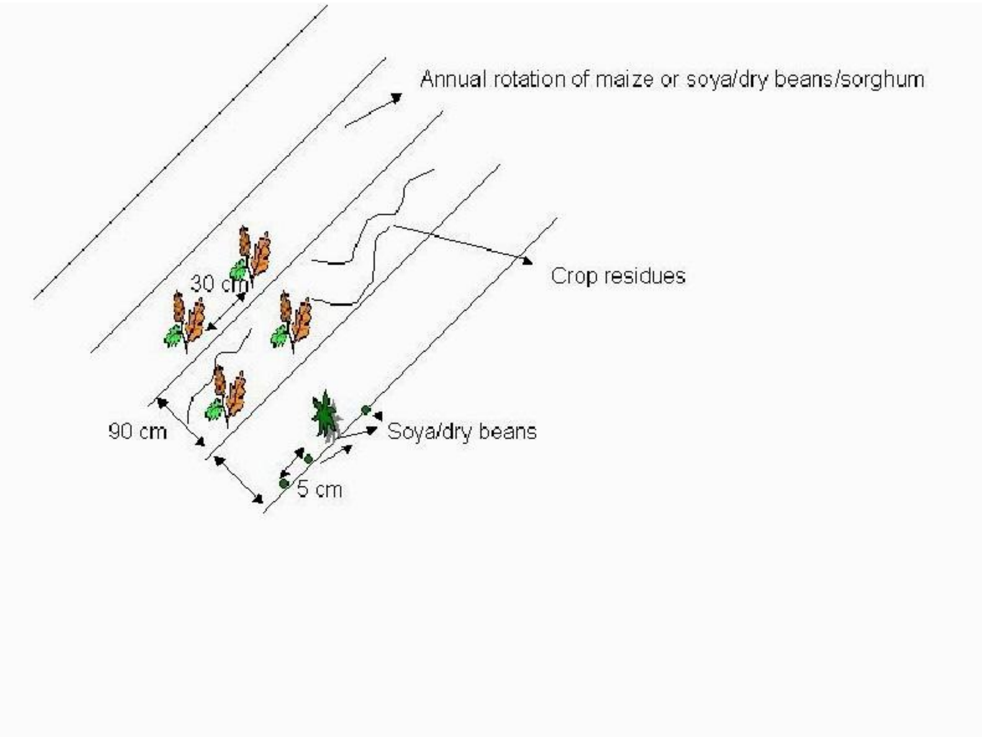
	<0.5
	0.5-1
■	1-2
■	2-5
■	5-15
	15-50
	50-100
	100-500
	500-1000
	1000-10000
	>10000

Land ownership: Individual, not titled: most common

Importance of off-farm income: > 50% of all income. Pensions to buy inputs.

Access to service and infrastructure: Leased: most common

Market orientation: Cropland: mainly subsistence



Technical drawing

Implementation activities, inputs and costs

Establishment activities

1. Agronomic measures
   - no-till
   - crop rotation
2. Management measures
   - exclude animals from field
   - fencing
   - spraying of weeds

Establishment inputs and costs per ha

Inputs	Costs (US$ or local currency)	% met by land user
Labour (__person days)		%
Equipment		
-		%
Materials		
-		%
Agricultural		
-		%
TOTAL		**100%**

Maintenance/recurrent activities

1. Management measure
   - keep lands weed free

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$ or local currency)	% met by land user
Labour (__person days)		%
Equipment		
-		%

Materials		
-		%
Agricultural		
- pesticides (8 L)	20	%
Others		
- save - ploughing	40	%
TOTAL	**60**	**%**

Remarks: Duration of establishment phase: 48 months

Assessment

Impacts of the Technology

Production and socio-economic benefits

- +++ Increased crop yield

Production and socio-economic disadvantages

Socio-cultural benefits

- +++ Improved conservation / erosion knowledge
- +++ Community institution strengthening

Socio-cultural disadvantages

Ecological benefits

- +++ Increased soil moisture
- +++ Improved soil cover
- ++ Biodiversity enhancement
- ++ Increase in soil fertility
- ++ Improved excess water drainage

Ecological disadvantages

Off-site benefits

- + Reduced downstream flooding

Off-site disadvantages

Contribution to human well-being/livelihoods

Benefits/costs according to land user

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

Concluding statements

Strengths and → how to sustain/improve

- Early planting - not dependent on tractors and ploughs → Training
- Soil - reduce soil erosion → Increase in organic material in soil
- Weed control - reduce weed population → Use of herbicides
- Improve water retention - lower risk of drought periods → Mulch
- Reduction in input cost (R500/ha)
- Increase yields → Training
- Cheaper way of planting
- Improve water infiltration → Mulch
- Reduce erosion → Mulch
- Time saving

Weaknesses and → how to overcome

- Lack of mechanization of no-till implements → Exposure to implements
- Lack of no-till implements

left: Group discussion in the field

right: Farmers involved in on-farm demonstration

Farmers Involved in Own Development

Mpumalanga Province, South Africa

Location: Mpumalanga Province
Approach area: 5.2 km^2
Type of Approach: project/programme based
Focus: mainly on conservation with other activities
WOCAT database reference: QA RSA43
Related technology (ies): Conservation Agriculture
Compiled by: Hester G. Janse van Rensburg, Agricultural Research Council, Institute for Soil, Climate and Water
Date:04/12/2001

Planting without ploughing in a crop rotation system to improve moisture management, reduce erosion and increase crop yield.

Aim / objectives: Farmers deal with major problems such as shortages and bad implements, soil erosion and high input costs. The purpose of the project is to involve farmers in their own development, by demonstrating and training in Conservation Agriculture technologies. The methods of doing this include on-farm demonstrations (farmer-led) and training courses (discovery-learning courses). The project is in the final stage; the exit plan is already implemented. The participants are both land owners and managers of the project.

Problem, objectives and constraints

Problems

Physically and chemically degraded land. Changing of attitudes and getting community to take ownership of project.

Aims/Objectives

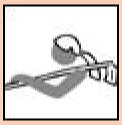
To empower community to take ownership of the projects. To train community in sustainable utilisation of their Natural Resources. To improve food security.

Constraints addressed

Major	Constraint	Treatment
Financial	Agriculture - high input cost with low return	Reduce input cost
Llegal / land use and water rights	No land tenure	
Minor	**Constraint**	**Treatment**
Technical	Lack of knowledge on improvement of agriculture technology	Training

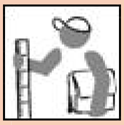
Participation and decision making

Stakeholders / target groups



land users / individual

land users / groups



SLM specialists / agricultural advisors

Approach costs met by:

Government	90%
International non-government	10%
TOTAL	100%

Annual budget for SLM component: US$100,000-1,000,000

Decisions on choice of the Technology (ies): mainly by land users supported by SLM specialists
Decisions on method of implementing the Technology (ies): mainly by land users supported by SLM specialists
Approach designed by: national specialists
Implementing bodies: government, national non-government, local community / land users

Land user involvement

Phase	Involvement	Activities
Initiation/motiviation	Payment/external support	Mainly: interviews/questionnaires; partly: rapid/participatory rural appraisal
Planning	Interactive	Mainly: public meetings; partly: workshops/seminars
Implementation	Self-mobilisation	Responsibility for major steps; Study groups/Training/Farm-led demonstrations/Experimentation
Monitoring/evaluation	Interactive	Mainly: interviews/questionnaires; partly: reporting
Research	Interactive	On-farm; On-farm research - technologies implemented on-farm by farmer-led demonstrations

Differences between participation of men and women: No
Involvement of disadvantaged groups: Yes, great. By the Agriculture Development Committee in consultation with farmer groups.

Technical support

Training / awareness raising:

Training provided for land user
Training was site visits / farmer to farmer, demonstration areas, public meetings, courses
Training focused on Farm planning/Soil fertility/Management/Post-management/No-tillage management etc.

Advisory service:

Name: Farming Systems Research & Extension
Key elements:
1. Training
2. Demonstrations/Experimentation
3. Participation

1) Mainly: government's existing extension system, Partly: non-governmental agency 2) Mainly: government's existing extension system, Partly: non-governmental agency; Extension staff: mainly government employees 3) Target groups for extension: land users; Activities: Farmer groups/On-farm - Farmer-led demonstrations
The extension system is very adequate to ensure continuation of activities. Must have a good understanding of SWC technology.

Research: Yes, moderate research. Topics covered include technology. Mostly on-farm research. Fertilizer calibration trials/Cultivar (different crops) trials, etc.

External material support / subsidies

Labour: Voluntary
Inputs: - Equipment (machinery, tools, etc) - machinery, hand tools. Not financed
- Agricultural (seeds, fertilizers, etc) - seeds, fertilizer. Partly financed
- Infrastructure (roads, schools, etc) - community infrastructure. Not financed
Credit: Credit was not available.
Support to local institutions: Yes, great support with training

Monitoring and evaluation

Monitored aspects	Methods and indicators)
Bio-physical	Regular observations by – Farmers, extention and researchers
Technical	
Socio-cultural	Regular observations by - Farmers, extention and researchers
Economic/production	Regular measurements by - Farmers, extention and researchers
Area treated	
No. of land users involved	Regular measurements by – Implementing team
Management of Approach	Regular measurements by – Key stakeholders or Implementing team
Other	

Changes as result of monitoring and evaluation: There were few changes in the approach. Had to focus more on participatory training.

Impacts of the Approach

Improved sustainable land management: Yes, great; Conservation Agriculture technology - new technologies (mulch, no-tillage, crop rotation).
Adoption by other land users / projects: Yes, some; Lusikisiki LandCare Project, Bergville LandCare Project, Bizane LandCare Project
Training, advisory service and research:
- Training effectiveness
  Land users - good
  SLM specialists - good
  Agricultural advisor / trainers - good
- Advisory service effectiveness
  Land users - excellent
  Technicians / conservation specialists - good
- Research contributing to the approach's effectiveness - Moderately
  Research on approaches done by other institutes was used in this project.

Land/water use rights: Help - moderately in the implementation of the approach. Hinder: moderate
The approach did reduce the land/water use rights problem (low).
Long-term impact of subsidies:
Positive long-term impact – Low. Incentives small - only used to implement ethnology at farm level.

Concluding statements

Sustainability of activities: Yes the land users can sustain the approach activities.

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Ownership of project → Follow-up meetings and training	Can only involve a certain amount of farmers every year → Train trainers
On-farm	
Extension services → On-going support	
Like new way of training → Learning-by-doing courses	
Like new way of training → Learning-by-doing courses	
Increase income	

left: Farmer applying minimum tillage for crop production

right: Preparation of pesticide for application

No-till Crop Production

Mpumalanga, South Africa

Introduction of No-Till crop production systems to rural small scale farmers.

Aim / objectives: Convert small-scale farmers from conventional ploughing to minimum tillage to no-till crop production. Introduce/upgrade technology by using certified seed, fertilizers, herbicides and pesticides. Associated cost increase results in a time saving which allows for additional production. Increased yields result in wealth creation. Develop marketing options for farmers, e.g. a maize farmer can sell green maize (boiled or roasted) for human consumption, maize grain, maize meal, poultry feed or poultry, small or large livestock feed or the carcass (feedlots). Change perception that farmers produce food for own consumption only. They must produce a surplus for sale to generate an income which is wealth creation in the rural areas. Rich farmers = Wealthy Nation, Poor farmers = Poor Nation, Government policies must support rural farmers and ensure a good price for agricultural produce. Upgrade the knowledge/skills level of extension officers (EOs) - gain farmers respect for EOs. EOs must be measured on farmer performance. Improve the link and information flow from research organisations to EOs (and then to the farmer). Research organisations are encouraged to initiate no-till projects to support farmers and EOs, e.g. herbicides for weed problems; fertilizer deficiencies and recommendations; crop options.

Location: Mpumalanga Province
Approach area: 0 km^2
Type of Approach: project/programme based
Focus: mainly on conservation with other activities
WOCAT database reference: QA RSA56
Related technology (ies): No-till/Minimum tillage
Compiled by: James, B.R. Findlay, Agricultural Resource Consultants, South Africa
Date: 25/05/2002

Problem, objectives and constraints

Problems

Lack of political support (e.g. Tanzania). Policy/Know-hows. Mechanisation is expensive – No-Till cheap – demonstrate. Soil and Water conservation. Crop surplus production – sale/process – financial benefit.

Aims/Objectives

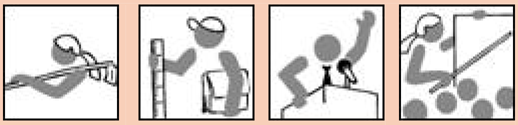
Introduce no-till crop production systems. Make farming profitable. Create markers - input and output. Develop local knowledge / expertise. Reduce / stop soil erosion.

Constraints addressed

Major	Constraint	Treatment
Social / cultural / religious	Overgrazing - too many cattle/too little food. Communal land – no responsibility	Plant pastures - fewer cattle (!!!!)
Financial	Banks do not educate 'poor poverty stricken' farmers in financial management	Banks - educate farmers / take a risk!
Institutional	Authorisation attitude by researchers	Let farmers decide on the advantages of a system
Legal / land use and / water rights	No legislation permitting genetically modified crops	Introduce Demo legislation permitting modern agriculture
Other	Tribal chiefs do not allow individual land ownership (freehold) = power	Government must encourage private land ownership

Participation and decision making

Stakeholders / target groups



land users / individual; SLM specialists / agricultural advisors; politicians / decision makers; teachers / school children / students

Approach costs met by:

Government	20%
International non-government	70%
Local community / land user(s)	10%
TOTAL	100%

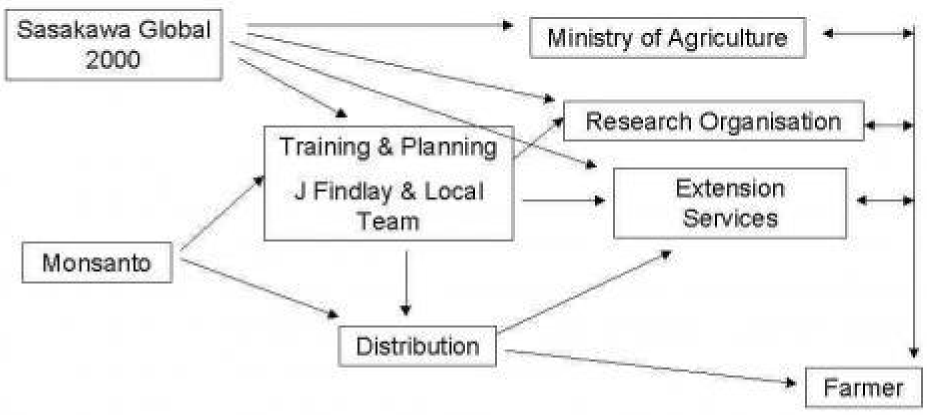
Decisions on choice of the Technology (ies): mainly by SLM specialists with consultation of land users
Decisions on method of implementing the Technology (ies): by SLM specialists alone (top-down)
Approach designed by: international specialists
Implementing bodies: international, government, international non-government, local community / land users

Land user involvement

Phase	Involvement	Activities
Initiation/motiviation	Passive	Other
Planning	Passive	Public meetings; Training of EO and farmers
Implementation	Payment/external support	Responsibility for major steps; Farmers conduct own demonstration with EO support
Monitoring/evaluation	Interactive	Measurements/observations; Farmer supervised by EO. EO compiles report
Research	Interactive	On-station

Differences between participation of men and women: Yes, moderate. Women probably appreciate the labour and time saving more than men.
Involvement of disadvantaged groups: Yes, little. If they have knowledge on the details of inputs, e.g. insect pest and control measures that work.

Organogram



Technical support

Training / awareness raising:
Training provided for land user, SWC specialists, extensionists/trainers, politicians
Training was on-the-job, site visits / farmer to farmer, demonstration areas, public meetings, courses
Training focused on Agronomic system. Herbicides and pesticide use. Processing. Fertilizers. Profitability.

Advisory service:
Name: Village demonstration
Key elements:
1. One EO with 5-8 farmers (1 farmer = failure)
2. Supply inputs for 0.1 ha demonstration (tree)
3. Farmer & EO must do their demo together (both learn)

1) Advisory service was carried out through: government's existing extension system 2) Advisory service was carried out through: government's existing extension system; Extension staff: mainly government employees 3) Target groups for extension: land users, technicians/SWC specialists; Activities: lectures, slide show, practicals, own demos
The extension system is very adequate to ensure continuation of activities. Yes : RSA, Ghana, Ethiopia, Kenya Almost: Malawi, Mozambique, Uganda No: Tanzania.

Research: Yes, moderate research. Mostly on station and on-farm research. Solving local problems - fertilizer levels, weed problems, cultivar choice. Soil benefits come later.

External material support / subsidies

Labour: Voluntary
Inputs: - Equipment (machinery, tools, etc) - hand tools. Fully financed
- Agricultural (seeds, fertilizers, etc) - seeds, seedlings, fertilizer, biocides. Fully financed
Credit: Credit was not available.
Support to local institutions: Yes, moderate support with financial, equipment.

Monitoring and evaluation

Changes as result of monitoring and evaluation: There were many changes in the approach. Application techniques. Choice of cultivars. Fertilizer type and dose. Herbicide dose. Pesticide dose and type. Planting technique.

Impacts of the Approach

Improved sustainable land management: Yes, great; No-Till.
Adoption by other land users / projects: Yes, many; No-Till has become a 'high profile' system for sustainable conservation agriculture in Africa.
Training, advisory service and research:

<u>- Training effectiveness</u> - Low political profile - no money in this for politicians.
Land users* - good
SLM specialists - excellent
Agricultural advisor / trainers - excellent
School children / students - fair
Politicians / decision makers - fair

<u>- Advisory service effectiveness</u>
Land users* - good
Politicians / decision makers - fair
Planners - fair
Teachers - fair
Technicians / conservation specialists - good
School children / students - fair

<u>- Research contributing to the approach's effectiveness</u> - Moderately
Some were excellent (Ghana). Some are poor communicators (Mozambique). Some get a ZERO (Tanzania). Ethiopia have 'self image' to protect!!

Land/water use rights: Help - low in the implementation of the approach. hinder: moderate. Communal lands or insecurity of tenure does not encourage investment (money and time). After harvest - communal grazing! The approach did reduce the land/water use rights problem (moderately). Increase in productivity.
Long-term impact of subsidies: Positive long-term impact – Greatly. Year 1 and 2 (sometimes also year 3) free seed and fertilizer & herbicides for 0.1 ha. Farmers keeps the harvest - helps finance adoption.

Concluding statements

Sustainability of activities: Yes the land users can sustain the approach activities.

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Increased yields → Adoption of technology - technical/extension support	Prices paid to farmers for surplus must be realistic → Maize grain: World price 100 dollar/ton. Mozambique farmer: 35 dollar/ton. Malawi farmer: 40 dollar/ton
Increased areas under production → Financial incentive for farmers to increase production	Politicians do not see that many farmers can get wealthy 'farmers are poor
Increased prosperity	Import supply → Expand distribution
Time and labour saving	Finance → Improve banking services
Increase in yields, area and income	

VEGETATIVE STRIPS / COVER (MAINLY VEGETATIVE MEASURES)

The effective control of soil erosion by water is based on three important principles. These are: a) reducing the velocity of run-off water, b) increasing the infiltration rate of water into the soil, or c) reducing or dissipating the kinetic energy of raindrops before they hit the soil surface. Vegetative techniques can be used to employ these principles and are generally less expensive and labor-demanding compared to engineering practices, for example. These techniques involve the maintenance of a vegetation cover (living or dead) or a barrier to reduce the force of falling raindrops and water runoff (Garrity, 1999). Vegetative techniques offer a wide range of tools for use by a wide range of land users. They do, however, require regular maintenance and land users need to understand that they require time to effectively control enough sediment to gradually change slope (Angima, 2006).

Vegetative strips or a good vegetative cover can be seen as farm management practices undertaken primarily for crop production purposes that are also beneficial from a conservation point of view. Such practices on arable land would be related to one or more of the following:

- Increase and maintain the protective ground cover provided by the growing crops (e.g. intercropping, early planting, use of improved seed and fertilizer)
- Increase and maintain soil organic matter levels, soil nutrients and topsoil erosion resistance (e.g. use of animal manure, compost incorporation of crop residues and green manures, improved tillage techniques, growing of legume crops, use of integrated plant nutrition system)
- Reduce surface runoff, increase infiltration, and improve soil moisture conditions (e.g., contour strip cropping, tied ridges, hedgerows and other cross slope barriers, mulching) (Douglas, 2000)

Vegetative barriers are planted in close rows along contours on slopes where plant roots and lateral stems can provide structure that holds soil particles in place. Plants used for such barriers should be perennial and include grass species, legumes, trees, shrubs, vetches and sods. Various types of vegetative barriers or strips can be classified such as grass strips, vegetated waterways, filter strip terraces, buffer and riparian strips and settling basins (Angima, 2006).

Natural Vegetative Strips (NVS) are narrow strips of naturally growing grasses and herbs that are intentionally left unplowed along the contours of sloped land farms. Such strips serve as buffers that prevent the soil from eroding during heavy rains and intensive cultivation. Over time, these strips form stable terraces along the contours. In addition to reducing runoff and topsoil loss, vegetative strips also filter pesticides, nitrates and soluble phosphorus. They improve water infiltration during heavy rains and can control soil erosion by more than 90% (http://www.agnet.org/library/pt/2002022/, 2009). The use of NVS can reduce the available cropping area by about 10 to 15% and the cropping area utilized for strips depends on the steepness of the slope. The steeper the slope, the greater the area used for strips.

Installing NVS is quite simple. Once contour lines are laid out, there is no additional investment in planting materials or labour. If any other type of vegetation is introduced as a hedgerow, the planting material must be obtained and planted out, which entails additional labour (Lal, 1998). Bands of grass that are about 1-2m wide can be planted along contours and spaced appropriately. Soil preparation is needed prior to planting after which the soil can be seeded with mixtures of adapted grasses and legumes to enhance a good stand. Once the vegetation is stabilized, silt builds up behind the grass and other grass shoots grow from the nodes above the deposited silt and can eventually form a natural terrace (Angima, 2006).

The primary factor influencing a field's susceptibility to soil erosion by wind not directly related to soil type is vegetation and residue. Since it is the one factor that land managers have most control over, it is usually an integral component of most effective wind erosion control systems. Growing crops and above ground residues (standing and flat) help control erosion by reducing exposure of soil to wind at the surface and intercepting wind transported material. The influence of growing vegetation and vegetative residues on wind erosion control is dependent upon the crop type and growth stage for growing vegetation, as well as the age, type and spatial distribution of residues (Wagner, Skidmore, 2000).

In conjunction with other best management practices, the use of vegetative techniques can substantially contribute to overall water and wind erosion control in agriculture (Angima, 2006).

left: Recently planted vetiver in a water course, to slow down the velocity of the water, to trap silt

top right: Well established, dense vetiver along the road to prevent erosion, important to fill gaps

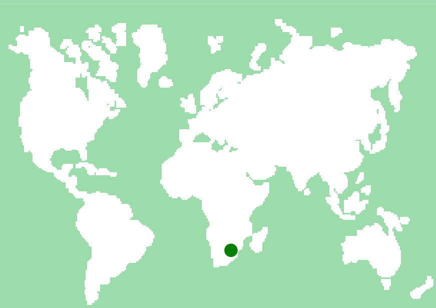
bottom right: Before new planting of new sugarcane, Vetiver grass is planted as a vegetative barrier (hedge), on the contour at 5 m vertical intervals within fields of sugarcane

Vetiver Grass Soil Conservation System

KwaZulu/Natal, South Africa

Vetiver grass is planted as a vegetative barrier (hedge), on the contour at 5 m vertical intervals within fields of sugarcane.

Vetiver grass (*Vetiveria zizanioides*) is planted on the contour and also in other situations (along stream banks and minor farm roads) to form a vegetative barrier and protect the land from surface erosion. This is the case study of a single large-scale commercial farm in KwaZulu/Natal, South Africa, where vetiver grass, which had been growing naturally on the farm for years in clumps, has been split and used in lines to protect the land, following instructions from a booklet. The process was initiated in 1989. Although sugar cane in itself protects the soil quite well, on the slopes and erodible soils of the north coast of KwaZulu/Natal, extra protection is required. The vetiver system can therefore supplement other soil conservation measures such as strip cropping and terraces. It also helps by permanently marking the contour line. Vetiver clumps are dug up and separated into splits, which are planted along the contour (or by stream banks, or along the roadside) just before the rains to ensure good establishment. This is started at the top of the slope, working downwards. The grass hedges are sited at 5 m vertical intervals down slopes of more than 10%, in lines about 200 m long. This is in combination with mulching and minimum tillage. Maintenance is very important, as vetiver often requires 'gapping up' to keep the barrier dense, and it also needs to be cut down before the dry season to prevent it from burning.

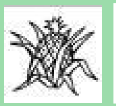


Location: Lower Tugela district
Technology area: 8 km²
Conservation measure(s): vegetative measure, agronomic measure, management measure
Land use type: Cropland: perennial (non-woody) cropping
Stage of intervention: mitigation / reduction of land degradation
Origin: through experiments / research, recently (< 10 years ago):
Climate: semi-arid, sub-humid
WOCAT database reference: QT RSA04
Related approach: Self teaching
Compiled by: Marie J.M. Robert, Vallonia Sugar Estate, South Africa Stranic Rowan
Date: 03/09/1999, updated 12/12/2003 by Rinda van der Merwe

Classification

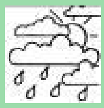
Land use problems: The steep topography and shallow soils limit the types of land use possible, e.g.. perennial grass cover (sugarcane or grazing) or commercial timber production. Annual cropping is not possible without major alteration to the landscape, e.g. terracing.

Land use



cropland: perennial (non-woody) cropping

Climate

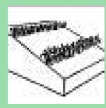


semi-arid
subhumid

Degradation

erosion by water:loss of topsoil by water

Conservation measure(s)



vegetative

Stage of intervention

- Prevention
- Mitigation/reduction (marked)
- Rehabilitation

Origin

- Land user's initiative:
- Experiments/research: recent (< 10 years) (marked)
- Externally introduced:
- Other's (specify):

Level of technical knowledge

- Low: field staff/agricultural advisor, land user (marked)
- Medium:
- High:

Main technical functions: ·

- control of dispersed runoff (impede/retard)

Secondary technical functions: ·

- control of concentrated runoff (impede/retard)
- increase/maintain water stored in soil

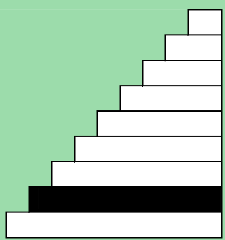
Environment

Natural Environment

Average annual rainfall (mm)

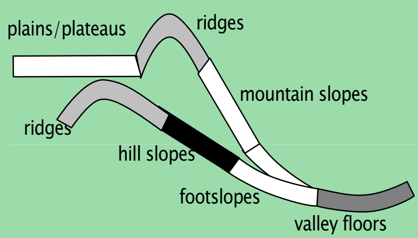
- >4000
- 3000-4000
- 2000-3000
- 1500-2000
- 1000-1500 (marked)
- 750-1000 (marked)
- 500-750
- 250-500
- <250

Altitude (m a.s.l.)

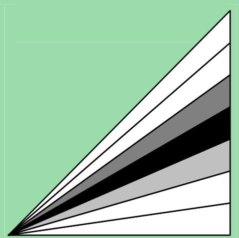


- >4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 500-1000
- 100-500 (marked)
- <100

Landform



Slope (%)



Soil depth (cm)

- 0-20
- 20-50 (marked)
- 50-80 (marked)
- 80-120 (marked)
- <120

Growing season(s): 200 days (October to April)

Soil texture: Medium (loam): most common; coarse (sandy): common

Soil fertility: Medium: most common

Topsoil organic matter: Medium (1-3%): most common; high (>3%): common

Soil drainage/infiltration: Good: most common; medium: common

Soil water storage capacity: Medium to high

Human environment

Cropland per household (ha)

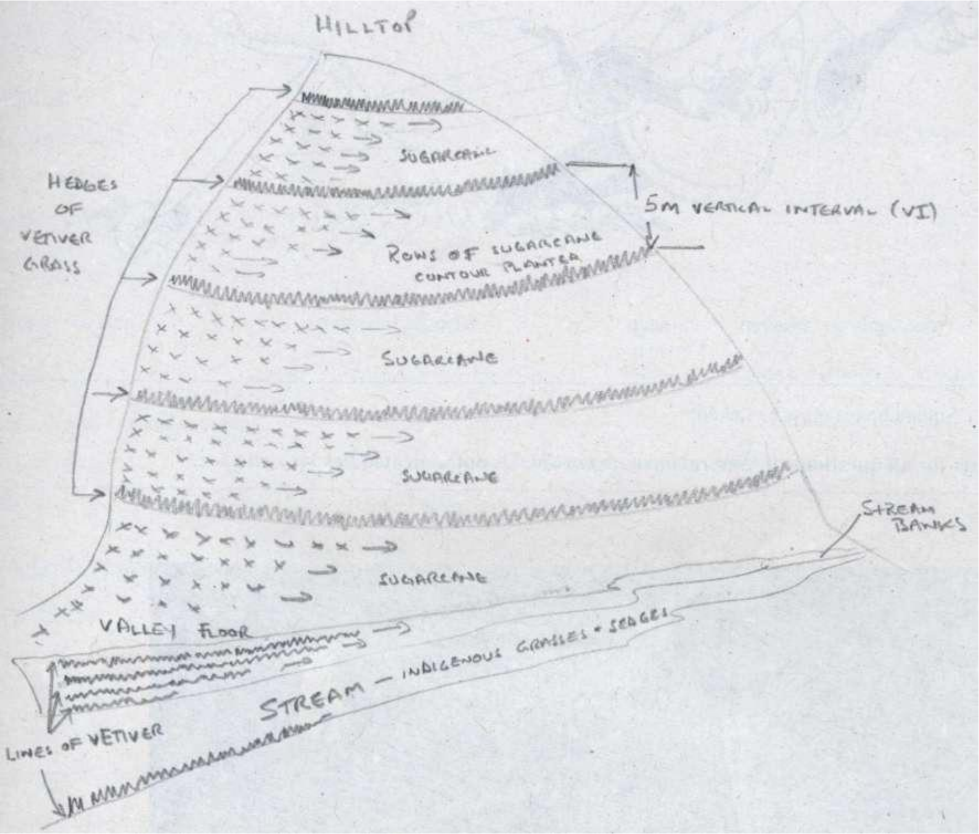
- <0.5
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100 (marked)
- 100-500
- 500-1000
- 1000-10000
- >10000

Land ownership: Individual, titled: most common

Importance of off-farm income: < 10% of all income

Access to service and infrastructure: Individual: most common

Market orientation: Cropland, mainly commercial



Vetiver grass is planted as a vegetative barrier (hedge), on the contour at 5 m vertical intervals within fields of sugarcane. (Marie Joseph Maxime Robert)

Implementation activities, inputs and costs

Establishment activities

1. Agronomic measures
   - minimum tillage
   - mulching at harvest
2. Vegetative measures
   - plant with fertilizer and water
   - weed and gap plant
   - cut back to promote tillering
3. Management measures
   - crop graduation
   - ridging of planting furrows
   - planting of sugarcane – fertilizer in furrow
   - top-dress fertilizer
   - herbicide application

Establishment inputs and costs per ha

Inputs	Costs (US$ or local currency)	% met by land user
Labour (15 person days)	30	100%
Equipment		
- hoes	3	100%
Materials		
- vetiver (2 m^3)	66	100%
Agricultural		
- fertilizer (200 kg)	40	100%
TOTAL	**139**	**100%**

Maintenance/recurrent activities

1. Vegetative measures
   - weed
   - gap plant
   - spray for creeper grasses
   - plant unwanted trees
2. Management measures
   - harvest sugarcane
   - trash management (mulch spreading)
   - fertilizer application
   - herbicide application
   - hand weeding

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$ or local currency)	% met by land user
Labour (5 person days)	10	100%
Equipment		
- hoes	3	100%
Materials		
-		%
Agricultural		
-		%
TOTAL	**13**	**100%**

Remarks: Duration of establishment phase: 24 months

Assessment

Impacts of the Technology

Production and socio-economic benefits

Production and socio-economic disadvantages

Socio-cultural benefits

Socio-cultural disadvantages

Ecological benefits

+ + +	Improved excess water drainage
+ + +	Reduced soil loss
+ +	Reduced wind velocity
+ +	Biodiversity enhancement

Ecological disadvantages

Off-site benefits

+ + +	Reduced downstream siltation
+	Reduced wind transported sediments
+	Reduced groundwater/river pollution
+	Increased stream flow in dry season/reliable and stable flows

Off-site disadvantages

Contribution to human well-being/livelihoods

Benefits/costs according to land user

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

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Grass seed is sterile, easy to contain	The grass burns very easily when mature, due to its density → Strategic burning before fire season
The retention of soil and soil moisture → Make sure there are no gaps	It is susceptible to certain chemicals used on a sugarcane farm → Keep chemical spray off the grass
The velocity of runoff water is slowed	Sugarcane residue is often blown against the hedges and this can form a thick blanket thus preventing ratooning of crop
Does not compete with other crops	
Its many uses e.g.. Thatching, mulching etc.	
Resistance to most chemicals once mature	
Resistance to pests and diseases	
Acts as a windbreak	
Increase in drop yield due to increase in soil moisture	
Its adaptability to work within a range of farming systems	
The author is the land user	

right: Vetiver grass planted in a continuous barrier hedge for soil and water conservation

left: Implementation of vetiver grass for soil conservation

Self-Teaching

KwaZulu/Natal, South Africa

Implementation of Vetiver system for soil conservation.

Aim / objectives: The manager of the farm was given a book and video on vetiver grass by the Mazda group from the UK. There had been some vetiver plants on the farm for 40 years, and it held the soil in place where it grew. This vetiver grew into huge clumps comprising many splits (tillers). The book demonstrated how vetiver could be dug up, split and planted in a continuous barrier hedge for soil and water conservation. In other words, the book offered the possibility of improving on what was already there. The approach therefore was to take ideas from a book, test those ideas and see how they worked in practice. This comprised self-teaching as an individual initiative.

Location: KwaZulu/Natal Province
Approach area: 8 km^2
Type of Approach: other (specify)
Focus: on conservation only
WOCAT database reference: QA RSA04
Related technology (ies): Vetiver grass soil conservation system
Compiled by: Marie J.M. Robert , Vallonia Sugar Estate, South Africa
Date: 06/09/1999

Problem, objectives and constraints

Problems

It is a long-term project. The quantity of vetiver was a problem, especially if you want to do a big part of the farm at once. Then it is expensive because you have to buy the grass and can't wait until your own nursery is established and produce what you need – about 2-5 ha per annum. This means 20-30 years on a big farm. With the vetiver, there is less work on the farm oce its implemented. One need to remark the lines, the vetiver shows the contours. Were 50-60 ha per year and at present about 400 ha per year vetiver.

Aims/Objectives

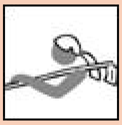
To test ideas taken from a book and see how they work in practice.

Constraints addressed

Major	Constraint	Treatment
Financial	To buy the seedlings is expensive	Slowing down, not do all at once; grow them in own nursery

Participation and decision making

Stakeholders / target groups



Land user/ individual

Approach costs met by:

Other	100%
	%
TOTAL	100%

Annual budget for SLM component: US$

Decisions on choice of the Technology (ies): by land users alone (self-initiative / bottom-up)
Decisions on method of implementing the Technology (ies): by land users alone (self-initiative / bottom-up)
Approach designed by: land users

Land user involvement

Phase	Involvement	Activities
Initiation/motivation	Self-mobilisation	
Planning	Self-mobilisation	
Implementation	None	
Monitoring/evaluation	None	
Research	None	

Differences between participation of men and women: No
Involvement of disadvantaged groups: No

Technical support

Training / awareness raising:
Research: Research

External material support / subsidies

Credit: Credit was not available

Monitoring and evaluation

Monitored aspects	Methods and indicators
Bio-physical	Regular observations by – land owner
Technical	
Socio-cultural	
Economic/production	Ad hoc observations by – land owner
Area treated	Ad hoc observations by – land owner
No. of land users involved	
Management of Approach	
Other	

Impacts of the Approach

Improved sustainable land management: Yes, great
Land/water use rights: Help – greatly in the implementation of the approach. Made own decision and started to implement immediately.

Concluding statements

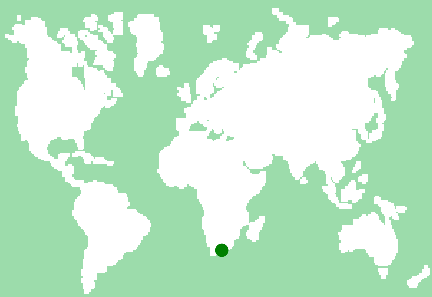
Sustainability of activities: Yes the land users can sustain the approach activities.

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Research (chemical use with vetiver) is needed, some chemicals can kill vetiver	
Creeper weeds a problem in water ways	

left and right: Grass strips left uncultivated to demarcate field boundaries

Grass Strips

Limpopo Province, South Africa



Location: Nebo and Central district
Technology area: 0.3 km²
Conservation measure(s): vegetative measure, management measure, agronomic measure
Land use type: Cropland: annual cropping
Stage of intervention: prevention of land degradation
Origin: through land user's initiative (innovation, traditional), traditional (> 50 years ago)
Climate: semi-arid
WOCAT database reference: QT RSA35
Compiled by: Andrei Rozanov, University of Stellenbosch, South Africa
Date: 17/10/1999, updated 12/12/2003 by Rinda van der Merwe

Combination of field demarcation and erosion protection by grass strips.

Grass strips are left uncultivated to demarcate field boundaries. The width of the grass strips varies widely depending on the availability of land (distance from the village). No establishment is required. The group of fields is fenced off with wire fences (in close vicinity to town) or natural fencing using aloes and dead branches from thorn trees (for gap filling). The fence protects the crops and grass strip during summer. In winter the fields and grass strips are grazed.

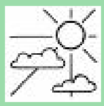
Classification

Land use problems: Low productivity due to lack of investment in fertilizer and pest control. (No credit system in place). Size of plots is too small for economic production. In land users' view: Insufficient funds, distance from markets.

Land use

cropland: annual cropping

Climate

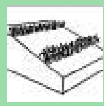


semi-arid

Degradation

erosion by water: loss of topsoil by water

Conservation measure(s)



vegetative

Stage of intervention

- [x] Prevention
- [ ] Mitigation/reduction
- [ ] Rehabilitation

Origin

- [x] Land user's initiative: traditional; recent (<10 years)
- [ ] Experiments/research:
- [ ] Externally introduced:
- [ ] Other's (specify):

Level of technical knowledge

- [x] Low: field staff/agricultural advisor, land user
- [ ] Medium:
- [ ] High:

Main technical functions: ·

- increase of surface roughness
- reduction of slope length
- control of concentrated runoff (impede/retard)
- control of dispersed runoff (impede/retard)

Secondary technical functions: ·

- improvement of ground cover
- increase in soil fertility
- increase of infiltration
- control of concentrated runoff (retain/trap)
- control of dispersed runoff (retain/trap)

Environment

Natural Environment

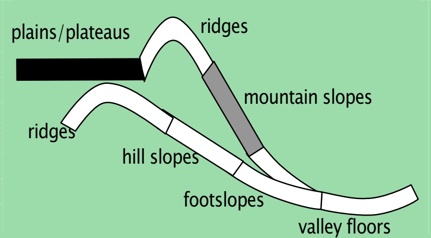
Average annual rainfall (mm)

- [ ] >4000
- [ ] 3000-4000
- [ ] 2000-3000
- [ ] 1500-2000
- [ ] 1000-1500
- [ ] 750-1000
- [x] 500-750
- [ ] 250-500
- [ ] <250

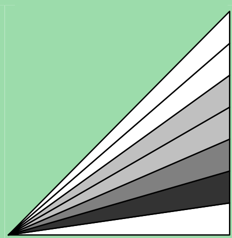
Altitude (m a.s.l.)

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

Landform



Slope (%)



Soil depth (cm) (2.7.9)

- [ ] 0-20
- [ ] 20-50
- [x] 50-80
- [x] 80-120
- [ ] <120

Growing season(s): 210 days (November to March)

Soil texture: Coarse (sandy): most common

Topsoil organic matter: Low (<1%): most common

Soil drainage/infiltration: Good: most common

Soil water storage capacity: High to low

Human environment

Cropland per household (ha)

- [ ] <0.5
- [ ] 0.5-1
- [x] 1-2
- [ ] 2-5
- [ ] 5-15
- [ ] 15-50
- [ ] 50-100
- [ ] 100-500
- [ ] 500-1000
- [ ] 1000-10000
- [ ] >10000

Land ownership: Communal/village

Importance of off-farm income: > 50% of all income; Government pensions; money earned by family members on mines and in urban areas

Access to service and infrastructure: Communal (organised): most common

Market orientation: Cropland: mainly subsistence, partly mixed; (subsistence/commercial)

Implementation activities, inputs and costs

Establishment activities

1. Management measures
   - fencing
   - cultivation between grass strips

Establishment inputs and costs per ha

Inputs	Costs (US$ or local currency)	% met by land user
Labour (10 person days)	50	100%
Equipment		
- tools	10	100%
Materials		
- wire, aloes, Thora tree, branches	200	100%
Agricultural		
-		%
TOTAL	**260**	**100%**

Maintenance/recurrent activities

1. Vegetative measures
   - grazing/mainly cattle
   - plant maize
   - close the fence
2. Management measures
   - winter grazing
   - cultivation
   - weeding

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$ or local currency)	% met by land user
Labour (2 person days)	10	100%
Equipment		
-		%
Materials		
- wire, aloes, Thora tree, branches	10	100%
Agricultural		
-		%
TOTAL	**20**	**100%**

Remarks: Duration of establishment phase: 36 months

Assessment

Impacts of the Technology

Production and socio-economic benefits

Production and socio-economic disadvantages

- Increased labour constraints
- Loss of land (decreased production area)

Socio-cultural benefits

Socio-cultural disadvantages

Ecological benefits

Ecological disadvantages

Off-site benefits

Off-site disadvantages

Contribution to human well-being/livelihoods

Benefits/costs according to land user

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

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Decrease runoff	
Increased water harvesting on grass strips	
Land demarcation	
Crop protection from grazing in summer	
Additional grazing in winter	
Manure input during grazing	

GRAZING MANAGEMENT

The objective of grazing management is to reach a plant composition of pastures which gives the maximum animal production in the short term and is sustainable in the long term. A good mix of desired plants within the pasture also benefits the grazing system by providing more ground surface coverage by plants for as many days of the year as possible.

In achieving the above mentioned goals the major management tools the farmer has is the decision regarding how many animals to allocate to a particular area of veld and for how long they will use the area. This is commonly referred to as the stocking rate. Stocking rate is the single most important factor influencing both the performance of the animals on veld and the response of the veld to grazing.
In communal grazing systems the objectives for keeping livestock are not aimed at direct financial gain to the farmer but rather to provide households with, amongst other products, milk, draught power, dung, equity and bride price (or *lobola*). Maximizing animal numbers rather than livestock production is one of the main objectives (Hardy, 1999).
Animal performance tracks rainfall so that when there is a series of ‘good’ rainfall years, animal performance and numbers increase. Inevitably, however, animal performance and numbers decline dramatically during times of drought, severely impacting on the livelihoods of communal graziers (Hardy, 1999).
The production systems in the communal areas are based on pastoralism and agropastoralism, and the majority of households are subsistence-based and labour intensive, with limited use of technology and external inputs. There is a tendency for high concentrations of people and livestock near permanent water. Animal numbers tend to be geared more to the quantity of reliable water than to the reliable quantity of forage, hence drought effects tend to be more severe in communal than in commercial areas (Palmer and Ainslie, 2005).

Important factors in a grazing management are:
- Frequency and intensity (grazing pressure) of the grazing cycle.
- The grazing system (distribution of animals).
- Under continuous grazing, the grazing pressure on any one area is low. Such condition allows greatest selection for the most nutritious plants, but part of the useful species decline and some types of pasture vegetation are not resilient under this system.
- Under rotational system, in many situations, the pasture stability is maintained.
- The choice of herbivores (species or types of animals).
- The various activities of pasture maintenance (such as controlled burning, slashing, oversowing, pasture rehabilitation, fertilisation) are combined with the pasture management techniques to manipulate the plant community composition.
- Monitoring the condition of the animals as well as the veld.

How to improve veld production (Smith, 1999)

- **Separate veld types**

The most effective means of separating veld types is fencing. However, in the communal areas, features such as streams, ridges, mountains and realigned roads could be used. The area boundaries could also be marked, for example, with painted stones. Where fences do not exist, herders should be employed to implement an appropriate grazing and resting system.

- **Grazing capacity**

Stocking within the grazing capacity of the veld is an important grazing principle because this directly dictates the calving or lambing percentage, weaning mass and percentage off-take of animal products. An ‘economic’ stocking rate would optimise production but in the communal areas an ‘ecological’ stocking rate occurs because numbers of animals are more important than production for direct financial gain. It is therefore up to the community to decide whether they wish to implement an ‘economic’ or an ‘ecological’ stocking rate. However, the inevitable consequence of implementing an ‘ecological’ stocking rate is a decline in veld condition and, ultimately, a reduction in the potential of the veld for livestock production.

- **Resting of veld**

In order to maintain the vigour of the veld, it is essential to rest the vegetation for the entire growing season at least once in 4 years. In the communal areas the implementation of this principle could have a marked beneficial effect on veld production.

- **Bush encroachment**

In the savanna areas, where bush is either encroaching or thickening up, grass production is detrimentally affected due to competition from the trees. Preventive measures such as providing a hot burn or chemical control are seldom necessary in the communal areas, as chopping trees for firewood and the browsing of goats are excellent control measures.

- **Stocking intensity**

In situations where it is possible to operate a multicamp system and, in particular, where it is difficult to demarcate areas with the same size or grazing capacity, it is necessary to ensure that the stocking intensity for all camps/grazing areas is similar. The stocking intensity is expressed in grazing days per ha.

left and right: Mechanical techniques employed to rehabilitate degraded areas

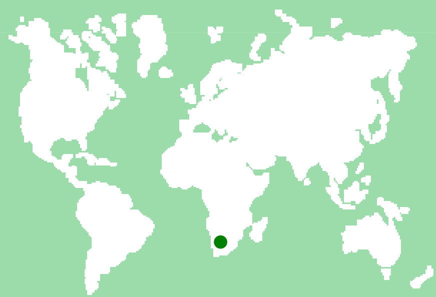
Rangeland Rehabilitation

North West province, South Africa

Rangeland rehabilitation where we use perennial grasses to rehabilitate the footslopes in a semi-arid region on a clay loam soil.

Different techniques (mechanical: e.g. ripper, dyker plough) as well as biological (stone dams, loose dams) are used to rehabilitate a totally degraded area. Different combinations are also used (e.g. ripper with seed and ripper without seed) to see if there is a natural seed bank left. The research is being done in a semi-arid area and on a footslope (medium depth and clay loam soil). The purpose is to get palatable vegetation back in the area for animal consumption. In the process, erosion is stopped and water runoff decreased. At the same time, the community is also trained and educated regarding management, grazing capacity, etc.

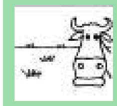
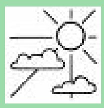
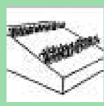
Researchers and technicians of the Provincial Department of Agriculture planted the experiment. The community is always present when any treatment is applied. The area is fenced off and maintained by the Department. The community will take full responsibility of the trial at a later stage. They are very eager to take over and their participation is very good.



Location: Leharatshe
Technology area: 0.4 km²
Conservation measure(s): vegetative measure
Land use type: Grazing land: extensive grazing
Stage of intervention: rehabilitation / reclamation of denuded land
Origin: through experiments / research, recently (< 10 years ago)
Climate: semi-arid
WOCAT database reference: QT RSA32
Related approach: On-farm research with community involvement
Compiled by: Franci P. Jordaan and Jaco van Rooyen, Department of Agriculture, South Africa,
Date: 06/10/1999, updated 12/12/2003 by Rinda van der Merwe

Classification

Land use problems: Too many animals for the specific area. No camps - so no form of rotation possible; no management plans - animals can walk and graze where they want to. In land users' view: Need more land so that the animals have a larger area to move in.

Land use	Climate	Degradation	Conservation measure(s)
			
grazing land: extensive grazing	semi-arid	erosion by water: loss of topsoil by water	vegetative

Stage of intervention
- Prevention
- Mitigation/reduction
- Rehabilitation

Origin
- Land user's initiative:
- Experiments/research: recent (<10 years)
- Externally introduced:
- Other's (specify):

Level of technical knowledge
- Low:
- Medium: field staff/ agricultural advisor
- High:

Main causes of land degradation:

- over-exploitation of vegetation
- overgrazing

Main technical functions: ·

- increase of infiltration
- control of concentrated runoff (impede/retard)

Secondary technical functions: ·

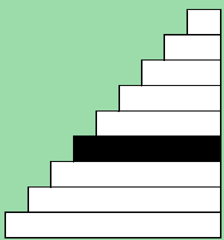
- improvement of ground cover
- control of raindrop splash

Environment

Natural Environment

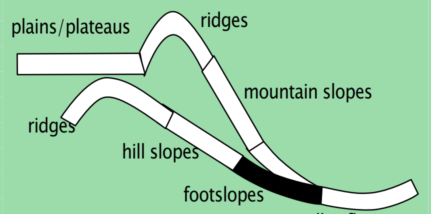
Average annual rainfall (mm)
- >4000
- 3000-4000
- 2000-3000
- 1500-2000
- 1000-1500
- 750-1000
- 500-750
- 250-500
- <250

Altitude (m a.s.l.)

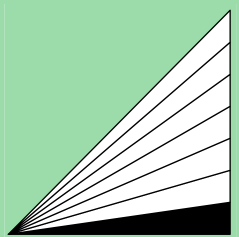


- >4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 500-1000
- 100-500
- <100

Landform



Slope (%)



Soil depth (cm)
- 0-20
- 20-50
- 50-80
- 80-120
- <120

Growing season(s): 210 days (October to April)

Soil texture: Medium (loam): most common

Soil fertility: Low: most common

Topsoil organic matter: Low (<1%): most common

Soil drainage/infiltration: Poor: most common

Soil water storage capacity: Very low

Human environment

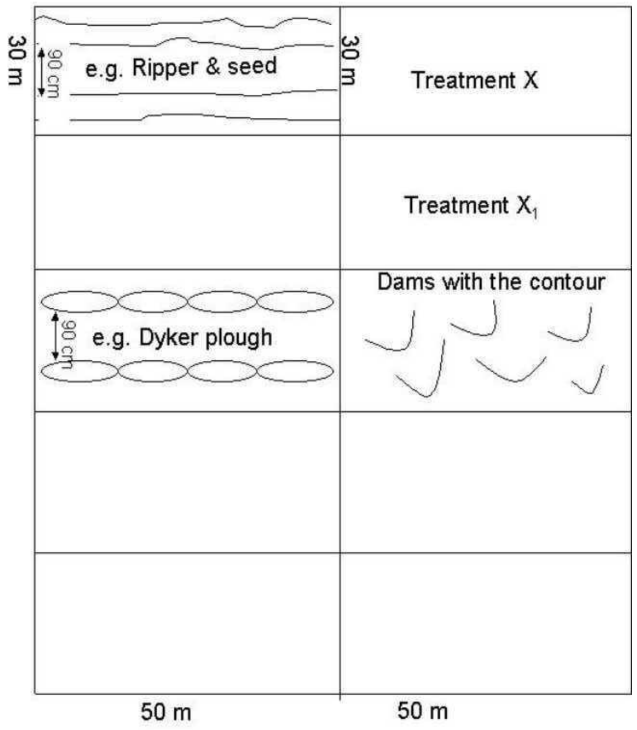
(*Type of) land per household (ha)
- <0.5
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1000
- 1000-10000
- >10000

Land ownership: Communal/village: most common

Importance of off-farm income: <10% of all income

Access to service and infrastructure: Communal (organized): most common

Market orientation: Cropland: mainly subsistence; Grazing land, mainly mixed (subsistence/commercial)



Technical drawing

Implementation activities, inputs and costs

Establishment activities

1. Vegetative measures
   - fencing of area
   - application of different techniques (treatments)
   - planting of grass

Establishment inputs and costs per ha

Inputs	Costs (US$ or local currency)	% met by land user
Labour (__person days)		%
Equipment		
- machine hours (24 h)		%
Materials		
- stones (1 qm)		%
Agricultural		
- seeds (6 kg)		%
TOTAL		**100%**

Maintenance/recurrent activities

1. Vegetative measure
   - keep fence intact

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$ or local currency)	% met by land user
Labour (__person days)		%
Equipment		
-		%
Materials		
-		%
Agricultural		
- seeds (0.3 kg)		%
TOTAL		**100%**

Remarks: Duration of establishment phase: 12 months

Assessment

Impacts of the Technology

Production and socio-economic benefits		Production and socio-economic disadvantages	
+ +	Fodder production/quality increase	-	Increased input constraints
		-	Increased labour constraints

Socio-cultural benefits		Socio-cultural disadvantages	
+ + +	National institution strengthening		
+ + +	Community institution strengthening		
+ +	Improved conservation / erosion knowledge		

Ecological benefits		Ecological disadvantages	
+ + +	Biodiversity enhancement		
+ +	Reduced wind velocity		
+ +	Reduced soil loss		
+ +	Increase in soil fertility		
+ +	Improved excess water drainage		
+ +	Increased soil moisture		
+ +	Improved soil cover		

Off-site benefits

Off-site disadvantages

Contribution to human well-being/livelihoods

Benefits/costs according to land user

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

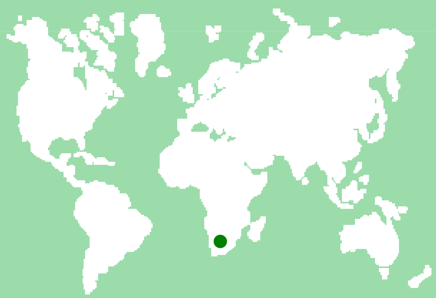
Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Quickest way to get more palatable grass, a more economical way	Community do not have implements → Maybe LandCare
Very effective	Lack of knowledge (a lot is needed) → Come and see, learnt a lot by implementing
Biological methods	On a bigger scale - fence off more or less impossible - at this stage (cannot afford) → Maybe branch packing (enough blackthorn bush encroachment)
Manpower to do it	Do not understand the system
Community was not paid, more sustainable	Expensive
Quickly done	It is difficult to get the seed
	Seed itself is expensive

left and right: the restoration of degraded soils making use of recommended soil treatments and the reestablishment of appropriate grass species

Veld Restoration on Degraded Duplex Soils

MpumalangaSouth Africa



Location: Mpumalanga Province
Technology area: 0.03 km²
Conservation measure(s): management measure, agronomic measure, vegetative measure
Land use type: Grazing land: extensive grazing
Stage of intervention: rehabilitation / reclamation of denuded land
Origin: through experiments / research, recently (< 10 years ago)
Climate: semi-arid
WOCAT database reference: QT RSA30
Compiled by: Francois de Wet, Enviropulse CC, South Africa
Date: 16/06/2000, updated 25/07/2005 by Rinda van der Merwe

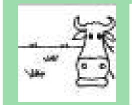
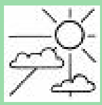
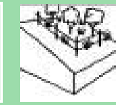
Restoration of degraded grazing land on culprac, sodic soils, sodic sites (bakbolle – Afrikaans).

Investigation of veld to assess situation and extent of problem, evaluating causes and making recommendations to minimise the problem. For a large area: Take soil samples and send for analysis to determine the type of grass seeds present and to assess the chemical composition of soil. Recommend required treatment of soil, chemical as well as mechanical and what quantitative inputs are needed. For duplex soils the addition of gypsum (communities use manure for organic matter) is recommended. The preparation phase of the soil is very important. Add necessary components (dung, etc.) and plant the seeds. Add some rocks on top of the soil for entrapment of nutrients (nutrients and water flow are enhanced).

It is important to take the grasses from the immediate area, because it might be found that grass from another area is not adapted for the specific area. *Dactyloctenium eagyptium*, *Sporobulus nites*, *Enteropgon monostachyuns* and *Cynodon dactylon* will be suitable for duplex soils. *Digitaria eriantha* will be better after the soil has improved a bit. For branch packing (preparation of site), the branches of encroached bushes (Ghurrie bush, *Acacia exofialus*, *nelotica*) are used. The area should be fenced off.

Classification

Land use problems: Soil erosion on lower lying duplex. In land users' view: Low production of grasses - seen as an example by specialist.

Land use	Climate	Degradation	Conservation measure(s)
 grazing land: extensive grazing	 semi-arid		 management

Stage of intervention

- □ Prevention
- □ Mitigation/reduction
- ■ Rehabilitation

Origin

- □ Land user's initiative:
- ■ Experiments/research:
- □ Externally introduced:
- □ Other's (specify):

Level of technical knowledge

- ■ Low:
- □ Medium:
- ■ High: field staff/agricultural advisor

Main technical functions: ·

- increase in organic matter

Secondary technical functions: ·

- increase in soil fertility
- improvement of ground cover

Environment

Natural Environment

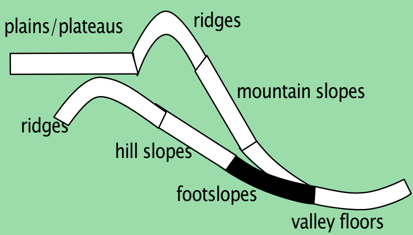
Average annual rainfall (mm)

□	>4000
□	3000-4000
□	2000-3000
□	1500-2000
□	1000-1500
□	750-1000
■	500-750
□	250-500
□	<250

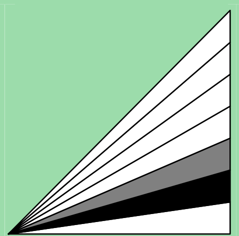
Altitude (m a.s.l.)

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

Landform



Slope (%)



Soil depth (cm)

■	0-20
□	20-50
□	50-80
□	80-120
□	<120

Growing season(s): 180 days (October to March)

Soil texture: Fine (clay): most common

Soil fertility: Low: most common

Topsoil organic matter: Low (<1%): most common

Soil drainage/infiltration: Poor: most common

Soil water storage capacity: Low

Human environment

(*Type of) land per household (ha)

□	<0.5
□	0.5-1
□	1-2
□	2-5
□	5-15
□	15-50
□	50-100
□	100-500
□	500-1000
□	1000-10000
□	>10000

Land ownership: Communal/village: most common; individual (titled): common

Importance of off-farm income: 10 - 50% of all income. Impression - not sure. Sabiesands and Mthethomusha: both eco-tourism, going well (game increasing) and Dumphries just cattle. Parks Board (Sabiesands) employ people from the community.

Access to service and infrastructure: Communal (organised): most common; individual: common

Market orientation: Grazing land: mainly subsistence, partly commercial

Implementation activities, inputs and costs

Establishment activities

1. Field activities for agronomic measures
   - ripping
   - add organic material
   - packing of stones
2. Vegetative measures
   - selected bush clearing (if necessary)
   - ripping
   - branch packing (should not exclude sunlight – 50%)

Establishment inputs and costs per ha

Inputs	Costs (US$ or local currency)	% met by land user
Labour (__person days)		%
Equipment		
-		%
Materials		
-		%
Agricultural		
-		%
TOTAL		**100%**

Assessment

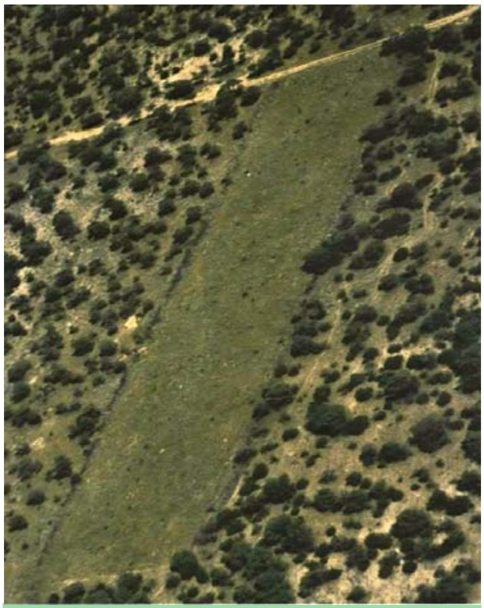
Impacts of the Technology

Production and socio-economic benefits		Production and socio-economic disadvantages	
+++	Increased farm income		
+++	Fodder production/quality increase		
Socio-cultural benefits		**Socio-cultural disadvantages**	
+++	Improved conservation / erosion knowledge		
++	Community institution strengthening		
Ecological benefits		**Ecological disadvantages**	
+++	Reduced wind velocity		
+++	Biodiversity enhancement		
+++	Reduced soil loss		
+++	Increase in soil fertility		
+++	Improved excess water drainage		
+++	Increased soil moisture		
+++	Improved soil cover		
Off-site benefits		**Off-site disadvantages**	
+++	Reduced wind transported sediments		
++	Reduced groundwater / river pollution		
+++	Reduced downstream siltation		
+++	Increased stream flow in dry season / reliable and stable low flows		
+++	Reduced downstream flooding		

Contribution to human well-being/livelihoods

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Dung available (organic matter)	Mechanical problems: not ripped deep enough you can experience problems
Provide income - people live on land	Need input from outside
Job creation (1 time and eco-tourism) so ongoing → If you could do it on bigger areas it will be better	Depending on knowledge from experts - expensive - need sponsor, from Government/other
4 weeks (per ha) to implement	Laws not enough, slight increase of awareness under the farmers
No maintenance (no costs)	
Not dependent on rainfall	
Job creation to community	
Better quality grazing available	
Initially getting attention - tourism with game	



left: Hundred present bush control (Photo by Chris Richter).

right: Chemical bush control by aerial application

Chemical Bush Control

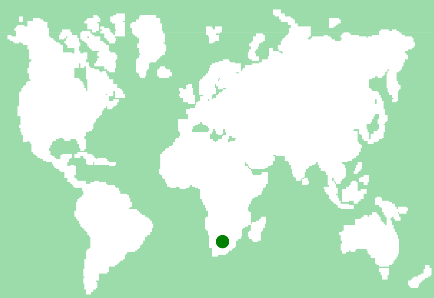
Free State Province and North West Province, South Africa

To either clear or thin bush (trees) in encroached areas by chemical means (Chemical bush control with special reference to thinning and clearing).

In some areas, the bushes are so dense (more than 2000 plants/ha) that access to the area is not possible and therefore the aerial application of chemicals is the only solution. All the plants in this area get treated this way, but no selective treatment is possible (this is still a problem to overcome). This aerial application can be selective to some extent because some bushes survive the treatment. If that is the case, selective thinning with chemical bush control can be done on bushes (but not on palatable/usable species).

The purpose was to characterise and control bush encroachment; to define and quantify grass-bush interactions in mixed savannahs, by chemical bush control; to be able to make recommendations for larger application chemical bush control like by aerial application. There was a lack of a technique for economic comparison between the potential loss of income due to bush encroachment and the cost of controlling bush.

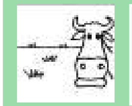
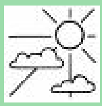
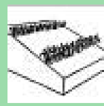
Aftercare is very important and is an on-going process. After the first application of the chemicals, it is possible to let in goats. Browsers are better than game because they browse the small bushes and prevent further bush encroachment in the area. The application of fire is also possible. In this area it should only be done every 7th - 10th year (depending on the rainfall and grass production). There is very little communal land in this large area (5 million ha).



Location: Vryburg, Griekwastad, Mafekeng
Technology area: 1.4 km²
Conservation measure(s): vegetative measure
Land use type: Grazing land: extensive grazing
Stage of intervention: rehabilitation / reclamation of denuded land
Origin: externally introduced through project, recently (< 10 years ago)
Climate: semi-arid
WOCAT database reference: QT RSA16
Related approach: Chemical bush control on commercial farms
Compiled by: Chris Richter, Department of Agriculture, South Africa
Date: updated 12/12/2003 by Rinda van der Merwe

Classification

Land use problems: The negative impact that bush encroachment has on the production and botanical composition of the grass layer in these areas - thus making economical farming impossible. In land users' view: In the small communal areas camps are not used, the area is overstocked.

Land use	Climate	Degradation	Conservation measure(s)
			
grazing land: extensive grazing	semi-arid	physical degradation:	vegetative

Stage of intervention
- [ ] Prevention
- [ ] Mitigation/reduction
- [x] Rehabilitation

Origin
- [ ] Land user's initiative:
- [ ] Experiments/research:
- [x] Externally introduced: recent (<10 years)
- [ ] Other's (specify):

Level of technical knowledge
- [ ] Low:
- [x] Medium: Field staff/agricultural advisor
- [ ] High:

Main causes of land degradation: Over-exploitation of vegetation (decrease in game led to over-utilising of grass and under-utilisation of woody species)

Main technical functions: ·
- improvement of ground cover

Secondary technical functions: ·
- control of dispersed runoff (retain/trap)
- increase/maintain water stored in soil

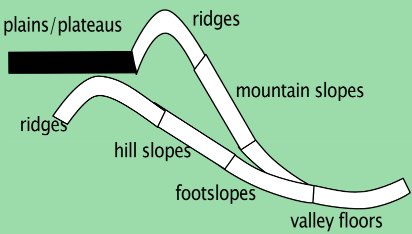
Environment

Natural Environment

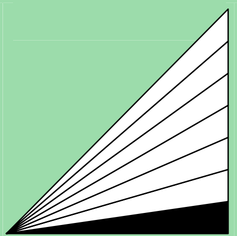
Average annual rainfall (mm)
- [ ] >4000
- [ ] 3000-4000
- [ ] 2000-3000
- [ ] 1500-2000
- [ ] 1000-1500
- [ ] 750-1000
- [ ] 500-750
- [x] 250-500
- [ ] <250

Altitude (m a.s.l.)
- [ ] >4000
- [ ] 3000-4000
- [ ] 2500-3000
- [ ] 2000-2500
- [ ] 1500-2000
- [x] 1000-1500
- [ ] 500-1000
- [ ] 100-500
- [ ] <100

Landform



Slope (%)



Soil depth (cm)
- [x] 0-20
- [ ] 20-50
- [ ] 50-80
- [ ] 80-120
- [ ] <120

Growing season(s): 180 days (October to April)

Soil texture: Coarse (sandy): most common; medium (loam): common

Soil fertility: Medium: most common; low: common

Topsoil organic matter: Low (<1%): most common

Soil drainage/infiltration: Good: most common, poor: most common

Soil water storage capacity: Low

Human environment

Grazing land per household (ha)
- [ ] <0.5
- [ ] 0.5-1
- [ ] 1-2
- [ ] 2-5
- [ ] 5-15
- [ ] 15-50
- [ ] 50-100
- [ ] 100-500
- [ ] 500-1000
- [x] 1000-10000
- [ ] >10000

Land ownership: Individual (not titled): most common; communal/village: common

Importance of off-farm income: 10 - 50% of all income; up to 25% farmers get involved in ecotourism (trend is to more game for ecotourism and hunting)

Access to service and infrastructure: Individual: most common; communal (organised): common

Market orientation: Grazing land: partly mixed (subsistence/commercial), mainly commercial

Implementation activities, inputs and costs

Establishment activities

1. Vegetative measures
   - soil applied chemicals (tebuthiuron)

Establishment inputs and costs per ha

Inputs	Costs (US$ or local currency)	% met by land user
Labour (680 person days)	40000	%
Equipment		
-	6000	%
Materials		
- chemicals, subsistence allowance travellng costs	20000	%
Agricultural		
-	66000	%
TOTAL		**100%**

Maintenance/recurrent activities

1. Management measures
   - burning the veld
   - browsing the veld by goats

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$ or local currency)	% met by land user
Labour (__person days)	10000	%
Equipment	1500	
-		%
Materials	5000	
- chemicals, subsistence allowance travellng costs		%
Agricultural		
-		%
TOTAL	**16500**	**100%**

Remarks: Duration of establishment phase: 12 months

Assessment

Impacts of the Technology

Production and socio-economic benefits

+	+	+	Fodder production/quality increase
+	+		Increased farm income

Production and socio-economic disadvantages

-			Reduced production

Socio-cultural benefits

Socio-cultural disadvantages

Ecological benefits

+	+	+	Improved soil cover
+	+		Increased soil moisture

Ecological disadvantages

-			Loss in biodiversity

Off-site benefits

Off-site disadvantages

Contribution to human well-being/livelihoods

Benefits/costs according to land user

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

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Improvement of veld condition and production	Under aerial application utilizable plants can be eradicated, if not adhered to directive → Hand application
Accessibility (because it was too dense)	Very expensive
Improvement in grazing capacity	
Improvement of veld condition and production	
Accessibility	

left and right: Stages of project implementation include pilot surveys, site visits, meetings, interviews and the completion of questionnaires

Participatory Rural Approach

North West Province, South Africa

Location: North West Province
Approach area: 35 km^2
Type of Approach: project/programme based
Focus: mainly on other activities
WOCAT database reference: QA RSA39
Related technology (ies): Control of bush encroachment
Compiled by: Saroné de Wet, School of Environmental Science and Development, North West University, South Africa
Date: 17/09/2001

Participatory Rural Approach including a partly holistic approach; between social and environmental sciences.

Aim / objectives: Developing sustainable management of land and other natural resources in rural communities. Assess the historical process, causes, nature and extent of desertification and its human impact. An empirical study of the attitudes, perceptions and knowledge of the local population with regard to land use. Develop policy guidelines for integrated rural development focussing on spatial planning, settlement models, land use control measures, ecological restoration and sustainable farming practices. Pilot interviews with the extension officers were followed by interviews with members of the communities themselves. Plant surveys were conducted at the study areas.

Stages of implementation: There were 5 stages of implementation included in the pilot interviews, the main interviews and the plant surveys. Task 1: Preliminary negotiations with officials, authorities and local communities, including a literature and methodological review. Task 2: Data collection includes satellite data and aerial photographs, ground truth (site visits, meetings, surveys, interviews and questionnaires - a PRA approach. Task 3: Analysis and interpretation include archival research, image processing and interpretation and analysis of surveys and questionnaires. Task 4: Validation and cross-referencing by accuracy testing of remotely sensed results, historical cross-referencing, comparison to Botswana results, comparison of results (communal land vs. commercial land). Task 5: Reporting.

Problem, objectives and constraints

Problems

Desertification and its human impact, with the specific incorporation of indigenous or traditional knowledge. Inadequate policy towards integrated rural development.

Aims/Objectives

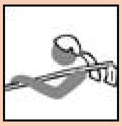
Developing sustainable management of land and other natural resources in rural communities. Specific objectives: Assess the historical process, courses, nature and extent of desertification and its human impact. Did an empirical study of the attitudes, perceptions and knowledge of the local population with regard to land use. Finally, we want to develop policy guidelines for integrated rural development focussing on spatial planning, settlement models, land use control measures, ecological restoration and sustainable farming practices.

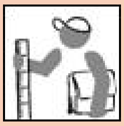
Constraints addressed

Major	Constraint	Treatment
Financial	Funding not sufficient	Funding
Institutional	Part of previous disadvantaged homeland	Policy recommendations
Minor	**Constraint**	**Treatment**
Technical	No contracts with large equipment companies	With the Department of Agriculture, these contracts have been established

Participation and decision making

Stakeholders / target groups


land user/ individual


SLM specialists/ agricultural advisors


politicians/ decision makers

Approach costs met by:	
International non-government	80%
Local community / land user(s)	20%
TOTAL	100%

Annual budget for SLM component: US$10,000-100,000

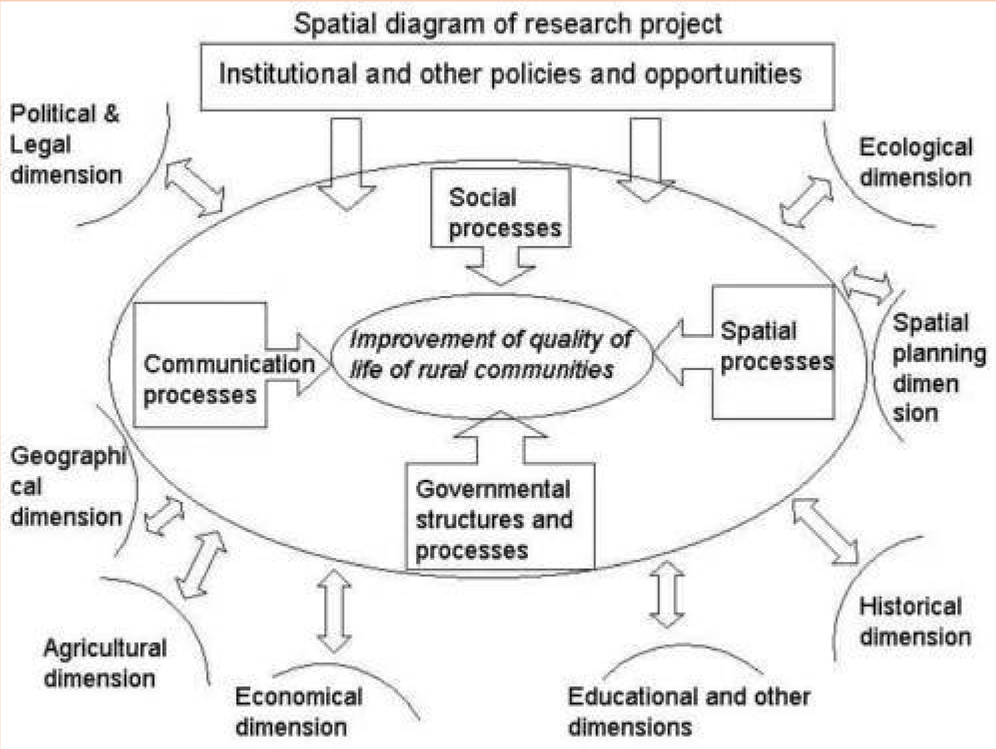
Decisions on choice of the Technology (ies): mainly by land users supported by SLM specialists
Decisions on method of implementing the Technology (ies): mainly by SLM specialists with consultation of land users
Approach designed by: national specialists, international specialists
Implementing bodies: local community / land users, national non-government, international

Land user involvement

Phase	Involvement	Activities
Initiation/motiviation	None	Interviews/questionnaires, public meetings; Interviews with most viable group. Public meetings: what should we look at in the areas
Planning	Interactive	Casual labour, responsibility for minor steps; Erosion control
Implementation	Interactive	
Monitoring/evaluation	None	
Research	None	

Differences between participation of men and women: No
Involvement of disadvantaged groups: Community members were invited to information sessions and given the opportunity to mention problems they experience.

Organogram



Technical support

Training / awareness raising:

Training provided for land user, school children/students
Training was on-the-job
Training focused on Gabion construction

Advisory service:

Name: Participatory rural approach
Key elements:
1. Involvement in gabion construction
1) Mainly: government's existing extension system, Partly: projects own extension structure and agent 2) Mainly: government's existing extension system, Partly: projects own extension structure and agent; Extension staff: mainly government employees 3) Target groups for extension: land users; Activities: erosion control through gabion construction
The extension system is inadequate to ensure continuation of activities. Extension officers available for information on erosion and encroachment control.

Research: Yes, moderate research. Topics covered include sociology, ecology, technology
Mostly on station and on-farm research.
Sociology: interviews/trust building. Ecology: explain what we are doing. Technology: gabion construction

External material support / subsidies

Labour: Food-for-work, rewarded with other material support. Guides received food parcels. Other incentives; future change in policy.
Credit: Credit was not available.
Support to local institutions: Yes, moderate support with training

Monitoring and evaluation

Changes as result of monitoring and evaluation: There were several changes in the approach. Initially only the extension officers were interviewed in groups; the communities as well, but in the end individual interviews proved more effective. Woody component analysis: Where all members worked on one quadrate at the start, we changed the strategy to three teams of two people each, each team having their own specific responsibilities.

Impacts of the Approach

Improved sustainable land management: Yes, moderate; They did not adapt, but their awareness was raised.
Adoption by other land users / projects: No
Improved situation of disadvantaged groups:
Training, advisory service and research:

- Training effectiveness
  Land users* - good
  SLM specialists - excellent
  Agricultural advisor / trainers - fair
  School children / students - excellent
- Advisory service effectiveness
  Land users* - fair
  Planners - fair
  Technicians / conservation specialists - fair
- Research contributing to the approach's effectiveness - Greatly
  Previous knowledge of community work enabled us to be open with them, adding towards co-operation.

Land/water use rights: Hinder - greatly in the implementation of the approach. No one takes responsibility for maintaining the applied technology. The approach did reduce the land/water use rights problem (greatly). The people worked with the specialist in establishing the technology.
Long-term impact of subsidies: Negative long-term impact – Low. Community members might expect incentives with future involvement, or fall into the habit of only co-operating when incentives are given.

Concluding statements

Sustainability of activities: No the land users can't sustain the approach activities. No: Erosion - the wire mesh baskets must be supplied by the appropriate companies, but otherwise they might pack stones without the wire mesh baskets. Yes for bush encroachment.

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Trust of people obtained → Deliver on the promises	Number of available SWC specialist insufficient for amount of work: Train the amount of specialist/give the necessary background
The community was motivated to implement their own water supply	Use of translators: Make it clear to exact translations are given
Awareness of grazing strategy on the condition of the grazing field: Motivate extension officer to really provide appropriate solutions	Linguistic abilities not sufficient: Use translators
Awareness of erosion and bush encroachment as well as possible solution to it School available; provide with poster, books, etc. Farmer's meetings.	The projects do not address the problems the land users have Refer identified problems to the relevant exp
A community member can make a difference.	Implementation of project takes a long time Explain to the involved person the planned time schedule

left and right: Coated and uncoated seeds were hand sown into furrows

Rip-Ploughing, Over-Sowing

North West Province, South Africa

Rip-ploughing and over-sowing (sod-sowing) of extensive grazing land in order to improve productivity of a semi-arid rangeland.

A pasture characterised by the unpalatable *Cymbopogen plurinoides* grass species was rip-ploughed to a depth of 20, 15 or 7 cm to uproot the unfavourable grass species. Coated and uncoated seeds of more palatable grass species were hand sown into the furrows and the soil kicked over the seeds. Grazing has been excluded for the past four years, giving the sown-in grass species the opportunity to establish and credit the soil seed bank. The purpose of the technology was threefold: first, the success of rip-ploughing as a restoration technology was researched; secondly, the suitability of coated or uncoated seeds was established; and thirdly, the suitability of the technology for restoration purposes was researched. This was done in the summer of 1995/96. The frequency and density was measured in the following years up to 1999. The density was measured within a 1 x 1 m^2; and tillers, vegetative and reproductive plants were distinguished. The purpose of the frequency measurement is to establish the percentage a grass species contributes to the grass community. The density measurement gives the amount of rooted plants in a square metre. Distinction between the life stages indicates the self-sustainability of a population. Seed bank analyses are also added.

Location: Madikwe, Koster, Potchefstroom
Technology area: 0.1 km^2
Conservation measure(s): vegetative measure; management measure
Land use type: Grazing land: extensive grazing
Stage of intervention: prevention of land degradation; rehabilitation / reclamation of denuded land
Origin: through experiments / research, recently (< 10 years ago)
Climate: semi-arid
WOCAT database reference: QT RSA07
Related approach: Restoration with the help of extension officer
Compiled by: Saroné De Wet and Asterid Hattingh, School of Environmental Science and Development, North West University, South Africa
Date: 25/03/1999, updated 01/04/2004 by Rinda van der Merwe

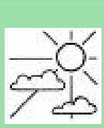
Classification

Land use problems: Overgrazing or rather grazing mismanagement led to i) dominance of the unpalatable grass species at Koster, and ii) bare soil at Totiuskraal, Davidkatnagel and Kromspruit. In land users' view: Erosion/overgrazing making area unsuitable for grazing because of lack of vegetation of appropriate palatability.

Land use

grazing land: extensive grazing

Climate

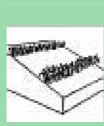


semi-arid

Degradation

erosion by water: loss of topsoil by water

Conservation measure(s)



vegetative

Stage of intervention

Prevention
Mitigation/reduction
Rehabilitation

Origin

Land user's initiative:
Experiments/research: recent (<10 years)
Externally introduced:
Other's (specify):

Level of technical knowledge

Low:
Medium:
High:

Main technical functions: ·

- improvement of ground cover
- increase in organic matter
- increase/maintain water stored in soil
- increase of infiltration
- improvement of soil structure
- increase of surface roughness
- control of concentrated runoff (drain/divert)

Secondary technical functions: ·

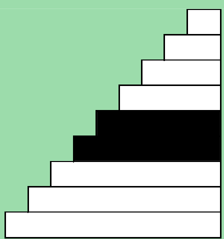
- increase in soil fertility
- control of concentrated runoff (impede/retard)
- control of concentrated runoff (retain/trap)
- control of dispersed runoff (impede/retard)
- control of dispersed runoff (retain/trap)
- control of raindrop splash
- reduction in wind speed
- sediment harvesting
- water spreading
- water harvesting
- reduction of slope length
- reduction of slope angle

Environment

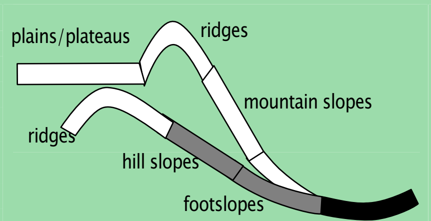
Natural Environment

Average annual rainfall (mm)

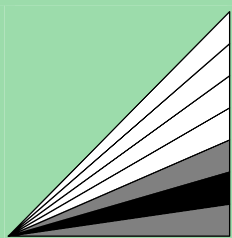
Altitude (m a.s.l.)



Landform



Slope (%)



Soil depth (cm) (2.7.9)

Growing season(s): 180 days (October to March)

Soil texture: Medium (loam): most common

Soil fertility: Very high: most common

Topsoil organic matter: Low (<1%): most common; medium (1-3%): common

Soil drainage/infiltration: Poor: most common; medium: common

Soil water storage capacity: Medium to high

Human environment

Grazing land per household (ha)

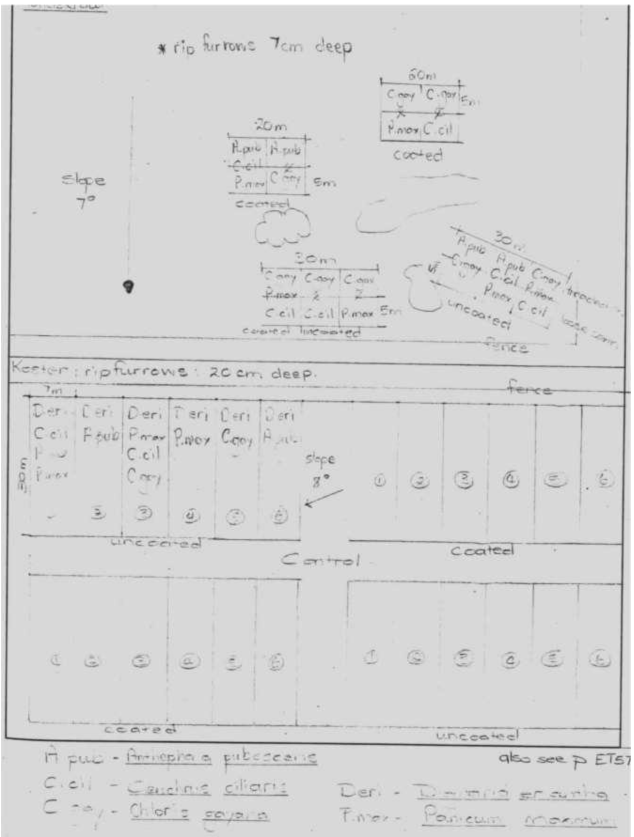
☐	<0.5
☐	0.5-1
☐	1-2
☐	2-5
☐	5-15
☐	15-50
☐	50-100
☐	100-500
☐	500-1000
■	1000-10000
☐	>10000

Land ownership: Communal/village; individual (titled)

Importance of off-farm income: >50% of all income: Farmers have extra-farm occupations for the Totiuskraal area

Access to service and infrastructure: Communal (organised) and individual

Market orientation: Grazing land: mainly subsistence, mainly commercial



Site plan for rip-ploughing and hand sowing of palatable grasses.

Implementation activities, inputs and costs

Establishment activities

1. Vegetative measures
   - seedbed preparation
   - sowing of seeds
   - enclosing site
2. Management measures
   - area enclosure

Establishment inputs and costs per ha

Inputs	Costs (US$ or local currency)	% met by land user
Labour (30 person days)	300	0%
Equipment		
- machine hours	10	%
Materials		
-		%
Agricultural		
-		%
TOTAL	**310**	**100%**

Maintenance/recurrent activities

1. Vegetative measures
   - grazing excluded
   - grazing
2. Management measures
   - Rotation grazing

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$ or local currency)	% met by land user
Labour (__person days)		%
Equipment		
-		%
Materials		

-		%
Agricultural		
-		%
TOTAL		**100%**

Remarks: Duration of establishment phase 24 months

Assessment

Impacts of the Technology

Production and socio-economic benefits		Production and socio-economic disadvantages	
+ + +	Fodder production/quality increase	-	Increased input constraints
+ +	Increased farm income		

Socio-cultural benefits		Socio-cultural disadvantages	
+ + +	Improved conservation / erosion knowledge	-	Socio-cultural conflicts

Ecological benefits		Ecological disadvantages	
+ + +	Biodiversity enhancement	-	Bush encroachment
+ + +	Reduced soil loss		
+ + +	Improved soil cover		
+ +	Increase in soil fertility		
+ +	Improved excess water drainage		
+ +	Increased soil moisture		

Off-site benefits		Off-site disadvantages	
+ + +	Reduced wind transported sediments	- -	Reduced sediment yields

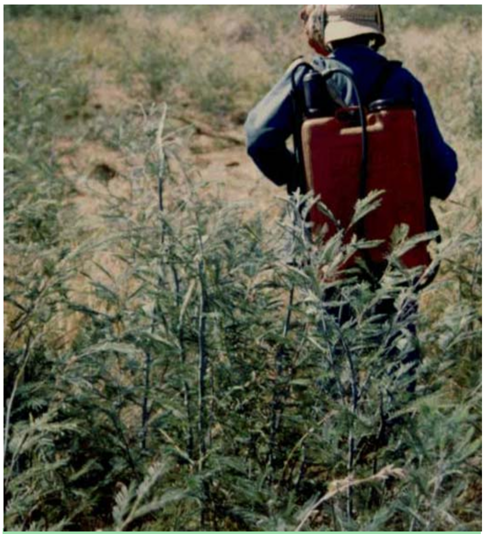
Contribution to human well-being/livelihoods

Benefits/costs according to land user

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

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Establishment of perennial grass cover → Grazing management; not graze to seed production stage.	Implementation in communal areas mostly → Brainstorm on implementation without gasoline needed
Increase of perennial grass production → Grazing management	Communication with landuser → Contact on monthly basis built friendship
Find suitable seed mixtures for different habitats → Literature study on habitat preferences	
Seed bed preparation enhance establishment → Know exact depth of sowing of seeds.	
Vegetation cover → Rotational grazing	



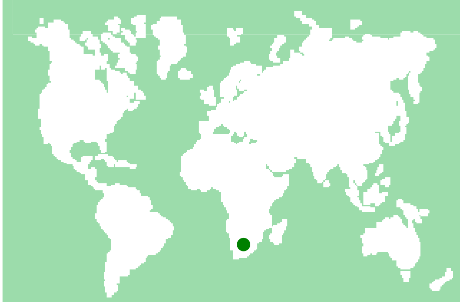
left: Stacking of heap of wood to prevent donga formation into the stream that is densely overgrown by re-growth presently on the right (Schalk Meyer)
right: Knapsack sprayer to treat the re-growth with chemical (Schalk Meyer)

Combating of Invader Plants and Brush Packing

Gauteng Province, South Africa

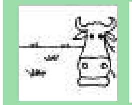
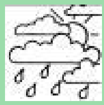
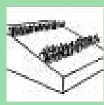
The combating of invaders to preserve water resources and the rehabilitation of the bare ground by means of brush packing to prevent soil erosion.

The technology is applied in areas under the Working for Water projects that are run by the National Department of Water Affairs in South Africa, in the fight to combat invaders exhausting the valuable water resources. Catchment areas are fields that are infected by invader species on riverbanks, and catchment areas that extract enormous amounts of water out of the system. The trees (Black wattle - *Acacia meansii*) are cut or ring barked. After the trees are felled, large areas of bare ground are exposed. In order to prevent soil erosion until the natural succession processes are completed and the area is in equilibrium with the rest of the environment, soil needs to be stabilised and sometimes also rehabilitated. These exposed areas must first be treated with a follow-up to prevent the coppice re-growth and seedlings from growing again. Sometimes in agricultural grazing areas, the bare areas are re-seeded with natural climax grasses, and in urban areas left to be stabilised by successional species, or pioneers and aveads, etc. The small branches of the felled trees are packed on bare areas, after the re-seeding to stop the topsoil from eroding. This reduces the off-flow and flow speed of the rainwater, lowering the raindrop impact, increasing the moist regime and preventing wind erosion. The thick stumps are either used for firewood or for the charcoal industry, as well as packed in wind rows horizontal with stream flow.



Location: Gauteng
Technology area: 2 km²
Conservation measure(s):vegetative measure; management measure
Land use type:
Stage of intervention: rehabilitation / reclamation of denuded land
Origin: externally introduced through project, recently (< 10 years ago)
Climate: sub-humid
WOCAT database reference: QT RSA09
Related approach: Technical & scientific support and job creation
Compiled by: Schalk Meyer, Department of Agriculture, Conservation and Environment, South Africa
Date: 04/08/1999, updated 25/07/2005 by Rinda van der Merwe

Classification

Land use	Climate	Degradation	Conservation measure(s)
			
grazing land: extensive grazing	subhumid	erosion by water: loss of topsoil by water loss of topsoil by water	vegetative

Stage of intervention

Prevention
Mitigation/reduction
Rehabilitation

Origin

Land user's initiative:
Experiments/research:
Externally introduced: recent (<10 years)
Other's (specify):

Level of technical knowledge

Low:
Medium:
High:

Main technical functions: ·

- increase/maintain water stored in soil
- control of dispersed runoff (retain/trap)
- control of dispersed runoff (impede/retard)
- control of concentrated runoff (retain/trap)
- control of concentrated runoff (impede/retard)
- control of concentrated runoff (drain/divert)
- reduction of slope length
- control of raindrop splash
- increase of infiltration
- reduction in wind speed
- water harvesting
- water spreading
- increase in organic matter
- increase in soil fertility
- sediment harvesting
- improvement of ground cover
- increase of surface roughness

Secondary technical functions: ·

- improvement of soil structure
- reduction of slope angle

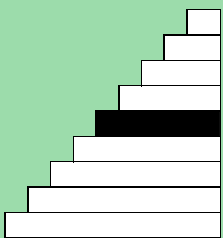
Environment

Natural Environment

Average annual rainfall (mm)

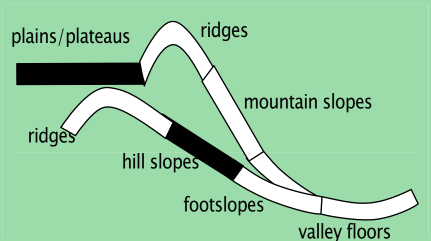
>4000
3000-4000
2000-3000
1500-2000
1000-1500
750-1000
500-750
250-500
<250

Altitude (m a.s.l.)

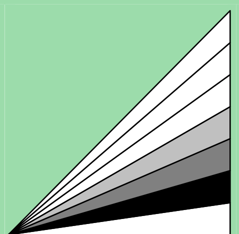


>4000
3000-4000
2500-3000
2000-2500
1500-2000
1000-1500
500-1000
100-500
<100

Landform



Slope (%)



Soil depth (cm)

0-20
20-50
50-80
80-120
<120

Growing season(s): 210 days (October to March)

Soil texture: Medium (loam): most common; coarse (sandy): common

Soil fertility: Medium and low: Most common

Topsoil organic matter: Low (<1%): most common

Soil drainage/infiltration: Poor: most common; medium: common

Soil water storage capacity: Medium

Ground water table: Low

Human environment

Grazing land per household (ha)

	<0.5
	0.5-1
	1-2
	2-5
	5-15
	15-50
	50-100
■	100-500
	500-1000
	1000-10000
	>10000

Importance of off-farm income: 10- 50% of all income. Family members are working in the city, to provide for the family (the children and brothers etc.)

Access to service and infrastructure:

Market orientation: Grazing land: partly subsistence, mainly mixed (subsistence/commercial), partly commercial

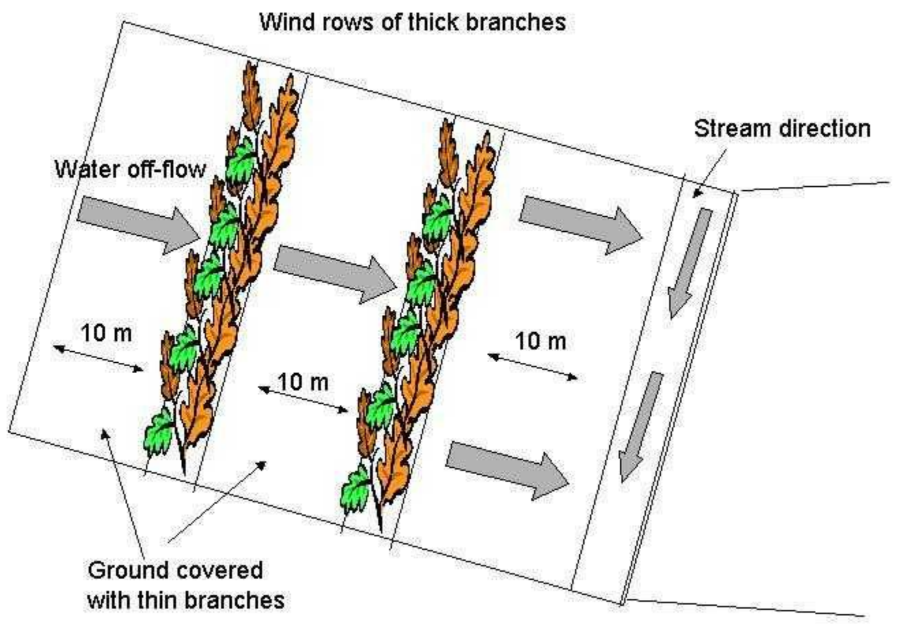


Diagram to indicate areas for push backing to prevent soil erosion.

Implementation activities, inputs and costs

Establishment activities

1. Management measures
    - cutting of trees
    - packing of branches

Establishment inputs and costs per ha

Inputs	Costs (US$ or local currency)	% met by land user
Labour (100 person days)	15000	0%
Equipment		
- tools	500	0%
Materials		
-		%
Agricultural		
- seeds (167 kg)	12500	0%
TOTAL	**32500**	**100%**

Maintenance/recurrent activities

1. Management measures
    - where reseeding took place the grazing must be maintained

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$ or local currency)	% met by land user
Labour (__person days)		%
Equipment		
-		%
Materials		
-		%

Agricultural		
-		%
TOTAL		**100%**

Remarks: Duration of establishment phase 0 months

Assessment

Impacts of the Technology

Production and socio-economic benefits		Production and socio-economic disadvantages	
++	Increased farm income		
++	Fodder production/quality increase		
++	Selling of wood for fire wood & charcoal		
Socio-cultural benefits		**Socio-cultural disadvantages**	
+++	Improved conservation / erosion knowledge		
++	Community institution strengthening		
Ecological benefits		**Ecological disadvantages**	
+++	Biodiversity enhancement		
+++	Reduced soil loss		
+++	Improved excess water drainage		
+++	Increased soil moisture		
+++	Improved soil cover		
++	Reduced wind velocity		
++	Increase in soil fertility		
Off-site benefits		**Off-site disadvantages**	
+++	Increased stream flow in dry season / reliable and stable low flows		
++	Reduced wind transported sediments		
++	Reduced downstream siltation		
Contribution to human well-being/livelihoods			

Benefits/costs according to land user

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

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Conserve water resource → Eradication and control of invaders	Labour intensive → No recommendations
Prevent soil loss → Packing of branches correctly and maintained - preventing of veld fires (wood from burning)	Time consuming → No recommendations
Reseeding of perennial grasses that enhanced grazing capacity and biodiversity → Correct seed mix and seeding method; preventing from grazing and veld fires	Expensive → No recommendations
Elandsfontein: prevent soil loss -> Improve farm soils - control → overgrazing	
Elandsfontein: Improve grazing capacity → Rotational grazing and rest for first 3 years after rehabilitation	

left and right: Cutting down and eradication of trees and alien invaders in an effective manner - opportunities for entrepreneurs to utilise wood as charcoal and firewood

Technical and Scientific Support and Job Creation in Community Sector

Gauteng Province, South Africa

To make the community aware of precious resources like water and the preservation of it, the control of alien encroachment, creation of job opportunities and the training of undeveloped communities.

Aim / objectives: The approach objective is to get communities involved in a national project to eradicate alien invaders to conserve the water resource in the main river catchment areas. The objectives of such a project are to make use of labour (job creation) under the poorest of the poor of the rural communities. A group of 25 people were trained in the use of chemicals; cutting down and eradication of trees and alien invaders in an effective manner, as well as different opportunities for entrepreneurs to utilise the wood, for example firewood and charcoal. The Government is the implementing agent, facilitating and managing the project as well as providing technical advice.

Location: Gauteng Province
Approach area: 0 km^2
Type of Approach: Project/Programme based
Focus: Mainly on conservation with other activities
WOCAT database reference: QA RSA09
Related technology (ies): Combating of invader plants & bush packing
Compiled by: Schalk Meyer, Department of Agriculture, Conservation and Environment, South Africa
Date:17/05/1999

Problem, objectives and constraints

Problems

Language differences (SA contains 11 different official languages). Literacy of the workers. Unqualified people -> expensive training courses. Too many role-players that hampered the initial starting process.

Aims/Objectives

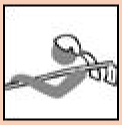
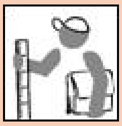
Community awareness. Training. Education. Job creation. Uplifting of the poor. Mutual understanding and better communication and labour relations.

Constraints addressed

Major	Constraint	Treatment
Social / cultural / religious	Workers out of different cultures	Field manager must be appointed that know the people and came out of the same community

Participation and decision making

Stakeholders / target groups

		
land user/ individual	SLM specialist/ agricultural advisor	politicians/ decision makers

Approach costs met by:

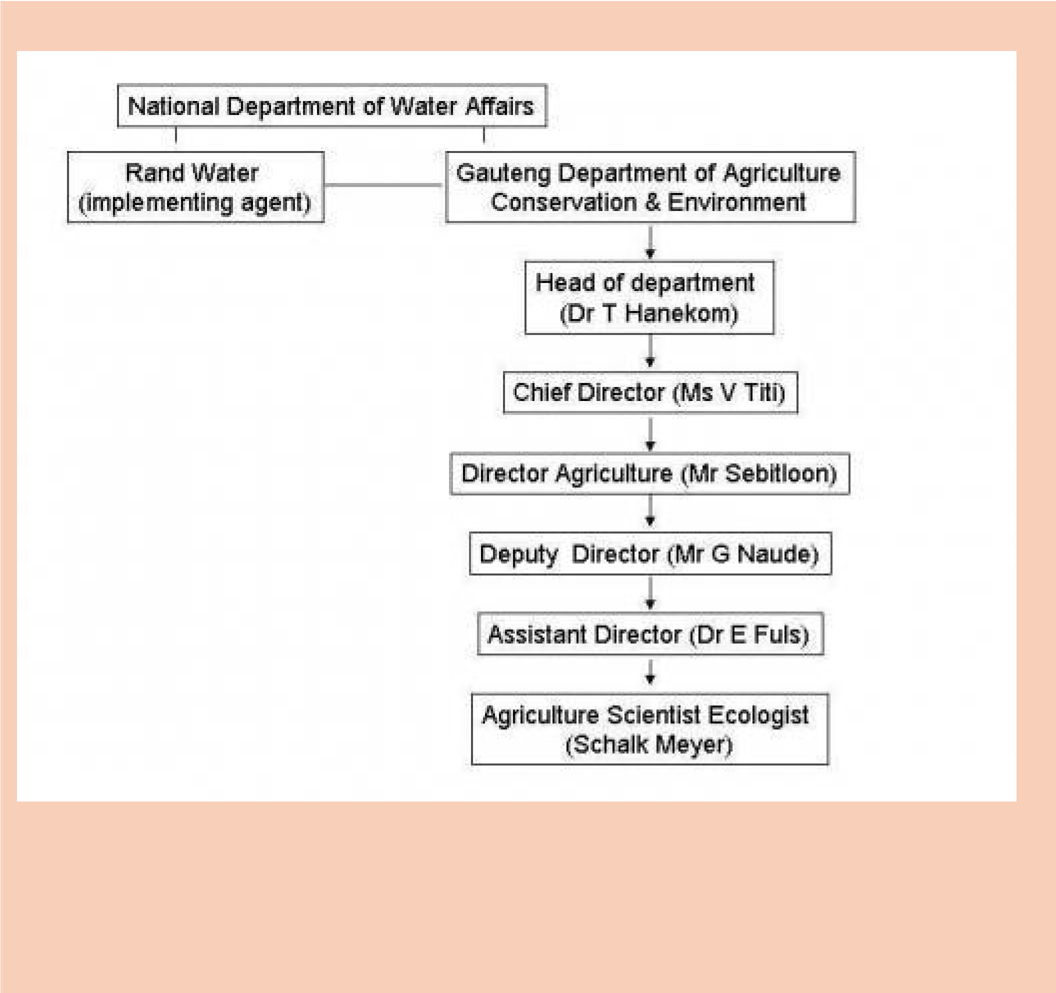
Government	100%
	%
TOTAL	100%

Decisions on choice of the Technology (ies): by SLM specialists alone (top-down)
Decisions on method of implementing the Technology (ies): by SLM specialists alone (top-down)
Approach designed by: national specialists
Implementing bodies: government, international non-government, local community / land users

Land user involvement

Phase	Involvement	Activities
Initiation/motiviation	None	
Planning	Passive	Public meetings
Implementation	Payment/external support	Casual labour
Monitoring/evaluation	Passive	Public meetings
Research	None	

Differences between participation of men and women: No
Involvement of disadvantaged groups: No



Organogram: Working for Water Clearing of alien plants

Technical support

Training / awareness raising:
Training provided by land user.
Training was on-the-job, courses.
Training focused on use of hand-tools: chainsaws, handsaws, pangas etc. Also the use of backpack herbicide sprayers.

Advisory service:
Name: Working for Water, Alien plant eradication
Key elements:
1. Financial act
2. Catchment areas
3. Job creation

1) Advisory service was carried out through: government's existing extension system.
2) Advisory service was carried out through: government's existing & training; In-house experience & training.
The extension system is inadequate to ensure continuation of activities. Funds were cut and only one follow-up will be done and the clearing of new catchment areas from aliens are stopped due to financial and political instability.

Research:
Yes, moderate research. Topics covered include ecology.
Mostly on-farm research.
Research on Rangeland reinforcement

External material support / subsidies

Labour: Paid in cash. Salary
Inputs: - Equipment (machinery, tools, etc) - machinery, hand tools. Fully financed
- Agricultural (seeds, fertilizers, etc) - seeds. Fully financed
Credit: Credit was not available.
Support to local institutions: Yes, moderate support with financial, training

Monitoring and evaluation

Changes as result of monitoring and evaluation: There were no changes in the approach.

Impacts of the Approach

Improved sustainable land management: Yes, great; Control of alien growth
Adoption by other land users / projects: No
Training, advisory service and research:

- Training effectiveness
  - Land users* - good
  - SLM specialists - good
- Advisory service effectiveness - Sustainable training skills
  - Land users* - good
- Research contributing to the approach's effectiveness - Moderately

Technical research by University of Potchefstroom and Institute for Soil, Climate and Water (ARC)
Land/water use rights: Help - moderately in the implementation of the approach. Improving resource soil and water.
Long-term impact of subsidies: Negative long-term impact – Moderately. If follow-up continues annually the project has a long-term impact.

Concluding statements

Sustainability of activities: No the land users can't sustain the approach activities. Too expensive

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Job creation	Maintenance of land user, follow-up on re-growth Subsidy
Training	Financial availability
Eradication of aliens/protect water resource Follow-up on regrowth	Project/work/job creation only for 3 months (for the duration of the project)
Awareness towards land care	
Improved grazing Protect area from over grazing and eradicate seedlings and re-growth	
Improved live standard with job creation	

left and right: Improvement of the standard of living of community members by making handicrafts and selling wood

Awareness Raising

Northern Cape Province, South Africa

To make the people aware of veld degradation, rehabilitation and the participation of the people.

Aim / objectives: Improve the standard of living of community members by making handicrafts and selling wood. It is an approach where the community is fully involved (a demand driven project). Training of the people to do packing and cutting of branches.

Location: Northern Cape Province
Approach area: 0 km^2
Type of Approach: project/programme based
Focus:mainly on conservation with other activities
WOCAT database reference: QA RSA19
Related technology (ies): Bush Packing
Compiled by: Belly Mpoko Malatji, Agricultural Land and Resources Management, South Africa
Date: 28/04/2004 (updated by Rinda van der Merwe)

Problem, objectives and constraints

Problems

Language. Literacy. Understanding of the social and cultural structure.

Aims/Objectives

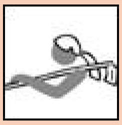
Community awareness. Training. Education.

Constraints addressed

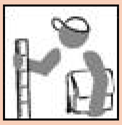
Major	Constraint	Treatment
Social / cultural / religious		The area
Financial		NGO's financial support
Technical		Training of land users
Minor	**Constraint**	**Treatment**

Participation and decision making

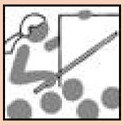
Stakeholders / target groups



land user/ individual



SLM specialist/ agricultural advisor



teachers/ school children/ students

Approach costs met by:

Government	80%
International non-government	10%
Local community / land user(s)	10%
TOTAL	100%

Annual budget for SLM component: US$< 2,000

Decisions on choice of the Technology (ies): mainly by SLM specialists with consultation of land users
Decisions on method of implementing the Technology (ies): mainly by SLM specialists with consultation of land users
Approach designed by: national specialists
Implementing bodies: international, national non-government, local community / land users

Land user involvement

Phase	Involvement	Activities
Initiation/motiviation	None	
Planning	Interactive	Mainly: public meetings, rapid/participatory rural appraisal; partly: interviews/questionnaires
Implementation	Interactive	Mainly: responsibility for minor steps; partly: responsibility for major steps
Monitoring/evaluation	None	
Research	None	

Differences between participation of men and women: Yes, great
Involvement of disadvantaged groups: Yes, little. Communication break down.

Technical support

Training / awareness raising:

Training provided for land user, school children/students, politicians/decision makers.
Training was on-the-job, demonstration areas, public meetings, courses.
Training focused on Rehabilitation, degradation, production increase, awareness, branch packing.

Advisory service:

1) Mainly: government's existing extension system, Partly: non-governmental agency 2) Mainly: government's existing extension system, Partly: non-governmental agency; Extension staff: mainly government employees 3) Target groups for extension: land users, The extension system is quite adequate to ensure continuation of activities.

Research: Yes, great research. Mostly on-farm research

External material support / subsidies

Labour: Paid in cash.
Inputs: - Equipment (machinery, tools, etc) - hand tools. Fully financed
- Agricultural (seeds, fertilizers, etc) - seeds, fertiliser. Fully financed
- Infrastructure (roads, schools, etc) - community infrastructure. Fully financed

Credit: Credit was not available.

Support to local institutions: Yes, great support with training

Monitoring and evaluation

Changes as result of monitoring and evaluation:
There were few changes in the approach. More people get involved, more meetings.

Impacts of the Approach

Improved sustainable land management: Yes, great; Control grazing, look after the rangelands
Adoption by other land users / projects: Yes, some
Training, advisory service and research:

- Training effectiveness

  Land users* - excellent
  SLM specialists - excellent
  Agricultural advisor / trainers - excellent
  Teachers - good
  School children / students - good
  Planners - good
  Politicians / decision makers - good

- Advisory service effectiveness

  Land users* - good
  Teachers - good
  Technicians / conservation specialists - good
  School children / students - good

- Research contributing to the approach's effectiveness - Moderately

  Use research to apply technology

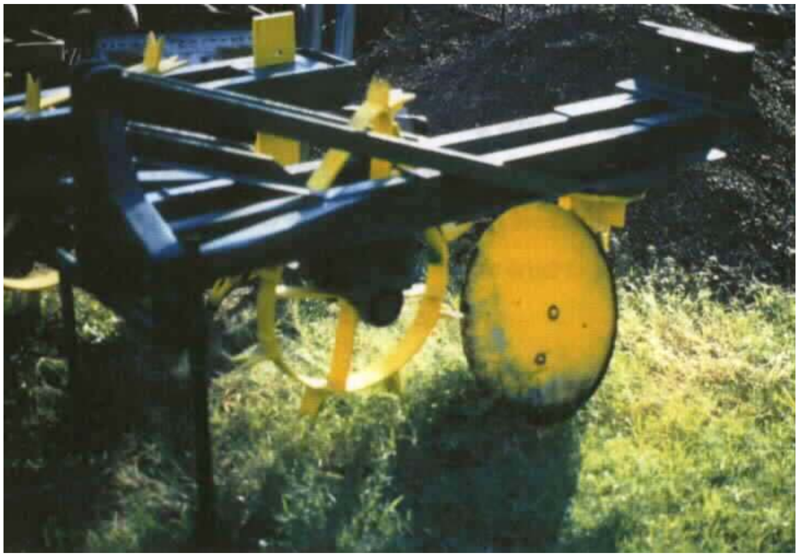
Land/water use rights:
Hinder - greatly in the implementation of the approach. People don't own the land
The approach did reduce the land/water use rights problem (moderately). People must increase field land on behalf of the cattle - it is not their own land

Long-term impact of subsidies:
Positive long-term impact - Moderately
People got more money, improvement of the life standard

Concluding statements

Sustainability of activities: Yes the land users can sustain the approach activities.

Strengths and → how to sustain/improve	**Weaknesses and → how to overcome**
Community participation	Slower acceptance
Awareness	To be sustainable you have to pay the people
Technology transfer	Continuous motivation
Improve life standard	Short term benefit is very low
Better understanding of social structure	Not all the people were involved, difficult to keep all the people together
Training of extension officers	



Left and right: Dyker plough and ripping (Klaus Kellner)

Agronomic and Vegetative Rehabilitation

North West Province, South Africa

Location: Zeerust (Eastern parts)
Technology area: 20 km²
Conservation measure(s): management measure, agronomic measure, vegetative measure, structural measure
Land use type: Grazing land: intensive grazing / fodder
Stage of intervention: prevention of land degradation, mitigation / reduction of land degradation, rehabilitation / reclamation of denuded land
Origin: externally introduced through project, recently (< 10 years ago)
Climate: semi-arid
WOCAT database reference: QT RSA33
Related approach: Land user participation with research
Compiled by: Kellner Klaus, School of Environmental Science and Development, North West University, South Africa
Date: 10/04/1999, updated 01/04/2004 by Rinda van der Merwe

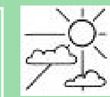
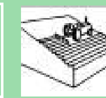
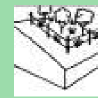
Combinations; cultivation and vegetative.

The purpose of the rehabilitation includes an increase in production potential, vegetative cover and density, biodiversity, fodder for grazing and palatable grass species.

To establish this technology, cultivation of the denuded areas was done by Dyker plough. Over-sowing with a grass-seed mixture followed. The seeds (indigenous) were purchased from a seed-company. If woody encroachment species are available, place the branches on the cultivated area. No maintenance is necessary; the area is left as it is for 3 years with no grazing if possible (no grazing for cattle, but for game some grazing areas are partly covered by branches to prevent grazing).

Classification

Land use problems: Bush encroachment, bare denuded land - open spaces. In land users's view: Not productive for grazing land. Erosion. Low grass cover.

Land use		**Climate**		**Degradation**				**Conservation measure(s)**			
											
grazing land: intensive grazing / fodder production		semi-arid		erosion by water: loss of topsoil	physical degradation:			agronomic	management		

Stage of intervention

■	Prevention
■	Mitigation/reduction
■	Rehabilitation

Origin

□	Land user's initiative:
□	Experiments/research:
■	Externally introduced:
□	Other's (specify):

Level of technical knowledge

□	Low:
■	Medium: field staff/agricultural advisor
□	High:

Main causes of land degradation:

- over-exploitation of vegetation
- overgrazing

Main technical functions:

- improvement of ground cover
- increase in soil fertility
- increase in organic matter
- increase/maintain water stored in soil
- increase of infiltration
- improvement of soil structure
- increase of surface roughness
- control of concentrated runoff (retain/trap)
- control of dispersed runoff (retain/trap)

Secondary technical functions: ·

- sediment harvesting
- water spreading
- water harvesting
- control of raindrop splash
- reduction of slope length
- reduction of slope angle

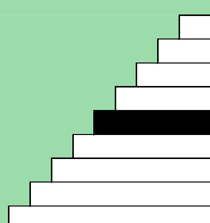
Environment

Natural Environment

Average annual rainfall (mm)

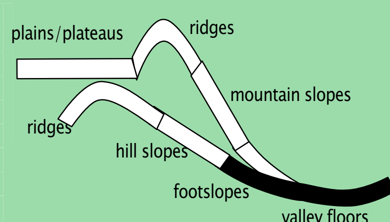
□	>4000
□	3000-4000
□	2000-3000
□	1500-2000
□	1000-1500
□	750-1000
■	500-750
□	250-500
□	<250

Altitude (m a.s.l.)

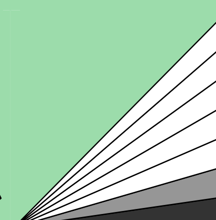


>4000
3000-4000
2500-3000
2000-2500
1500-2000
1000-1500
500-1000
100-500
<100

Landform



Slope (%)



Soil depth (cm)

▒	0-20
■	20-50
□	50-80
□	80-120
□	<120

Growing season(s): 180 days (October to March)

Soil texture: Fine (clay): most common

Soil fertility: Very low: most common; low: common

Topsoil organic matter: Low (<1%): most common

Soil drainage/infiltration: Poor: most common

Soil water storage capacity: Very low to low

Human environment

Grazing land per household (ha)

	<0.5
	0.5-1
	1-2
	2-5
	5-15
	15-50
	50-100
	100-500
■	500-1000
	1000-10000
	>10000

Land ownership: Individual (titled): most common

Importance of off-farm income: < 10% of all income, Commercial 10-50%, Communal, poor. Commercial: < 10%

Market orientation: Grazing land: partly mixed (subsistence/commercial), mainly commercial

Forest land: mainly commercial

Implementation activities, inputs and costs

Establishment activities

1. Agronomic measures
   - Dyker plough cultivation on contours
   - chopping of woody branches of encroaching species
2. Vegetative measures
   - Dyker plough making hollows
   - sowing of perennial grass seeds (in hollows, waiting for rain)

Establishment inputs and costs per ha

Inputs	Costs (US$ or local currency)	% met by land user
Labour (60 person days)	480	%
Equipment		
- machine hours	1400	%
Materials		
-		%
Agricultural		
- seeds (500 kg)	4000	%
TOTAL	**5880**	**100%**

Maintenance/recurrent activities

1. Vegetative measures
   - brush packing on cultivated area
2. Management measure
   - fences

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$ or local currency)	% met by land user
Labour (__person days)		%
Equipment		
-		%
Materials		
-		%
Agricultural		
-		%
TOTAL		**100%**

Remarks: Duration of establishment phase: 12 months

Assessment

Impacts of the Technology

Production and socio-economic benefits

+++	Increased farm income
++	Fodder production/quality increase

Production and socio-economic disadvantages

--	Increased input constraints
-	Loss of land (decreased production area)
-	Increased labour constraints
-	Increased economic inequity
-	Reduced production

Socio-cultural benefits

++	Improved conservation / erosion knowledge
++	Community institution strengthening

Socio-cultural disadvantages

Ecological benefits

++	Reduced soil loss
++	Increase in soil fertility
++	Improved excess water drainage

Ecological disadvantages

-	Increased soil erosion (locally)

+ +	Increased soil moisture		
+ +	Improved soil cover		

Off-site benefits		**Off-site disadvantages**	
+ +	Reduced wind transported sediments	-	Reduced riverflows
+ +	Reduced downstream siltation		
+ +	Reduced downstream flooding		

Contribution to human well-being/livelihoods

Benefits/costs according to land user

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

Concluding statements

Strengths and → how to sustain/improve	**Weaknesses and → how to overcome**
Decrease bush encroachment and invasion of woody species → New growth of species must be controlled	Low cost/benefit rates in short term → Keep it up and don't get discouraged - see advantages over the long term
Increase vegetation cover and density → Keep out grazing	Need tractor and implements → Hire implements from Agriculture of other land users
Increase soil moisture and infiltration rate → Deep cultivation, cover by twigs/branches	Must have knowledge about the SWC technology → Ask technical and support by Agricultural extension or researchers or other land users
Increase seed bank for whole area → Let the grasses sown - reproductive and make seed so that it can be distributed by wind or animals	
Increase grazing capacity, more fodder → Good and controlled management	
Better and more income: meat, funds → Good and controlled management	

left and right: Photo's to illustrate the principles of degradation and restoration

Land User Participation with Research

North West Province, South Africa

Land user participation with researchers to improve existing and develop new technologies.

Aim / objectives: Land users implemented the technology but the success was never evaluated. Contacted researcher who quantitatively assessed the technology. The pros and cons of the technology were discussed with the land user and other farmers in the area. All gave comments and shared experiences of how these technologies can be improved. Adjustments were made and in an experimental and demonstrative way, the adjustments were implemented and evaluated.

Location: North West Province
Approach area: 20 km^2
Type of Approach: project/programme based
Focus: on conservation only
WOCAT database reference: QA RSA33
Related technology (ies): Agronomic and vegetative rehabilitation
Compiled by: Klaus Kellner, School of Environmental Science and Development, North West University, South Africa
Date: 01/04/1999

Problem, objectives and constraints

Problems

Degraded and denuded rangeland. Low production of grazing land.

Aims/Objectives

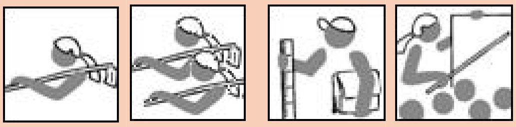
Radical veld improvement. Better grazing land. Understand degradation - causes and how to control it. Convey knowledge about restoration technologies to as many land users as possible.

Constraints addressed

Major	Constraint	Treatment
Financial	Low cost/benefit ratio in the short term	Proper advice to land user about advantages in the long term
Technical	No knowledge	Awareness and technical support by agriculturists & scientists
Minor	**Constraint**	**Treatment**

Participation and decision making

Stakeholders / target groups



land user/ individual; land user(s)/ groups; SLM specialists/ agricultural advisors; teachers/ school children/ students

Approach costs met by:

Local community / land user(s)	40%
Government	40%
Other	20%
TOTAL	100%

Annual budget for SLM component: US$2,000-10,000

Decisions on choice of the Technology (ies): mainly by land users supported by SLM specialists
Decisions on method of implementing the Technology (ies): mainly by land users supported by SLM specialists
Approach designed by: national specialists, international specialists, land users
Implementing bodies: government, local community / land users

Land user involvement

Phase	Involvement	Activities
Initiation/motiviation	Interactive	Mainly:public meetings; partly: rapid/participatory rural appraisal; Land users approached researcher/scientist for help
Planning	Interactive	Mainly: public meetings; partly: workshops/seminars; What & how to implement technology
Implementation	Interactive	Responsibility for major steps; Did apply the technology on their own land
Monitoring/evaluation	Interactive	Measurements/observations; By scientist & students primarily but also with land users who helped
Research	Interactive	On-farm; On the farmers/land users owned land

Differences between participation of men and women: Yes, great. Only men. Men own the land
Involvement of disadvantaged groups: No. Commercially owned and managed land

Technical support

Training / awareness raising:

Training provided for land user, extensionists/trainers
Training was site visits / farmer to farmer, demonstration areas
Training focused on Land users approached researcher/scientist for help on degradation; natural resources, utilisation & conservation, restoration, reclamation technologies

Advisory service:

Name: Learning by doing and seeing is believing
Key elements:
1. Demonstration
2. On site/farm
3. Participation

1) Mainly: government's existing extension system, Partly: projects own extension structure and agent 2) Mainly: government's existing extension system, Partly: projects own extension structure and agent; Extension staff: mainly government employees 3) Target groups for extension: land users, technicians/SWC specialists; Activities: Demonstration - participation; Demonstration - participation
The extension system is quite adequate to ensure continuation of activities. Knowledge gained and understood

Research: Yes, moderate research. Topics covered include ecology
Mostly on-farm research. Research for better or adjustment of existing reclamation technologies - based in ecology

External material support / subsidies

Labour: Voluntary. By land owner
Inputs: - Equipment (machinery, tools, etc) - machinery, hand tools. Not financed
- Agricultural (seeds, fertilizers, etc) - seeds. Partly financed
Credit: Credit was not available
Support to local institutions: Yes, moderate support with training

Monitoring and evaluation

Changes as result of monitoring and evaluation: There were few changes in the approach. First - demonstration & awareness. Second - implementation & training

Impacts of the Approach

Improved sustainable land management: Yes, great; Oversowing, cultivation, erosion & bush encroachment control
Adoption by other land users / projects: Yes, many; Results - to many other districts & land users by workshops, presentations at conferences, collaborations etc.
Training, advisory service and research:

- Training effectiveness

Land users* - good
SLM specialists - good
Agricultural advisor / trainers - good
Politicians / decision makers - fair
scientists - good

- Advisory service effectiveness - Adoption by other land users. Policy change & making restoration of degraded rangelands a priority on regional & national scale. Scientists - collaboration - multidisciplinary

Land users* - good
Politicians / decision makers - fair
scientists - good

- Research contributing to the approach's effectiveness - Greatly

Research institute at University - knowledge gained from other projects was incorporated & applied at this project

Land/water use rights: Help - low in the implementation of the approach. Hinder: low. Privately owned commercial farms

Concluding statements

Sustainability of activities: Yes the land users can sustain the approach activities.

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
On farm Encouragement by researchers & technicians/extension	Not as many farmers involved as would have liked
Participation by land owners Follow-up meetings & evaluation	Farmers are scared to leave their farms and families alone to go to meetings & workshops, especially at night
Farmer to farmer. Farmer to scientist. Scientist to farmer. Scientist to extension - farmer Communication; on going support and show interest, continued evaluation & feedback	Too little communication between researchers, farmers & extension - Better participation & interest by all
Learning by doing	

left: Areas ploughed and re-seeded

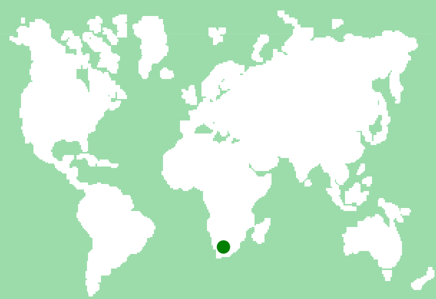
right: Cattle in degraded area

Re-Vegetation and Re-Seeding

Limpopo Province, South Africa

Re-vegetation of old degraded land. Restoring area to increase grazing capacity and production.

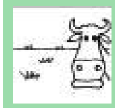
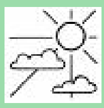
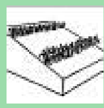
Vegetative (re-vegetation/re-seeding) improvement for an increase in grass production and to increase the grazing capacity of the area. The rural community identified an old degraded land - the area was fenced to exclude grazing by large herbivores. The woody species that encroached the area were debushed. Area was ploughed and re-seeded with palatable, climax, big tufted, perennial grass species. Some plots were covered with twigs (brush packing). The area was protected from grazing. Monitoring of vegetation was done at the end of the growing season.



Location: Polokwane
Technology area: 1 km²
Conservation measure(s): vegetative measure
Land use type: Grazing land: extensive grazing
Stage of intervention: mitigation / reduction of land degradation, rehabilitation / reclamation of denuded land
Origin: through experiments / research, recently (< 10 years ago)
Climate: semi-arid
WOCAT database reference: QT RSA37
Related approach: Government funded demonstrations
Compiled by: Kellner Klaus, School of Environmental Science and Development, North West University, South Africa
Date: 03/09/2001, updated 01/04/2004 by Rinda van der Merwe

Classification

Land use problems: Overgrazing and loss of palatable, climax vegetation. In land users's view: No grazing for animals; bush/woody encroachment.

Land use	Climate	Degradation	Conservation measure(s)
			
grazing land: extensive grazing	semi-arid	erosion by water: loss of topsoil by water	vegetative

Stage of intervention

□	Prevention
■	Mitigation/reduction
■	Rehabilitation

Origin

□	Land user's initiative:
■	Experiments/research: recent (<10 years)
□	Externally introduced:
□	Other's (specify):

Level of technical knowledge

□	Low:
■	Medium: field staff/agricultural advisor, land user
□	High:

Main causes of land degradation:

- over-exploitation of vegetation
- overgrazing

Main technical functions: ·

- improvement of ground cover
- increase in soil fertility
- increase in organic matter
- control of raindrop splash

Secondary technical functions: ·

- sediment harvesting
- increase/maintain water stored in soil
- increase of infiltration
- improvement of soil structure
- increase of surface roughness
- control of concentrated runoff (retain/trap)
- control of dispersed runoff (impede/retard)
- control of dispersed runoff (retain/trap)
- reduction in wind speed
- water spreading
- water harvesting
- reduction of slope angle

Environment

Natural Environment

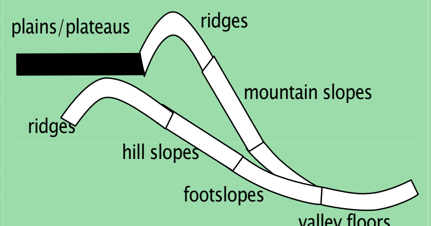
Average annual rainfall (mm)

□	>4000
□	3000-4000
□	2000-3000
□	1500-2000
□	1000-1500
□	750-1000
□	500-750
■	250-500
□	<250

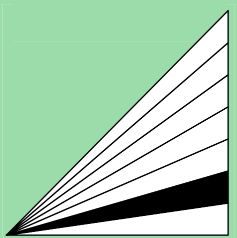
Altitude (m a.s.l.)

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

Landform



Slope (%)



Soil depth (cm)

□	0-20
■	20-50
□	50-80
□	80-120
□	<120

Growing season(s): 210 days (October to April)

Soil texture: Medium (loam): most common

Soil fertility: Low: most common

Topsoil organic matter: Low (<1%): most common

Soil drainage/infiltration: Medium: most common

Soil water storage capacity: Low

Human environment

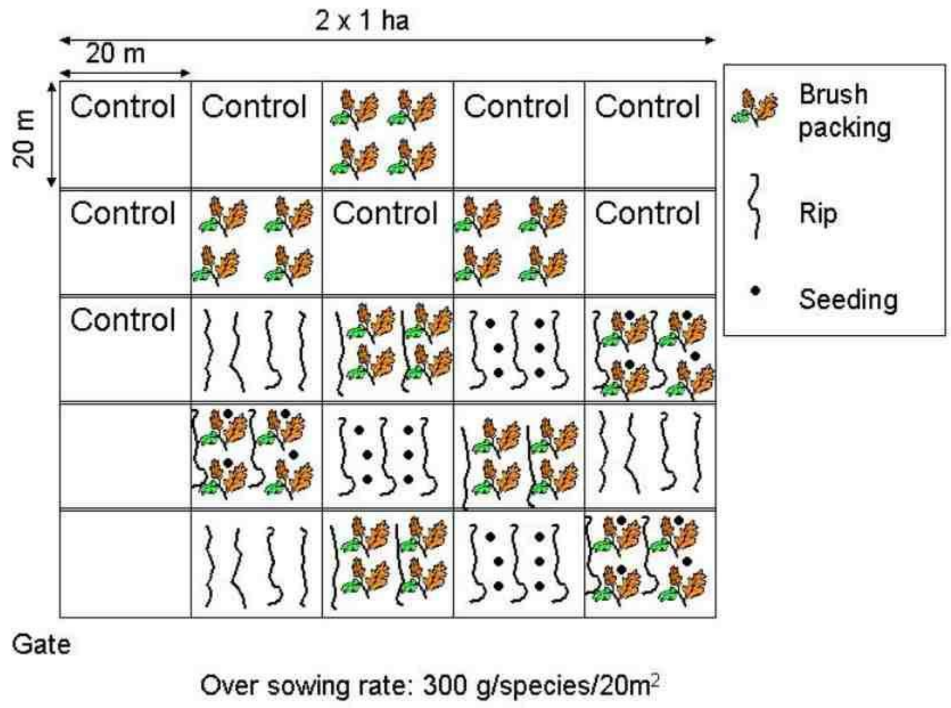
(*Type of) land per household (ha)

	<0.5
	0.5-1
	1-2
	2-5
	5-15
	15-50
	50-100
	100-500
	500-1000
	1000-10000
	>10000

Land ownership: Communal/village: most common

Importance of off-farm income: > 50% of all income. Old age pensions (state pensions), Mine workers (family members working in cities).

Market orientation: Grazing land: partly subsistence, mainly mixed (subsistence/commercial)



Technical drawing of the plot lay out.

Implementation activities, inputs and costs

Establishment activities

1. Vegetative measures
   - ripping
   - oversowing
   - brush packing

Establishment inputs and costs per ha

Inputs	Costs (US$ or local currency)	% met by land user
Labour (15 person days)	550	10%
Equipment		
- tools (3),	20	%
- machine hours (8)	30	%
Materials		
- fencing (6000 m), wood (15 qm)	1100	%
Agricultural		
- seeds (25 kg)	150	%
TOTAL	**1850**	**10%**

Maintenance/recurrent activities

1. Vegetative measures
   - no maintenance

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$ or local currency)	% met by land user
Labour (5 person days)	200	10%
Equipment		

• fencing in tact	-		%
	Materials		
	- fencing (2 m)	50	%
	Agricultural		
	-		%
	TOTAL	**250**	**10%**

Assessment

Impacts of the Technology

Production and socio-economic benefits

+ +	Increased farm income
+ +	Fodder production/quality increase

Production and socio-economic disadvantages

-	Increased labour constraints

Socio-cultural benefits

+ + +	Job-creation
+ + +	Improved conservation / erosion knowledge
+ +	National institution strengthening
+ +	Community institution strengthening

Socio-cultural disadvantages

-	Socio-cultural conflicts

Ecological benefits

+ + +	Reduced soil loss
+ + +	Increase in soil fertility
+ + +	Improved excess water drainage
+ + +	Increased soil moisture
+ + +	Improved soil cover
+ +	Reduced wind velocity
+ +	Biodiversity enhancement

Ecological disadvantages

Off-site benefits

+ +	Reduced downstream siltation
+ +	Reduced downstream flooding
+	Reduced wind transported sediments
+	Reduced groundwater / river pollution

Off-site disadvantages

Contribution to human well-being/livelihoods

left: Awareness raising and community participation – capacity building to improve the condition of the land for production potential and high grazing capacity

right: Degraded land

Government-Funded Demonstrations

North West Province, South Africa

Government-funded restoration demonstration site to restore degraded land – by community participation. Community becomes the key stakeholders – capacity building.

Aim / objectives: Awareness raising and community participation. Capacity building, to teach the aim and type of technologies to the communities with the help of extension workers, scientists and academic staff, including postgraduate students. The main aim is to improve the condition of the land for high grazing capacity and production potential.

Location: North West Province
Approach area: 1 km^2
Type of Approach: project/programme based
Focus: mainly on conservation with other activities
WOCAT database reference: QA RSA37
Related technology (ies): Re-vegetation and reseeding
Compiled by: Klaus Kellner, School of Environmental Science and Development, North West University, South Africa
Date: 03/09/2001

Problem, objectives and constraints

Problems

Restoring degraded land (old lands) by cultivation and oversowing technologies.

Aims/Objectives

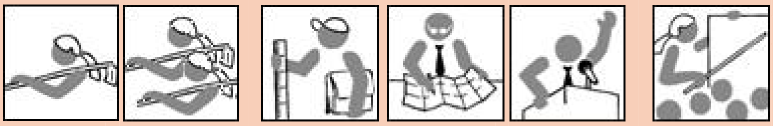
Awareness and participation. Training of technologies for restoration. On site or 'On-Farm' technology application.

Constraints addressed

Major	Constraint	Treatment
Financial	No money for restoration. Negative cost/benefit ration in short term.	Apply more cost effective technologies
Technical	No awareness and skills	Capacity building and job creation. Commitment by stakeholders and rural communities assured

Participation and decision making

Stakeholders / target groups



land user/ individual; land users/ groups; SLM specialists/ agricultural advisors; planners; politicians/ decision makers; teachers/ school children/ students

Approach costs met by:	
Government	80%
National non-government	20%
TOTAL	100%

Annual budget for SLM component: US$< 2,000

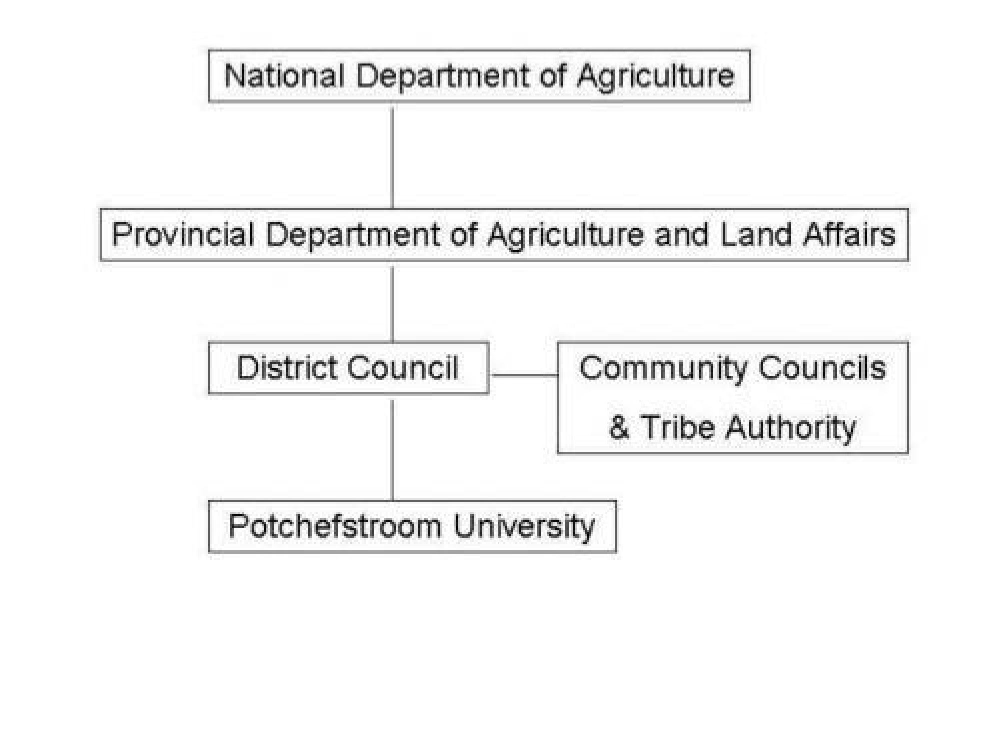
Decisions on choice of the Technology (ies): mainly by SLM specialists with consultation of land users
Decisions on method of implementing the Technology (ies): mainly by SLM specialists with consultation of land users
Approach designed by: national specialists, land users
Implementing bodies: international, government, national non-government, local community / land users

Land user involvement

Phase	Involvement	Activities
Initiation/motiviation	Passive	Mainly:public meetings; partly: workshops/seminars
Planning	Passive	Mainly: workshops/seminars; partly: public meetings
Implementation	Payment/external support	Mainly: responsibility for major steps; partly: casual labour
Monitoring/evaluation	Interactive	
Research	Interactive	On-farm

Differences between participation of men and women: Yes, little. Mostly women as they need to earn money for food and household.
Involvement of disadvantaged groups: Community councils; tribal authority - Chiefs make decisions.

Organogram



Technical support

Training / awareness raising:
Training was site visits / farmer to farmer, demonstration areas, public meetings
Training focused on Ecological principles; Restoration technologies; NRM principles.

Advisory service:
Name: Demonstration/Participation
Key elements:
1. 'Learning by Doing'
1) Mainly: government's existing extension system, Partly: non-governmental agency Partly: partly: non-governmental agency 2) Mainly: government's existing
extension system, Partly: non-governmental agency Partly: partly: non-governmental agency; Extension
The extension system is inadequate to ensure continuation of activities. Monitoring, data analysis and presenting of results will be conducted by Research staff and project implementation. Expert advice needed on a continuous basis.

Research: Yes, great research. Topics covered include ecology, technology
Mostly on-farm research. Vegetation and soil monitoring/analysis. Application of restoration technologies in demonstration plots.

External material support / subsidies

Labour: Voluntary, paid in cash. Job-creation incentives
Inputs: - Equipment (machinery, tools, etc) - machinery. Partly financed
- Agricultural (seeds, fertilizers, etc) - seeds, fertiliser, fencing. Fully financed
Credit: Credit was not available
Support to local institutions: Yes, little support with training

Monitoring and evaluation

Changes as result of monitoring and evaluation: There were no changes in the approach.

Impacts of the Approach

Improved sustainable land management: Yes, great; Oversowing and better soil seed bank; good cultivation methods; certain adapted grass species used.
Adoption by other land users / projects: Yes, some; Approach will be extended to other rural areas. Yes, some; Approach will be extended to other rural areas.
Training, advisory service and research:

- Training effectiveness
  Land users* - good
  SLM specialists - good
  Agricultural advisor / trainers - good
  Teachers - fair
  School children / students - fair
  Planners - fair
  Politicians / decision makers - fair
- Advisory service effectiveness
  Land users* - good
  Politicians / decision makers - good
  Planners - fair
  Teachers - fair
  Technicians / conservation specialists - excellent
  School children / students - fair
- Research contributing to the approach's effectiveness - Greatly
  Principles of restoration ecology effectively explained. To implement SWC technologies is only of value if it is correctly monitored, scientifically assessed and evaluated and the results scientifically sound carried over to all stakeholders - especially

Land/water use rights:
Help - low in the implementation of the approach. Help: land users again appreciated the role and importance of the natural resources. Hinder: lack of land tenure and ownership.

Long-term impact of subsidies:
Positive long-term impact - Greatly
More land users will hopefully apply the SWC technology (restoration method) in other areas or on a larger scale. Maybe without payment if the awareness campaign is positive and land users committed.

Concluding statements

Sustainability of activities: Yes the land users can sustain the approach activities

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Co-operation between all stakeholders By making data and analysis scientifically sound - results better	Often too long before action is taken Faster action. Extension better and more committed
Land users, technicians/extension, researcher, policy makers	Linguistic abilities. Land user has another language (Sotho), not spoken by specialist: Take local language classes and learn local language
SWC technology will be monitored by scientists - value added to project	SWC technology application must not only be build on job-creation incentives, but must be sustainable in the long term and applied by land user without payment
Learned a lot - especially with regard to the restoration process	Often too long before action is taken Faster action. Extension better and more committed
Earned money - job-creation	Linguistic abilities. Land user has another language (Sotho), not spoken by specialist: Take local language classes and learn local language
Knowledge about sustainable rangeland management strategies improved	
School children and teachers involved. School projects on SWC technologies and restoration ecology in particular	SWC technology application must not only be build on job-creation incentives, but must be sustainable in the long term and applied by land user without payment

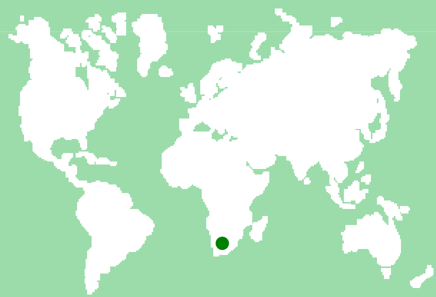
left and right: Rangeland management of communal grazing land: camp system vs. open system

Communal Grazing Management

North West Province, South Africa

Rangeland management of communal grazing land, to improve grazing capacity by applying rotation - Using benchmarks as demonstration of NRM strategies. Camp system vs. Open system.

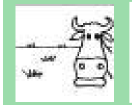
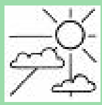
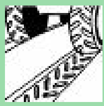
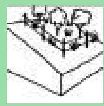
Benchmarks were identified and monitored to see how the production and vegetation would change if proper management was applied to a specific area. The benchmarks will only be grazed in the winter and rested in summer. The benchmarks were constructed with goat-proof fencing. Benchmarks will illustrate how grazing land can improve with the right management system. Monitoring of vegetation is done twice a year.



Location: Kudumane
Technology area: 1 km²
Conservation measure(s): management measure
Land use type: Grazing land: extensive grazing
Stage of intervention: mitigation / reduction of land degradation
Origin: externally introduced through project, recently (< 10 years ago)
Climate: semi-arid
WOCAT database reference: QT RSA41
Related approach: Communal stakeholders
Compiled by: Anja Jansen van Vuuren en Klaus Kellner, School of Environmental Science and Development, North West University, South Africa
Date: 27/09/2001, updated 28/04/2004 by Rinda van der Merwe

Classification

Land use problems: Overgrazing, loss of palatable species and thus nutrients for cattle. In land users's view: Reduced animal performance.

Land use		Climate		Degradation				Conservation measure(s)			
											
grazing land: extensive grazing		semi-arid		physical degradation :compaction				manage-ment			

Stage of intervention
- Prevention
- Mitigation/reduction
- Rehabilitation

Origin
- Land user's initiative:
- Experiments/research:
- Externally introduced: recent (<10 year)
- Other's (specify):

Level of technical knowledge
- Low:
- Medium: field staff/agricultural advisor, land user
- High:

Main causes of land degradation:
- over-exploitation of vegetation
- overgrazing
- natural causes (droughts)

Main technical functions: ·
- reduction of soil compaction
- reduction in wind speed
- improvement of ground cover
- increase in soil fertility
- increase in organic matter
- increase/maintain water stored in soil
- increase of infiltration
- improvement of soil structure
- increase of surface roughness
- control of concentrated runoff (impede/retard)
- control of concentrated runoff (retain/trap)
- control of dispersed runoff (impede/retard)
- control of dispersed runoff (retain/trap)
- control of raindrop splash

Secondary technical functions: ·
- sediment harvesting
- water spreading
- control of concentrated runoff (drain/divert)
- water harvesting

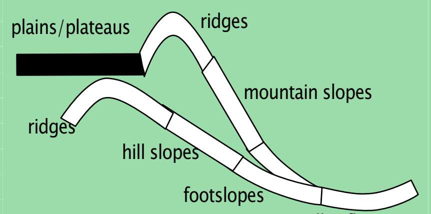
Environment

Natural Environment

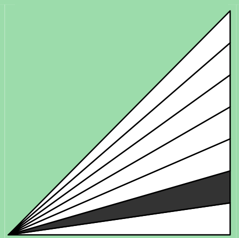
Average annual rainfall (mm)
- >4000
- 3000-4000
- 2000-3000
- 1500-2000
- 1000-1500
- 750-1000
- 500-750
- 250-500
- <250

Altitude (m a.s.l.)
- >4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 500-1000
- 100-500
- <100

Landform



Slope (%)



Soil depth (cm)
- 0-20
- 20-50
- 50-80
- 80-120
- <120

Growing season(s): 120 days (October to April)

Soil texture: Coarse (sandy): most common

Soil fertility: Medium: most common

Topsoil organic matter: Low (<1%): most common

Soil drainage/infiltration: Good: most common

Soil water storage capacity: Low

Human environment

land per household (ha)	
	<0.5
	0.5-1
	1-2
■	2-5
	5-15
	15-50
	50-100
	100-500
	500-1000
	1000-10000
	>10000

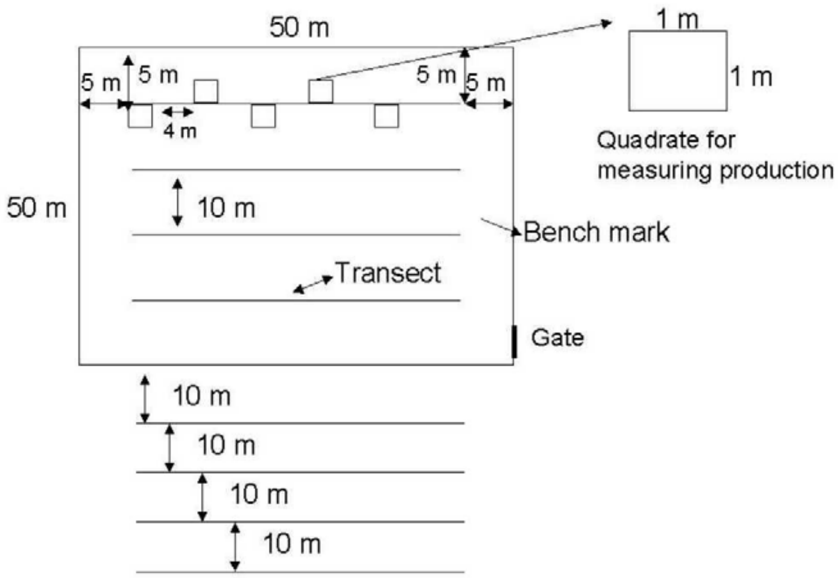
Land ownership: Communal/village: most common

Importance of off-farm income: > 50% of all income. State pension, mine workers, family working in the city.

Access to service and infrastructure: Communal (organised): most common

Market orientation: Grazing land: partly subsistence, mainly mixed (subsistence/commercial)

Technical drawing



Implementation activities, inputs and costs

Establishment activities

1. Management measures
   - area divided into camps
   - identification and construction of benchmarks
   - initial survey

Establishment inputs and costs per ha

Inputs	Costs (US$ or local currency)	% met by land user
Labour (10 person days)	426.83	0%
Equipment		
-		%
Materials		
- fencing (5000 m^2)	914.64	0%
Agricultural		
- transport (10-7 km/l) (1500)	67.07	0%
TOTAL	**1438.54**	**0%**

Maintenance/recurrent activities

1. Management measures
   - further survey
   - data analysis

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$ or local currency)	% met by land user
Labour (3 person days)	32.93	%
Equipment		
-		%

- establishing a gradient
- maintenance of fencing

Materials		
-		%
Agricultural		
- transport (10-7 km/l) (2000)	129.27	%
- data sheets (27)	1	%
- paper bags (220)	8.05	%
TOTAL	**171.25**	**100%**

Remarks: Duration of establishment phase:12 months

Assessment

Impacts of the Technology

Production and socio-economic benefits

+	Fodder production/quality increase

Production and socio-economic disadvantages

- - -	Increased labour constraints

Socio-cultural benefits

+ + +	Improved conservation / erosion knowledge

Socio-cultural disadvantages

Ecological benefits

+ +	Reduced soil loss
+	Biodiversity enhancement
+	Increased soil moisture
+	Improved soil cover

Ecological disadvantages

Off-site benefits

Off-site disadvantages

Contribution to human well-being/livelihoods

Benefits/costs according to land user

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

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
The committed ADC Manager → Meetings	Community participation → Give more information
The maintenance of benchmarks as examples	Cattle must be reduced → Improve rangeland - larger carrying Capacity
Improved rangelands. → Better cattle	

left: Community members receiving training on rangeland management

right: Cattle in fenced off camp

Communal Stakeholders

North West Province, South Africa

Government funded project aimed at rangeland management to enhance natural resource management, the community being the key stakeholders.

Aim / objectives: The community was approached to show where the benchmarks should be erected. The whole community was informed about the project and how they would benefit from it. Benchmarks were erected by the community, thus creating jobs. Initial surveys were conducted so that later comparison in production and species composition could be made after further surveys. The rotational approach was introduced in a communal system.

Location: North West Province
Approach area: 0 km^2
Type of Approach: project/programme based
Focus: mainly on conservation with other activities
WOCAT database reference: QA RSA41
Related technology (ies): Communal grazing management
Compiled by: Anja Jansen van Vuuren, School of Environmental Science and Development, North West University, South Africa
Date: 27/09/2001

Problem, objectives and constraints

Problems

Degraded rangelands, thus insufficient grazing for the cattle.

Aims/Objectives

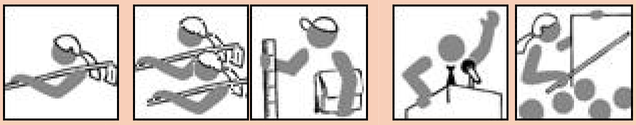
On-site technology application. Seeing is believing. Community participation. Empowerment of the community to better their own situation. Job creation, community-based natural resource management. Promoting partnerships between public, community and private sectors.

Constraints addressed

Major	Constraint	Treatment
Institutional	Communication between parties	More structured and organised meetings
Technical	Lack of community participation during surveys	Make a big issue about environmental awareness
Minor	**Constraint**	**Treatment**
Financial	Availability of government funds	

Participation and decision making

Stakeholders / target groups



land user/ individual; land users/ groups; SLM specialists/ agricultural advisors; politicians/ decision makers; teachers/ school children/ students

Approach costs met by:

Government	80%
National non-government	20%
TOTAL	100%

Annual budget for SLM component: US$10,000-100,000

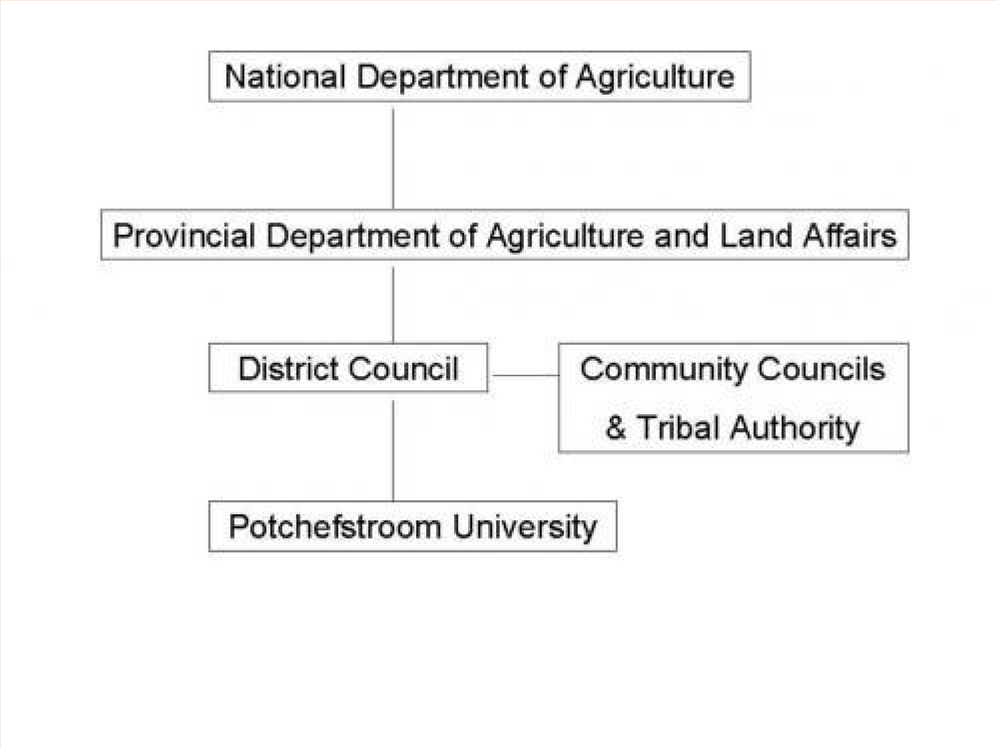
Decisions on choice of the Technology (ies): mainly by SLM specialists with consultation of land users
Decisions on method of implementing the Technology (ies): mainly by SLM specialists with consultation of land users
Approach designed by: national specialists, international specialists, land users
Implementing bodies: international, government, local government (district, county, municipality, village etc)

Land user involvement

Phase	Involvement	Activities
Initiation/motiviation	Passive	Workshops/seminars, public meetings; Training for surveys was provided
Planning	Passive	Workshops/seminars; Training
Implementation	Interactive	Responsibility for minor steps; Should apply the rotation
Monitoring/evaluation	Interactive	Measurements/observations; Help with monitoring
Research	Interactive	On-farm; Benchmarks was erected

Differences between participation of men and women: Yes, great. Only men.
Involvement of disadvantaged groups: Yes, great. The community was asked where the benchmarks should be situated.

Organogram



Technical support

Training / awareness raising:

Training provided for land user, SWC specialists, extensionists/trainers
Training was site visits / farmer to farmer, demonstration areas, public meetings
Training focused on Ecological principles, NRM principles.

Advisory service:

Name: Demonstration

Key elements:

1. Benchmark sites
2. Learning by doing

1) Mainly: government's existing extension system, Partly: non-governmental agency 2) Mainly: government's existing extension: land users, technicians/SWC specialists; Activities: Public demonstrations

The extension system is inadequate to ensure continuation of activities. Monitoring does not persist if someone is not doing it with them.

Research: Yes, great research. Topics covered include ecology. Mostly on-farm research. Vegetation, NRM, production monitoring, soil composition, on-site application.

External material support / subsidies

Labour: Voluntary, paid in cash. Job creation incentive.
Inputs: Equipment (machinery, tools, etc) - hand tools. Not financed
Credit: Credit was not available.
Support to local institutions: Yes, little support with training

Monitoring and evaluation

Changes as result of monitoring and evaluation: There were no changes in the approach.

Impacts of the Approach

Improved sustainable land management: Yes, moderate; Rotational grazing system was adopted.
Adoption by other land users / projects: Yes, some; Other regions in North West Province are following the example.
Training, advisory service and research:

- Training effectiveness - The extension officers participated more with the surveys.
  Land users* - fair
  SLM specialists - excellent
  Agricultural advisor / trainers - good
- Advisory service effectiveness - Rotational grazing was implemented.
  Land users* - good
  Technicians / conservation specialists - excellent
- Research contributing to the approach's effectiveness - Greatly
  The approach was totally applicable to the area and suited everyone well. The approach can only be good if it can be soundly scientifically proven and illustrated in a understandable way.

Land/water use rights: Help - greatly in the implementation of the approach. The chiefs favoured the approach.
Long-term impact of subsidies: Positive long-term impact – Greatly. The value of resting the veld will be greatly realised. The visible change in veld conditions will promote better NRM strategies. The economical value of better animals will be visible.

Concluding statements

Sustainability of activities: Yes the land users can sustain the approach activities.

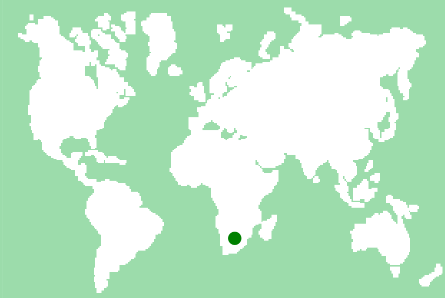
Strengths and → how to sustain/improve	**Weaknesses and → how to overcome**
The committed ADC manager. Keep him motivated through communication	Linguistic abilities not sufficient : Learn to speak Tswana
LandCare. The buzz words were introduced and community was made aware of the environment	Times delays. The sites are a bit remote and the people only drive during working hours
Interaction between different cultures. Specialists and communities were introduced to one another	NRM application should be sustainable. Not only based on incentives, but the benefits should be realised
Better grazing. Keep to the rules of rotational grazing. Keep cattle out of resting velds	Specialists are very remote: Not always reachable
Specialists help. The specialists made surveys easy. Assist in erecting	Reduction of cattle numbers: Resistant to reducing wealth

left: Restored area (Anuschka Barac)

right: Positive effect of packing contours between different applied technologies (Anuschka Barac)

Restoration of Degraded Rangeland

Gauteng Province, South Africa



Research investigation into alternative treatments for eradicating invasive species and revegetating degraded rangelands with palatable herbaceous species - Rehabilitation/restoration of an area, after control of alien invasive species.

A research investigation was undertaken in an area of degraded communal rangeland, which had been invaded by an alien tree species (*Acacia mearnsii* - black wattle). Competition from the high water-demanding *A. mearnsii*, combined with overgrazing, had resulted in an almost total absence of palatable grasses from the range. All that was left were a few patches of *Cynodon dactylon*.

The purpose of the trials was to determine how best to eradicate the invasive species and re-vegetate the rangeland. The restoration area was not fenced off and was thus open to grazing by livestock. The trials comprised 5 different treatments, with 3 replicates per treatment, on plots 10 m by 20 m. In all 5 treatments the *A. mearnsii* was eradicated manually, and then chemical biocide was applied to the stumps to prevent any regrowth. Lime and grass seed (palatable species) were applied to the loosened topsoil and covered with soil. The five treatments included:

Treatment A - oversowing with grass seed mixture, supplementing of dolomitic lime, cattle dung, and brush packing.
Treatment B - oversowing with grass seed mixture and supplementing of cattle dung.
Treatment C - oversowing with grass seed mixture and supplementing of dolomitic lime.
Treatment D - oversowing with grass seed mixture and brush packing.
Treatment E - oversowing with grass seed mixture only.
In addition stone lines were laid out on the contour, between different plots down the slope, to retard runoff, trap soil, and improve conditions for seed germination.

The restoration trials began in 1997 and continued for 3 years. The results showed treatment A to be the most effective in restoring the productive and protective function of the rangeland. From the trials the estimated cost per ha of applying the best technology would be US$ 205.00/ ha (US$ 1 = R7.00).

The key constraints for successful adoption are: (i) need to protect the area from grazing and trampling by animals during the initial establishment period; (ii) need for community agreement on the initial protection and subsequent sustainable utilisation of the restored range; and (iii) removal of the brushwood for firewood, as this is hard to cut.

Location: Johannesburg
Technology area: 9 km²
Conservation measure(s): vegetative measure, structural measure
Land use type: Grazing land: extensive grazing
Stage of intervention: mitigation / reduction of land degradation, rehabilitation / reclamation of denuded land
Origin: through experiments / research, recently (< 10 years ago)
Climate: sub-humid
WOCAT database reference: QT RSA42
Related approach: Working for water
Compiled by: Barac Anuschkaand Klaus Kellner, Maxim Planning Solutions, South Africa,
Date: 28/09/2001, updated 25/07/2005 by Rinda van der Merwe

Establishment activities:
1. Manual eradication of trees with chainsaw and axe.
2. Application of chemical biocide to the stumps to prevent any re-growth.
3. Ripping of soil surface to a depth of 5 cm using a three-tined hand implement.
4. Application of dolomitic lime and raking it into soil after ripping of the soil.
5. Application of organic material (cattle dung) after ripping and lime application.
6. Oversowing with grass seed mixture after ripping of the soil and application of lime and organic material.
7. Brush packing against contour and packing of rock contours against the slope. All the branches and stones were collected from the restoration area. Rock contours were packed against (perpendicular) to the slope in the study area at varying intervals (approximately 10-15 m apart) in order to retard runoff water, trap soil, and improve conditions for seed germination (see inserted drawing below and attachment). Branches were packed (brush packing) along the slope in certain treatments within the study site in order to trap soil, retard runoff water and serve as a micro-climate for germinating and establishing grass seedlings.

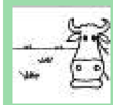
Total duration of restoration took 3 years, from removal of trees until re-vegetation trials were laid out and technology was established.

Maintenance / recurrent activities per year:
Following initial establishment maintenance was limited to two follow-up applications of herbicide (after 3 and 5 months). Maintenance of contours was not done after restoration.

Classification

Land use problems: Occurrence of bare areas after control of alien invasive. In land users's view: Minimal grazing for cattle, due to the occurrence of bare areas.

Land use



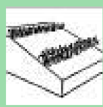
grazing land: extensive grazing

Climate

sub-humid

Degradation

Conservation measure(s)



vegetative

Stage of intervention
- Prevention
- Mitigation/reduction
- Rehabilitation

Origin
- Land user's initiative:
- Experiments/research: recent (<10 years
- Externally introduced:
- Other's (specify):

Level of technical knowledge
- Low:
- Medium: land user
- High: field staff/agricultural advisor

Main causes of land degradation:
- deforestation (alien invasives)
- over-exploitation of vegetation (trampling)
- overgrazing (cattle and goat)

Main technical functions: ·
- improvement of ground cover
- increase in soil fertility
- increase in organic matter
- control of dispersed runoff (impede/retard)
- control of raindrop splash

Secondary technical functions: ·
- sediment harvesting
- increase of infiltration
- improvement of soil structure
- reduction of slope angle
- reduction in wind speed
- water spreading
- water harvesting
- increase of surface roughness
- control of concentrated runoff (impede/retard)

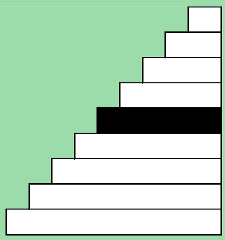
Environment

Natural Environment

Average annual rainfall (mm)

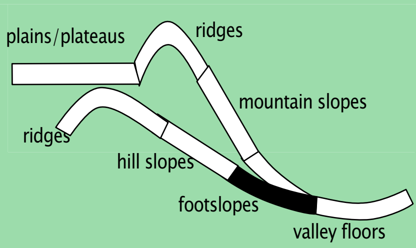
>4000
3000-4000
2000-3000
1500-2000
1000-1500
750-1000
500-750
250-500
<250

Altitude (m a.s.l.)

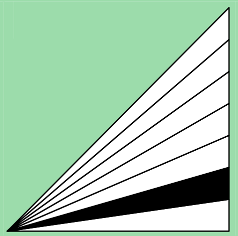


>4000
3000-4000
2500-3000
2000-2500
1500-2000
1000-1500
500-1000
100-500
<100

Landform



Slope (%)



Soil depth (cm)

0-20
20-50
50-80
80-120
<120

Growing season(s): 210 days (October to April)

Soil texture: Medium (loam): most common; coarse (sandy): common; fine (clay): less common

Soil fertility: Low: most common

Topsoil organic matter: Low (<1%): most common

Soil drainage/infiltration: Poor: most common

Soil water storage capacity: Medium

Human environment

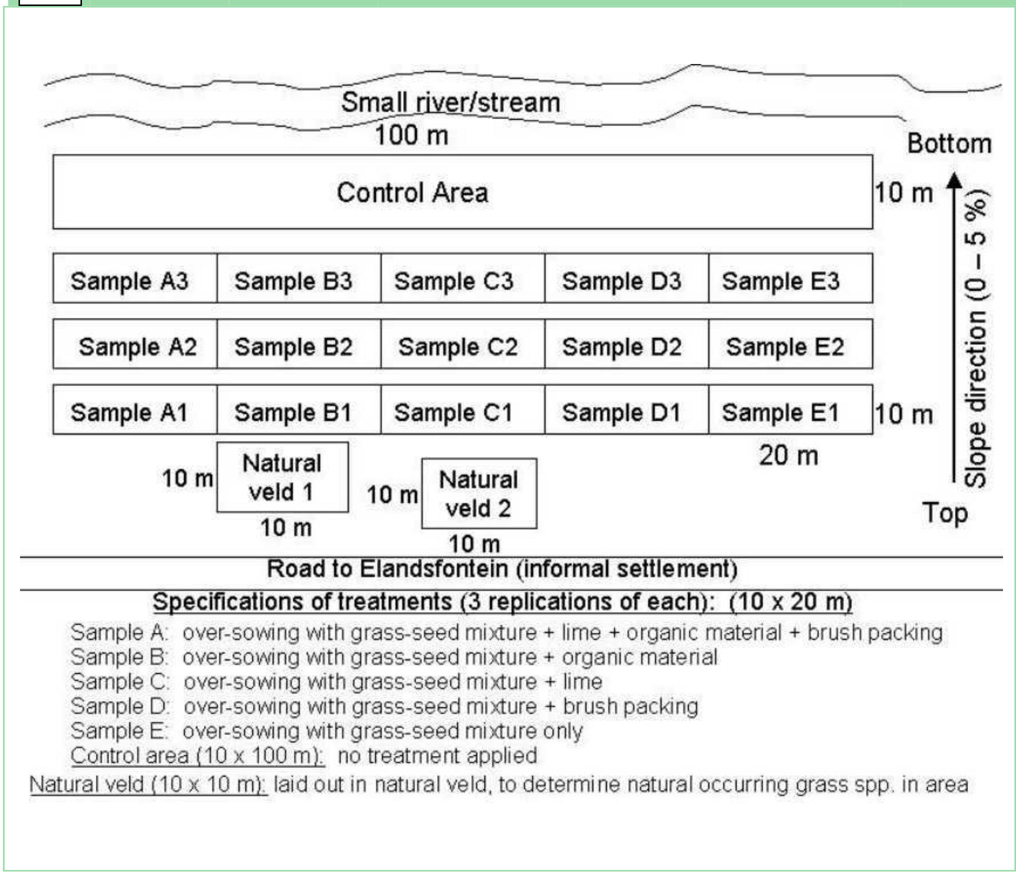
Grazing land per household (ha)

<0.5
0.5-1
1-2
2-5
5-15
15-50
50-100
100-500
500-1000
1000-10000
>10000

Land ownership: State

Importance of off-farm income: > 50% of all income. Informal settlers work in the city/mine, also mostly live off old age pension funds. Farmers (low percentage) have an income on-farm by means of selling cattle, crops and dairy products.

Market orientation: Grazing land: mainly mixed (subsistence/commercial), partly commercial



Technical drawing

Implementation activities, inputs and costs

Establishment activities

1. Vegetation measures
   - follow-up with herbicide
   - loosening of soil
   - lime application
   - application of organic material
   - oversowing with grass seed mixture
   - brush packing
   - eradication of trees

Establishment inputs and costs per ha

Inputs	Costs (US$ or local currency)	% met by land user
Labour (10 person days)	35	%
Equipment		
- tools	5	%
- machine hours (4 hours)	65	%
Materials		
- wood (25 qm)	0	%
- stone (50 qm)	0	%
Agricultural		
- compost/manure (50 kg)	0	%
- biocides (1.5 kg/ha)	30	%
- feritlizer (4 ton/ha)	25	%
- seeds (16 kg/ha)	70	%
TOTAL	**230**	**0%**

Maintenance/recurrent activities

1. Vegetative measures
   - two follow-ups with herbicide

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$ or local currency)	% met by land user
Labour (4 person days)	10	%
Equipment		
- tools	5	%
Materials		
-		%
Agricultural		
- biocides	20	%
TOTAL	**35**	**0%**

Remarks: Duration of establishment phase: 36 months

Assessment

Impacts of the Technology

Production and socio-economic benefits		Production and socio-economic disadvantages	
+++	Increased farm income	---	Hindered farm operations
+++	Fodder production/quality increase	-	Increased labour constraints

Socio-cultural benefits		Socio-cultural disadvantages	
+++	Improved conservation / erosion knowledge	-	Socio-cultural conflicts
+++	Job creation		
+++	Community institution strengthening		

Ecological benefits		Ecological disadvantages	
+++	Reduced wind velocity		
+++	Biodiversity enhancement		
+++	Reduced soil loss		
+++	Improved soil cover		
++	Increased soil moisture		
+	Increase in soil fertility		
+	Improved excess water drainage		

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

+	reduced downstream flooding	

Contribution to human well-being/livelihoods

Benefits/costs according to land user

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

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Improvement of grazing resources. → Fencing rehabilitated areas to keep cattle out until the grasses are sufficiently established should be part of the technology in future	Removal of brushwood for firewood by community members. → Negotiation and consultation with the community
Improved soil moisture availability by removing an alien species with a high water demand. → Use of a biocide on the cut stems to prevent any re-growth of the alien species	Insufficient aftercare. → Secure additional funds to pay labourers and buy biocides
Reduced erosion by controlling runoff. → Regular maintenance of the contour stone lines	Too many cattle and goats. → Reduce numbers to match grazing resources available
Gazing improvement. → Fences	

left and right: The control of alien woody invasive vegetation to restore the degraded area to its nearest original state

Working for Water

Gauteng Province, South Africa

Government-funded restoration/rehabilitation initiative as part of Working for Water project. Aim was to eradicate alien invasives.

Aim / objectives: The aim was to eradicate alien invasive species and then to revegetate the area in order to recover the natural grazing for livestock. Community participation plays a very important role, making them aware of the importance of restoring degraded rangelands. The approach for applying SWC technologies included making use of community members (at a daily wage) to carry out the labour-intensive technologies and thus also playing a part in increasing community awareness.

Location: Gauteng Province
Approach area: 1 km^2
Type of Approach: project/programme based
Focus: mainly on conservation with other activities
WOCAT database reference: QA RSA42
Related technology (ies): Eradication of invasive species
Compiled by: Anuschka Barac, School of Environmental Science and Development, North West University, South Africa
Date: 28/09/2001

Problem, objectives and constraints

Problems

The evaluation of a restoration trial after the control of alien woody invasive vegetation in the Gauteng Province and to restore degraded rangeland to nearest original state before degradation took place (= improve grazing).

Aims/Objectives

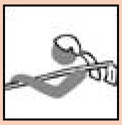
On-site or on-farm technology application, thus making the community aware of positive effect of restoration technology. To see to it that job creation occurs in surrounding communities.

Constraints addressed

Major	Constraint	Treatment
Financial	No funds available for restoration	Apply more cost-effective approaches or apply for funds
Technical	Equipment used is too labour intensive and take a lot of time	If enough funds were available, mechanical equipment could be used (faster and more effective)
Other	Involvement of community	Negotiation and awareness programmes

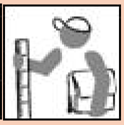
Participation and decision making

Stakeholders / target groups

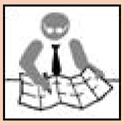


land users, individual

land users, groups

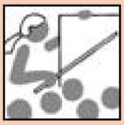


SLM specialists / agricultural advisors



planners

politicians / decision makers



teachers / school children / students

Approach costs met by:

International	10%
Government	80%
National non-government	10%
TOTAL	**100%**

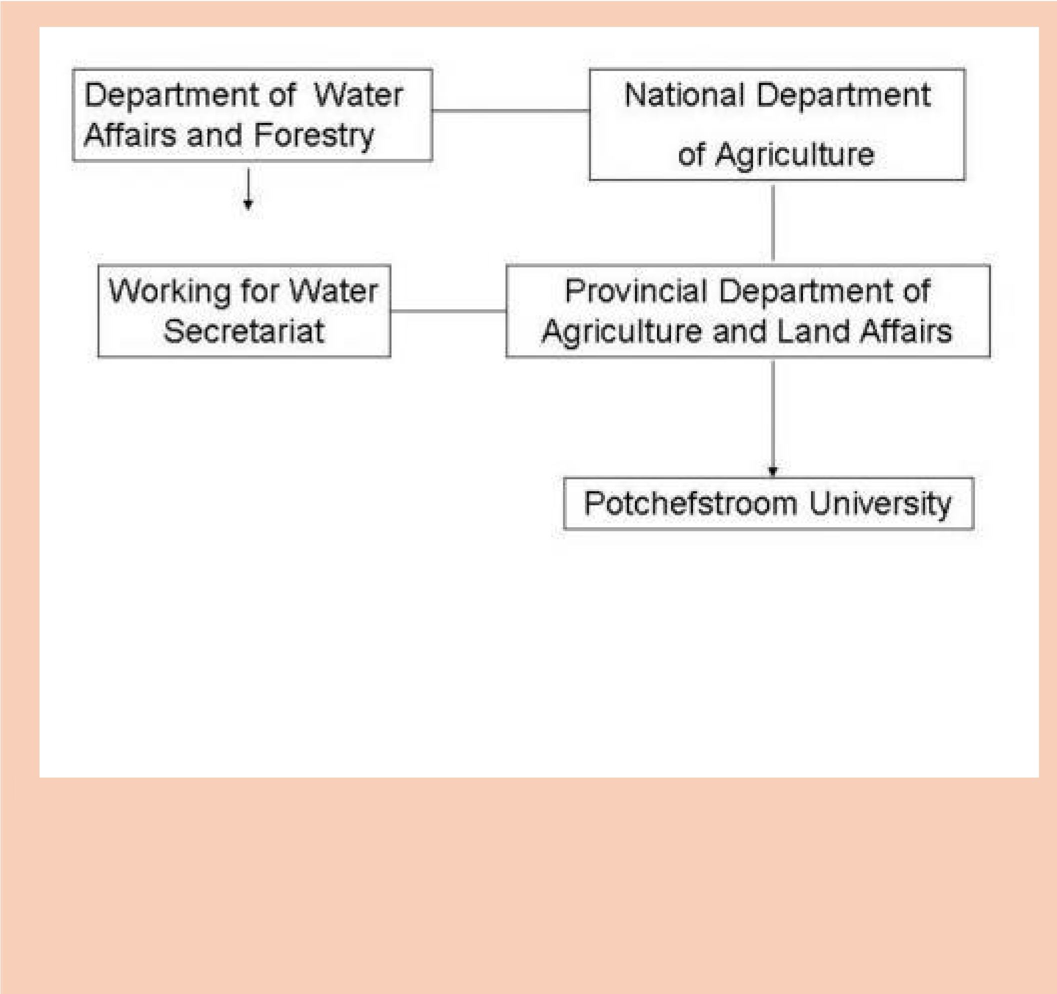
Annual budget for SLM component: US$< 2,000

Decisions on choice of the Technology (ies): by SLM specialists alone (top-down)
Decisions on method of implementing the Technology (ies): by SLM specialists alone (top-down)
Approach designed by: national specialists, international specialists, land users
Implementing bodies: international, government

Land user involvement

Phase	Involvement	Activities
Initiation/motiviation	Passive	Public meetings
Planning	Passive	
Implementation	Payment/external support	Mainly: responsibility for major steps; partly: casual labour
Monitoring/evaluation	Passive	
Research	Passive	On-farm

Differences between participation of men and women: No
Involvement of disadvantaged groups: No



Organogram: Actors in approach

Technical support

Training / awareness raising:

Training provided for land user, SWC specialists, extensionists/trainers
Training was on-the-job, demonstration areas
Training focused on Ecological principles, restoration technologies.

Advisory service:

Name: Demonstration
Key elements:

1. Rural community appraisal
2. Participatory rural approach

1) Advisory service was carried out through: government's existing extension system 2) Advisory service was carried out through: government's existing extension system; Extension staff: specifically hired project employees 3) Target groups for extension: technicians/SWC specialists; Activities: People in charge of field work etc.

The extension system is inadequate to ensure continuation of activities. Except for being inadequate, there are not enough funds available to continue the activities. Expert advice from specialists after evaluation is also needed to be adequate.

Research:

Yes, great research. Topics covered include ecology, technology
Mostly on-farm research.
Soil related research and analyses and also restoration technology application information.

External material support / subsidies

Labour: Paid in cash. Job creation and community involvement
Inputs: - Equipment (machinery, tools, etc) - machinery, hand tools. Fully financed
- Agricultural (seeds, fertilizers, etc) - seeds, fertilizer, biocides. Fully financed
Credit: Credit was not available
Support to local institutions: Yes, little support with training

Monitoring and evaluation

Changes as result of monitoring and evaluation: There were no changes in the approach

Impacts of the Approach

Improved sustainable land management: Yes, great; To lay out contours to prevent erosion and serve as catchment for water. Establishment of grass also served as stabiliser to prevent erosion and serves as fodder in addition.
Adoption by other land users / projects: No; Unsure.
Training, advisory service and research:

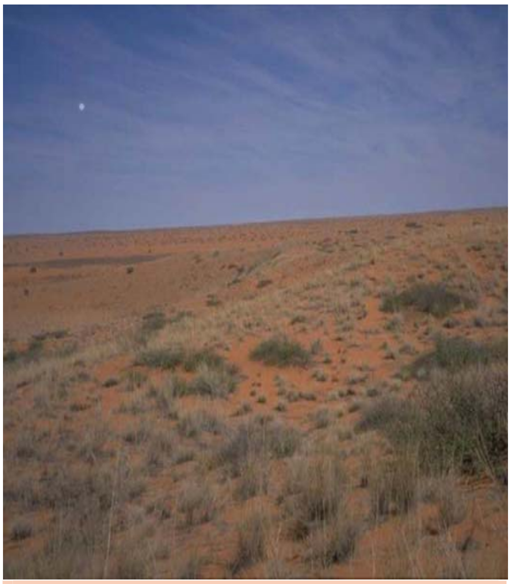
- Training effectiveness - All involved parties benefited to a great extent from training.
  Land users* - good
  SLM specialists - excellent
  Agricultural advisor / trainers - good
- Advisory service effectiveness - All involved parties benefited to a great extent from training.
  Land users* - good
  Technicians / conservation specialists - excellent
- Research contributing to the approach's effectiveness - Greatly
  A great deal, because research involved correct monitoring, scientifically accessed and evaluated and the results were scientifically sound as well. Results were also very positive.

Land/water use rights: Help - low in the implementation of the approach. Land users did not like what happened, do not think the approach will work. Some appreciation for what is being done.
Long-term impact of subsidies: Positive long-term impact - Moderately
The incentives in the form of money helped the restoration/rehabilitation project get started. In the long term that impact would be that the land owners benefit by the improved grazing. Once they see the result of this, they might be willing to carry on with the restoration over a long period of time on their own account, without further incentives.

Concluding statements

Sustainability of activities: Yes the land users can sustain the approach activities.

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Job creation. Appoint a community member to look after the area and see that if is managed	Not enough communication between specialists and community members on important factors. Better communication from start of approach or project
Awareness and training. Personal improvement to understand how to take care of land and how to improve it.	Linguistic abilities not sufficient (especially on side of specialists). To obtain some simple linguistic abilities, such as how to greet and ask approach related questions
Inter-cultural co-operation	SWC technology application must not be built on job creation incentives (only), but must be sustainable in the long term without incentives (job creations) by the land users
Job creation. Appointing members could involve rest of community to help look after restored area (improved grazing).	
Training. Community members learnt a lot about conservation and they can now carry on with it on their own (they have the knowledge).	



left: Bush packing, dunes in the Kalahari - Different techniques of bush packing.

right: Grass on dunes and in streets, no bushes – good condition.

Rehabilitation Techniques in Southern Kalahari - Vegetative and Management

Northern Cape Province, South Africa

Location: Northern Cape Province
Approach area: 40 km^2
Type of Approach: project/programme based
Focus: mainly on conservation with other activities
WOCAT database reference: QA RSA55
Related technology (ies):
Compiled by: Andre F van Rooyen
Date: 01/04/2004 (updated Rinda van der Merwe)

Shared interest by Mier Management Council and Provincial Department of Agriculture.

Aim / objectives: Initially a combined effort by Department of Agriculture and Mier Management Council to combat degradation of game camps. Directed towards a male dominated farming community, also involving a few females (ages ranging from middle to old age). An objective was to educate towards awareness of degradation and techniques involving the rehabilitation of these areas and the prevention of getting to this state. Also including methods which prevent returning to this state. Initially using farmer's days - education. Research came later, focussing on understanding the ecology of the area and then to concentrate on rehabilitation techniques. This was later introduced in farmer's days, school education and education of management council. Stages of implementation: 1) Realisation by management council that veld was degraded. 2) Department of Agriculture requested to assist in the form of trial and error (e.g. resting camps, poisoning of shrubs). 3) Resting of camps showed no improvement, so Department requested assistance from Agricultural Research Council (Range and Forage Institute) to gain understanding of ecology of area. 4) Once understanding gained and techniques developed, education in the form of farmer's days, school days and management council. Role of participants: 1) Nature Conservation: Initially involved in game number management. 2) Department of Agriculture: Advisory capacity management of techniques. 3) ARC: Research and advisory. 4) Management council labour control. 5) Community - involved through council in decision-making also jobs provided through labour.

Problem, objectives and constraints

Problems
Finance, education (very little education with regards to labours).

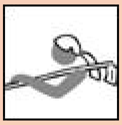
Aims/Objectives
Education in techniques to combat desertification, also in prevention of degradation. Financial empowerment. Management techniques.

Constraints addressed

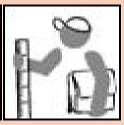
Major	Constraint	Treatment
Financial	Very poor community	LandCare (money)
Institutional	Financial - no money in Institute and Department	Money
Minor	**Constraint**	**Treatment**
Other	Political: leads to mistrust and uneasiness w.r.t. Money	Work on the problem at hand and ignore politics

Participation and decision making

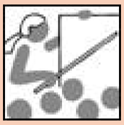
Stakeholders / target groups


land users / individual


land users / group


SLM specialists / agricultural advisors


politicians / decision makers


teachers / school children / students

Approach costs met by:

Government	80%
Local community / land user(s)	20%
TOTAL	100%

Annual budget for SLM component: US$

Decisions on choice of the Technology (ies): mainly by SLM specialists with consultation of land users
Decisions on method of implementing the Technology (ies): mainly by SLM specialists with consultation of land users
Approach designed by: national specialists, land users
Implementing bodies: government, international non-government, local community / land users

Land user involvement

Phase	Involvement	Activities
Initiation/motiviation	Passive	Workshops/seminars, public meetings; Discussions to indicate where researchers see the project going and how the land users would like to see it go
Planning	Interactive	Workshops/seminars, public meetings; Field workshops & meetings-discuss how and where the project should be carried out
Implementation	Payment/external support	Responsibility for major steps; Labour used for bushpacking responsibility for LandCare committee for salaries and labour
Monitoring/evaluation	None	Public meetings,measurements/observations, reporting, workshop/seminars; Monitoring of project is on going by researchers with help of few labours. Congresses/workshops are used to describe process & public meetings allow community to be informed
Research	None	On-station; On-farm & on-station is ongoing. Lab work for information on germination processes

Differences between participation of men and women: Yes, great. Labour work far too heavy for women (injuries have occurred). Women are directed towards cultivation techniques of *Harpagophytum procumbens* or basic homeskills (sewing etc.). Males - chopping & packing Rhigozum on dunes (degraded dunes).
Involvement of disadvantaged groups: Yes, moderate. Farmers - advice on what they are capable of doing w.r.t. costs and labour.

Organogram: Approach

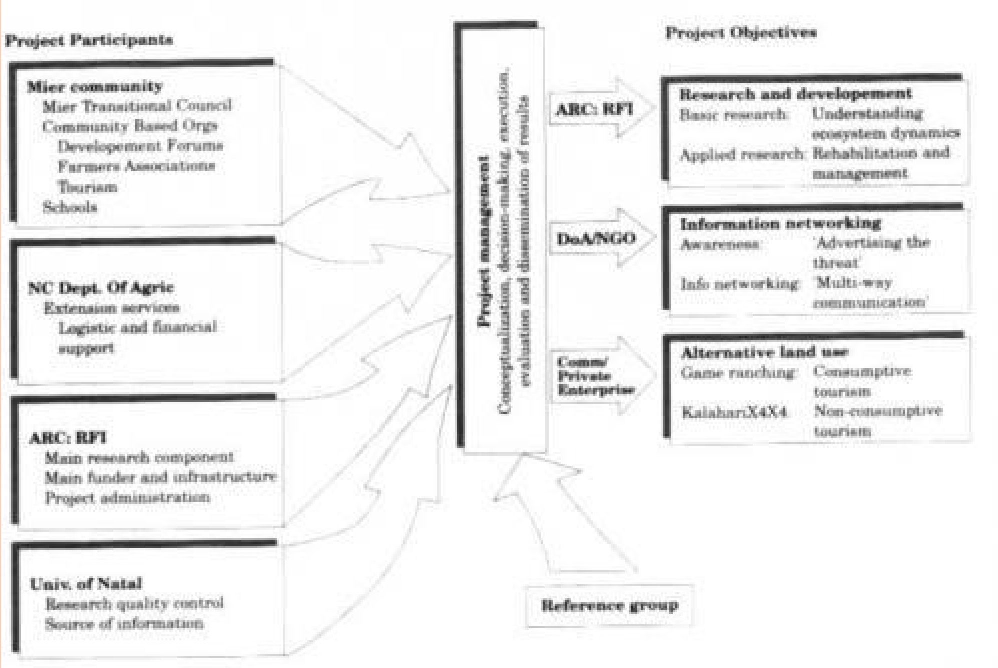


Figure 2. Combating desertification in Mier, a holistic approach based on research and development, information networking and alternative forms of land use.

Technical support

Training / awareness raising:

Training provided for school children/students, planners, politicians/decision makers, land user
Training was site visits / farmer to farmer, demonstration areas
Training focused on Rehabilitation ecological processes, cultivation, preventative agriculture

Advisory service:

Name: Not formal approach

Key elements:

1. Education
2. Labour
3. Development

1) Advisory service was carried out through: government's existing extension system 2) Advisory service was carried out through: government's existing extension system; Extension staff: mainly government employees 3) Target groups for extension: land users, school children/students; Activities: Bushpacking techniques, education; Education

The extension system is inadequate to ensure continuation of activities. The project is still in first phase - next phase will include female section of community

Research: Yes, great research. Topics covered include ecology. Mostly on-farm research. Rehabilitation techniques must fall within the capabilities and finance of the community.

External material support / subsidies

Contribution per area (state/private sector):

Labour: Paid in cash

Inputs: - Equipment (machinery, tools, etc) - machinery, hand tools. Fully financed
- Agricultural (seeds, fertilizers, etc) - seeds, seedlings, other (food, transport). Fully financed

Support to local institutions: Yes, little support with equipment, advice

Monitoring and evaluation

Changes as result of monitoring and evaluation: There were few changes in the approach. Packing designs of Rhigozum plants on bare dunes. The less expensive, most efficient design was chosen.

Impacts of the Approach

Improved sustainable land management: Yes, great; Stabilisation of dunes, greater vegetation on dunes
Adoption by other land users / projects: Yes, some; South African Railways - lines which cut through dune systems
Training, advisory service and research:

<u>- Training effectiveness</u> - All target groups have benefited from the project.
Land users* - excellent
SLM specialists - good
Agricultural advisor / trainers - excellent
Teachers - excellent
School children / students - excellent
Planners - good
Politicians / decision makers - good

<u>- Advisory service effectiveness</u>
Land users* - excellent
Politicians / decision makers - good
Planners - good
Teachers - excellent
Technicians / conservation specialists - excellent
School children / students - excellent

<u>- Research contributing to the approach's effectiveness</u> - Greatly
Techniques used needed to be researched before being implemented successfully

Land/water use rights: Help - moderately in the implementation of the approach. Hinder: moderate - government won't allow farmers to own land so attitude can be negative. Community reaps benefits from game farms. The approach did reduce the land/water use rights problem (greatly). Farmers realised the simplicity of rehabilitation.
Long-term impact of subsidies: Positive long-term impact – Low. Money from government can only last so long. Long-term impacts will come in the form of higher productive land.

Concluding statements

Sustainability of activities: Yes the land users can sustain the approach activities

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Community participation: Greater responsibility to community	Low recovery of natural resources I don't think there is a way to increase reaction time in this area
Healthy integration of Scientists & Community action Good communication (Scientists & Community)	Do not know
Own input into R &D	

GULLY CONTOL AND REHABILITATION

Gully erosion is one of the most significant sources of the accumulation of sediment and pollutants to streams and has severe impacts on the environment and river health. Gullies (dongas) are common features of mountainous or hilly regions with moderate to steep slopes and are found throughout South Africa.

Gullies normally start when fast-flowing water is concentrated on an area due to the shape of the land surface. This process can be natural or as a result of human activity such as overgrazing, livestock tracks, furrows and ruts left by farm machinery. However, as soon as the vegetation and topsoil are removed, gullies spread rapidly up and down drainage lines until there is insufficient runoff that will result in the formation of gullies. It has been proven that gully erosion is the most significant type of erosion that contributes to sediments affecting water quality of any catchment.

Gully erosion severely impacts soil fertility by:

- removing top soil which is rich in nutrients and organic matter,
- reducing the depth of soil available for rooting and for storing available plant water, and
- reducing infiltration of water into soil and increasing run off.

On-site and off-site impacts of gully erosion are:

- loss of productive agricultural land,
- the provision of a harbour for pests and invasive weeds,
- deposition of sediments,
- the downstream sedimentation of waterways,
- detrimental impacts to aquatic biodiversity, and
- the transportation of nutrients and contaminants from agricultural catchments.

When waste materials such as car bodies and tyres are dumped into gullies they act as a pollution source of hydrocarbons and heavy metals into the immediate vicinity and downstream catchment area.

There are four stages of rehabilitation of gully erosion:

- Remove the existing pressures.
- Assess the stability of the drainage line where the gully occurs.
- Identify the source of the water causing the erosion.
- Identify the appropriate remediation option/s.

Rehabilitation options:

a) The soft option - vegetation cover

Adequate vegetation is vital for soil protection. Varying layers of trees, shrubs and ground cover intercept the force of raindrops hitting the ground and slow the speed of surface runoff. Plant roots hold the soil together, improving soil physical properties such as stability and porosity.

b) The hard option - earthworks
In many cases a gully can be so severe that simple re-vegetation and stock reduction techniques will not be adequate to arrest the erosion.

Treatment of gullies depends on a range of factors including:

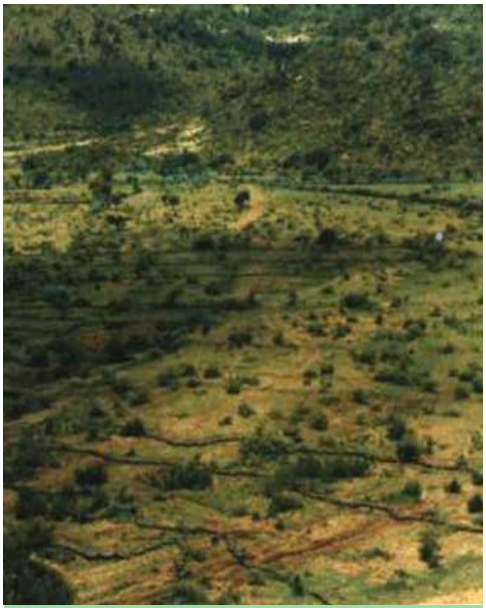
- the size of the gully,
- whether it is actively eroding or not,
- the soil type,
- the size and frequency of water flow,
- the topography of the area,
- the desired use of the land after rehabilitation.

The first requirement is to remove the cause of the gullying. This may involve the removal or exclusion of stock, relocation of tracks, re-vegetation of cleared areas, and/or drainage redesign.

Filling should only be attempted after the water flow that caused the problem has been controlled or diverted, and can be achieved through the construction of diversion structures such as earthen banks that divert run off away from the gully. The sides of the gully should be smoothed off and its head stabilised with formal structures made out of rock, concrete or rock mattresses. In most cases, a layer of topsoil will be required for the establishment of suitable vegetation. A protective cover of erosion resistant material may be required where seeding and irrigation is impractical. This may include stones, mattresses and/or geo-textiles. The area should be fenced off during the rehabilitation process to prevent grazing.

The heads of severely eroded areas can be stabilised through the construction of a series of structures, designed so that the flow in the gully is reduced to a non-scouring velocity. Sediment is dropped between the structures, filling the gully naturally.

Rocks can also be used to construct grade stabilisation structures. Vigilant monitoring is necessary to ensure that control structures are working effectively.



left: Old motor tyres and/ or vegetation (Agave) along contour.

right: Lines of tyres placed along true contours

Old Motor Tyre Contours

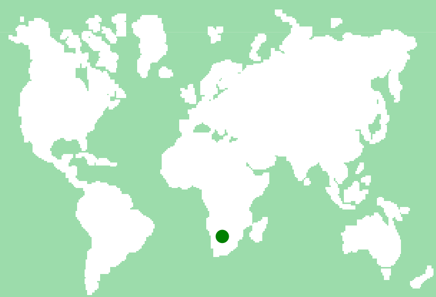
Limpopo Province, South Africa

Old motor tyres and/or vegetation along contours.

The site of Geen Einde is typical of many areas in Lebowa: a large gully approximately 200 m wide and 10 m deep in places with semi-eroded pedestals remaining. Flood waters from the mountain meanders causes further gouging of the sides of the pedestals. Tributary gullies have formed in the highly erodible soil (high clay content) adjacent to the main gully. Signs of old contour bunds indicate that the land was cultivated in the past.

1. An earth silt dam was mechanically constructed across the main erosion gully.
2. Several gabion structures were constructed in the minor gullies.
3. Vetiver grass was planted in the silt to act as nursery material for future planting.
4. Old motor tyres were laid on a level contour above the minor gullies to harvest water.
5. Several species of indigenous trees were planted in the gullies and along the rows of tyres.
6. Two Agave species, local aloes and vetiver grass were planted along level contours.
7. Agave was planted along the edges of the gullies.
8. Shallow gullies were stabilised with old tyres and Agave.
9. Couch grass (*Cynodon dactylon*) was planted at a few places in the gullies and along the rows of tyres.

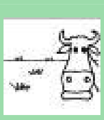
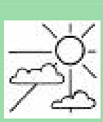
The main reason for these actions was to reduce the water velocity.



Location: Sekhukhuneland
Technology area: 0.1 km^2
Conservation measure(s): structural measure, vegetative measure.
Land use type: Cropland: tree and shrub cropping, Grazing land: extensive grazing
Stage of intervention: prevention of land degradation
Origin: through experiments / research, recently (< 10 years ago)
WOCAT database reference: QT RSA01
Related approach: Assistance to community
Compiled by: Christo W. Spies, Consultant, South Africa
Date: 06/12/1995, updated, 01/04/2004 by Rinda van der Merwe

Classification

Land use problems: Severe environmental degradation (less graze cover, overgrazing; considerable silt in the rivers going into Olifants River, a main resource for Kruger National Park, which below gabion construction were silted up in one year, some even in one rainstorm). In land users's view: Poverty, land tenure free range for the whole community.

Land use		Climate	Degradation	Conservation measure(s)
				
cropland: tree and shrub cropping	grazing land: extensive grazing	semi-arid	erosion by water: loss of topsoil by water gully erosion / gullying	structural

Stage of intervention

- Prevention
- Mitigation/reduction
- Rehabilitation

Origin

- Land user's initiative:
- Experiments/research: recent (<10 years)
- Externally introduced:
- Other's (specify):

Level of technical knowledge

- Low:
- Medium: Field staff/agricultural advisor
- High:

Main technical functions: ·

- improvement of ground cover
- increase in organic matter
- water harvesting

Secondary technical functions: ·

- increase/maintain soil water storage
- increase of infiltration

Environment

Natural Environment

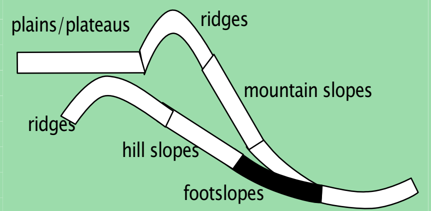
Average annual rainfall (mm)

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

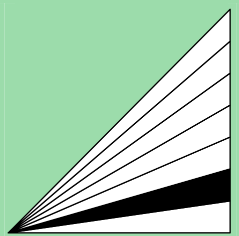
Altitude (m a.s.l.)

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

Landform



Slope (%)



Soil depth (cm) (2.7.9)

- 0-20
- 20-50
- 50-80
- 80-120
- <120

Growing season(s): 210 days

Soil texture: Fine clay – most common

Soil fertility: Low **-** Most common, very low - common

Topsoil organic matter: Low (>1%) – most common

Soil drainage/infiltration: Poor – most common

Soil water storage capacity: Low to medium

Human environment

Grazing land per household (ha)

- <0.5
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1000
- 1000-10000
- >10000

Land ownership: Communal/village

Importance of off-farm income: <10% of all income, pension very important

Access to service and infrastructure: Open access (unorganised)

Market orientation: Grazing land: mainly subsistence. Forest land: mainly subsistence

Implementation activities, inputs and costs

Establishment activities

1. Vegetative measure
   - transplanting Vetiver and trees
   - planting Agave
2. Structural measure
   - placing motor tyre and earth

Establishment inputs and costs per ha

Inputs	Costs (US$ or local currency)	% met by land user
Labour (30 person days)	83.35	%
Equipment		
- spades		%
Materials		
- tyres (transport)	138	%
- machine hours	11	
Agricultural		
- trees	888	%
TOTAL	**1120.35**	**100%**

Maintenance/recurrent activities

1. Pruning/trimming

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$ or local currency)	% met by land user
Labour (__person days)		%
Equipment		
- spades, pickaxes		%
Materials		
-		%
Agricultural		
-		%
TOTAL		**100%**

Assessment

Impacts of the Technology

Production and socio-economic benefits

+++	Stabilised gullies can be used for production
++	Relatively cheap method using old tyres and ripper
++	Increased wood production
++	Fodder production/quality increase

Production and socio-economic disadvantages

Socio-cultural benefits

+++	Improved conservation / erosion knowledge
+++	Community institution strengthening

Socio-cultural disadvantages

Ecological benefits

+++	Biodiversity enhancement
+++	Improved soil cover
++	Reduced soil loss
++	Increase in soil fertility
++	Improved excess water drainage
++	Increased soil moisture

Ecological disadvantages

Off-site benefits

++	Reduced downstream siltation

Off-site disadvantages

Contribution to human well-being/livelihoods

Benefits/costs according to land user

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

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Capture water and sediment for growth of plants → More of the same technology.	Transport costs of tyres → Selesert sponsorship
Improved graze cover.	Tyres all over the area may be unsightly → Cover the tyres with soil and vegetation
Improved trees cover	Paths may be blocked → Put more soil on the tyres
Improved water management	
Improved biodiversity	
Easy to implement and benefits from food, fuel and fodder	

left and right: Motor tyres and gabion structures to assist with the rehabilitation of the degraded areas to trap runoff water

Assistance to Community

Limpopo province, South Africa

Community requested assistance to combat soil erosion, only possible when 'Drought Relief Funds' became available.

Aim / objectives: During the national drought of 1992, the Government made funds available for job creation to temporarily alleviate poverty in the rural areas. This community, with a population of approximately 4000, applied for funds, and suggested that the funds be used to combat soil erosion within their communal area of 3800 ha. The area was inspected by technicians from the then Lebowa Government: Directorate Agricultural Engineering, and a project site was identified where both proven high technology methods, as well as novel and unproven low technology biological methods, which can easily be adopted by relatively unskilled workers from the community, could be tried. Work started in 1992 with sufficient funds for six months. Fortunately, for the project, the national drought continued and funds were made available again during the subsequent three years for six monthly periods. No work has been done on the project since 1996 because of a lack of funds. In view of the visible improvement of the environment, the community is keen to expand the project to include more techniques to make the project more viable. The project has proved to be highly educational, not only to the local community, but also to all other communities who have visited the project. A prime example is that of the two communities from the Western Region who have adopted and adapted similar techniques at their own projects.

Location: Sekhukhuneland, Limpopo Province
Approach area: 0 km^2
Type of Approach: project/programme based
Focus: mainly on conservation with other activities
WOCAT database reference: QA RSA01
Related technology (ies): Old motor tyres and contours
Compiled by: Christo W Spies, Consultant, South Africa
Date: 13/12/1995

Problem, objectives and constraints

Problems

Soil degradation caused by water erosion as a result of over-utilisation.

Aims/Objectives

Rehabilitation of the environment by trapping runoff rainwater to plant trees, grass and other vegetation to improve the general biodiversity.

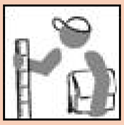
Constraints addressed

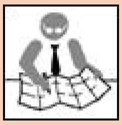
Major	Constraint	Treatment
Financial	Government job creation funds	
Technical	Department of Agriculture	

Participation and decision making

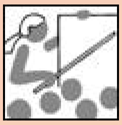
Stakeholders / target groups


Land users, groups


SLM specialists / agricultural advisors


Planners


Politicians / decision makers


Teachers / school children / students

Approach costs met by:

Government	100%
TOTAL	100%

Annual budget for SLM component: US$ 10,000-100,000

Decisions on choice of the Technology (ies): Mainly by SLM specialists with consultation of land users
Decisions on method of implementing the Technology (ies): Mainly by SLM specialists with consultation of land users
Approach designed by: National specialists land users
Implementing bodies: Government, local community / land users

Land user involvement

Phase	Involvement	Activities
Initiation/motivation	Interactive	Mainly public meetings; rapid/participatory rural appraisal; Community meeting never regularly, meeting as often as needed, on side participation
Planning	Interactive	Rapid/participatory rural appraisal; The specialists planned and discussed it with the people
Implementation	Interactive	Mainly: casual labour; partly: responsibility for major steps; The specialists planned and discussed it with the people
Monitoring/evaluation	Interactive	Measurements/observations; Observation by technical staff, regularly reporting to the Department
Research	Passive	On-farm; Continuous contact while working on the project.

Differences between participation of men and women: No
Involvement of disadvantaged groups: Yes, great. With discussion, the Phaahla Mohlaka tribe.

Technical support

Training / awareness raising:
Training provided for land user
Training was on-the-job
Training focused on People were instructed how to do the job, but not real training.
Advisory service:
Name: Government extension staff
<u>Key elements:</u>
Rangeland management
Advisory service was carried out through: Government's existing extension system; Extension staff: Mainly government employees.
The extension system is inadequate to ensure continuation of activities. Too few officers adequately conversant with SWC.
Research:
Yes, moderate research. Topics covered include technology.
Mostly on-farm research.
Determine sediment deposit and erosion control of the techniques.

External material support / subsidies

Labour: Paid in cash. A daily wage is paid by means drought relief job creation.
Inputs:
- Equipment (machinery, tools, etc)
- Hand tools. Govt. property
- Agricultural (seeds, fertilizers, etc) - Seedlings. Trees free of charge from government nursery or bought.

Credit: Credit was not available.
Support to local institutions: No

Monitoring and evaluation

Changes as result of monitoring and evaluation:
There were several changes in the approach:
1) Grass growing where there were none.
2) Numbers of grass species have increased considerably.
3) Gullies are stabilizing.
4) Water runoff reduced.

Impacts of the Approach

Improved sustainable land management: No
Adoption by other land users / projects: No, too early to comment.
Training, advisory service and research:
- Training effectiveness – Not much done yet.
  Land users* - poor
- Advisory service effectiveness – Only one officer adequately enthusiastic.
  Land users* - fair
- Research contributing to the approach's effectiveness – Moderately
  Measurements are being taken of sediment deposit and is an ongoing exercise.

Land/water use rights:
Help – low in the implementation of the approach. Help and hinder low, n/a.
The approach did reduce the land/water use rights problem (low).
Long-term impact of subsidies: Negative long-term impact – None

Concluding statements

Sustainability of activities: No the land users can't sustain the approach activities.
It is a social problem, cause in human nature.

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Improvement of the general economic → expanding it	Lack of funds → Find more funds
Increase job creation → But only for a short time	No individual benefits for the local → Land tenure
At the beginning the workers regarded the work mainly as a source of income → Lack of understanding. After some rain had fallen that they came to realise what was being accomplished, and their enthusiasm grew steadily from that time.	Lack of funds
Increased job creation → but only for a short time	No individual benefits for the local
Improvement of the general economic situation → Expanding it	

Key reference(s):
Contact person(s):

left and right: Gabion structures used for donga erosion control

Gully Control (Gabions) at Maandagshoek

Limpopo Province, South Africa

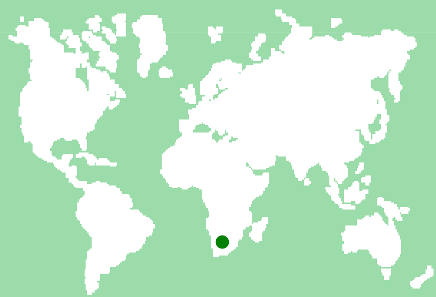
Stone walls and re-vegetation (planting of indigenous trees) = Rehabilitation - Donga control, Maandagshoek Soil Conservation Project.

For the pilot project loose stones and sometimes concrete walls that work well were used. It is not more expensive than gabions, because a trucker is needed for gabions and it is labour intensive. Wire is also often stolen off the gabions.

The following steps were followed in this technology: The areas are fenced, barricades (gabion-like structures) erected, and planting done. Rehabilitation and environmental education was the overall purpose. Severe erosion dongas can be improved and used for controlled grazing. The request came from the communities, which would like to make money and make land available for Nature Reserves (seen as a status symbol). Hunting by professional hunters produces meat for biltong. The excess game goes to hunting (local) and the meat is sold to the community at a lower price. Very little poaching or damage to the fences occurs.

Looking after the fences, roads, gabions and water points (infrastructure) is all part of the maintenance. The Nature Reserves are actually surrounded by villages, but there are no problems with people going into the Reserves.

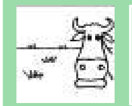
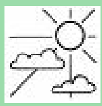
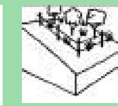
The areas are classified as Nature Reserve - Savannah woodlands (Acock's veld type: 19), Nebo - transitional zone between 61 and 18 (Acock's veld type 61) and Sekhukuhne as mixed bushveld (Acock's 19).



Location: Nebo District, Sekhukhuneland
Technology area: 29.01 km²
Conservation measure(s): management measure, structural measure, vegetative measure
Land use type: Grazing land: extensive grazing
Stage of intervention: Rehabilitation / reclamation of denuded land
Origin: externally introduced through project, recently (< 10 years ago)
Climate: semi-arid
WOCAT database reference: QT RSA31
Related approach: Interactive community approach
Compiled by: Igmé W. Terblanche, Action Green Heritage (NGO), South Africa
Date: 10/04/1999, updated 01/04/2004 by Rinda van der Merwe

Classification

Land use problems: Overpopulation (big pressure on veld), poor veld management (overgrazing), poor people. Population density most important factor. In land users' view: Not enough land or water for basic needs, agricultural development. Infrastructure was in place in 1964, Government did a lot of training, but there is not much left of anything. Before the new Government (from 1990) things went downhill. People are unsure about their future.

Land use	Climate	Degradation	Conservation measure(s)
			
grazing land: extensive grazing	semi-arid	erosion by water: gully erosion / gullying	management

Stage of intervention

	Prevention
	Mitigation/reduction
■	Rehabilitation

Origin

	Land user's initiative:
	Experiments/research:
■	Externally introduced: recent (<10 years)
	Other's (specify):

Level of technical knowledge

■	Low: field staff/agricultural advisor, land user
	Medium:
	High:

Main causes of land degradation:

- agricultural causes (poor land-use practice)
- overgrazing

Main technical functions:

- improvement of ground cover
- sediment harvesting

Secondary technical functions:

- reduction of slope angle

Environment

Natural Environment

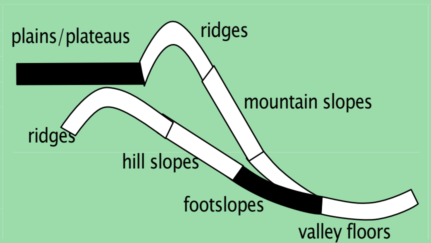
Average annual rainfall (mm)

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

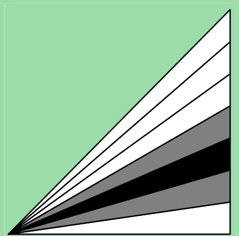
Altitude (m a.s.l.)

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

Landform



Slope (%)



Soil depth (cm)

■	0-20
	20-50
	50-80
■	80-120
	<120

Growing season(s): 150 days (October to February)

Soil texture: Coarse (sandy): most common; medium (loam): most common

Soil fertility: Medium: most common; Low: most common

Topsoil organic matter: Medium (1-3%): most common; low (1%): most common

Soil drainage/infiltration: Good: most common

Human environment

(*Type of) land per household (ha)

	<0.5
	0.5-1
	1-2
	2-5
	5-15
	15-50
	50-100
	100-500
	500-1000
	1000-10000
	>10000

Land ownership: Communal/village: most common

Importance of off-farm income: 10 - 50% of all income. Working people are in towns, people who are living in the rural areas are children, women, and old people.

Access to service and infrastructure: Communal (organised): most common

Market orientation: Grazing land: mainly mixed (subsistence/commercial), mainly commercial

Implementation activities, inputs and costs

Establishment activities

1. Vegetative measures
   - dig a hole
   - plant the seedling
   - watering
2. Structural measures
   - collecting stones
   - for concrete structures, fix it on the side (dig in)
3. Management measures
   - fencing area off
   - reintroduction of game (Government paid for this)

Establishment inputs and costs per ha

Inputs	Costs (US$ or local currency)	% met by land user
Labour (1200 person days)	3100	%
Equipment		
-		%
Materials		
- fencing	210	%
Agricultural		
- tree seedlings	625	%
- machine hours	210	%
TOTAL	**4145**	**100%**

Maintenance/recurrent activities

1. Vegetative measure
   - watering
2. Structural measure
   - bring loose stones back after very heavy storms

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$ or local currency)	% met by land user
Labour (__person days)		%
Equipment		
-		%
Materials		
-		%
Agricultural		
-		%
TOTAL	**2500**	**100%**

Remarks: Duration of establishment phase: 36 months

Assessment

Impacts of the Technology

Production and socio-economic benefits

+	+	+	Thatch grass
+	+	+	Increased farm income
+	+	+	Increased wood production
+	+	+	Fodder production/quality increase

Production and socio-economic disadvantages

-	-		Loss of land (decreased production area)

Socio-cultural benefits

+	+	+	National institution strengthening
+	+	+	Community institution strengthening

Socio-cultural disadvantages

Ecological benefits

+	+	+	Biodiversity enhancement
+	+	+	Reduced soil loss
+	+	+	Increased soil moisture
+	+	+	Improved soil cover
+	+		Improved excess water drainage

Ecological disadvantages

Off-site benefits

+			Reduced groundwater / river pollution
+			Reduced downstream siltation

Off-site disadvantages

Contribution to human well-being/livelihoods

Benefits/costs according to land user

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

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Reduce siltation for whole catchment (dam built in 1965 silted up → in ±20 years!	High cost for fencing etc.
For recovery of vegetation and made wasteland available again for grazing	Soil conservation project – temporary loss of land
Retain water for aquifer and household uses	
Nature Reserves: Increase in biodiversity and income for community	
Nature Reserves a possible income source	

left and right: Soil and water conservation measures needed to control soil erosion and to reduce siltation riverbed

Interactive Community Approach, Biodiversity Increase

Limpopo Province, South Africa

Location: Limpopo Province
Approach area: 0 km^2
Type of Approach: project/programme based
WOCAT database reference: QA RSA31
Related technology (ies): Gully control (gabions) at Maandagshoek
Compiled by: Igmé W. Terblanche, Action Green Heritage (NGO), South Africa
Date: 10/04/1999

Community involvement.

Aim / objectives: Community involvement in SWC and environmental conservation. SWC project for erosion control, reduction of siltation, water conservation, biodiversity increase, and environmental education. An interactive method in some cases combined the approach of the Department or Action Green Heritage, who worked through the tribal chief (traditional authority), the relevant government representatives (extension), and the Transitional Local Council (TLC - Government elected body, e.g. municipality). The SWC projects are still in the on-going phase, having passed the implementation stage. The Nature Reserves are also ongoing (the development phase has been finalised). The SWC programmes of NGO and government extension officer, environmental education officer and community are interlinked with the NGO for funding. The Government provides technical background and the TLC ensures broad involvement.

Problem, objectives and constraints

Problems

Erosion project: land degradation, siltation of dams/rivers. Nature Reserves: land degradation, poverty, awareness (lack of environmental knowledge).

Aims/Objectives

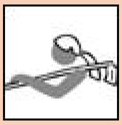
Raising awareness, reduce silt soil loss. Nature Reserves: financial gain for the community, protection of natural resources and increase biodiversity, awareness raising. Erosion projects: reduce siltation and soil loss and raising awareness. Natural Resources: Financial gain, protection of Natural Resources, an increase in biodiversity and raising awareness. To get community involvement in environmental issues.

Constraints addressed

Major	Constraint	Treatment
Financial	Not enough funding	Keep on looking for funding & generate a bigger awareness of the problem & what could be done, also outside of government like Olifant River Forum (some people are there involved with a lot of funding behind them)
Minor	**Constraint**	**Treatment**
Other	Develop a project across a tribal border	Environmental education
Social / cultural / religious	High population density - shortage of land - not always so easy to get land for building up nature reserve	Financial benefit

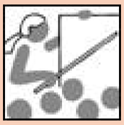
Participation and decision making

Stakeholders / target groups


land user/ individual


land users/ groups


politicians/ decision makers


teachers/ school children/ students

Approach costs met by:	
Government	80%
International non-government	20%
TOTAL	100%

Annual budget for SLM component: US$100,000-1,000,000

Decisions on choice of the Technology (ies): mainly by SLM specialists with consultation of land users
Decisions on method of implementing the Technology (ies): mainly by SLM specialists with consultation of land users
Approach designed by: national specialists
Implementing bodies: government, international non-government, local community / land users

Land user involvement

Phase	Involvement	Activities
Initiation/motiviation	Passive	Public meetings; Rapid/participatory rural appraisal is used today
Planning	Passive	Rapid/participatory rural appraisal, public meetings
Implementation	None	
Monitoring/evaluation	Passive	Public meetings, reporting
Research	None	

Differences between participation of men and women: Yes, great. In tribal meetings mainly men, for work mainly women
Involvement of disadvantaged groups: Yes, great. Chief will not take any decision before the community agreed

Technical support

Training / awareness raising:
Training was on-the-job
Training focused on On the site for work, fencing, gabions, planting of trees
Advisory service:
Name: LEP
Key elements:
1. NGO was responsible for education for the people of Lebowa
1) Advisory service was carried out through: non-governmental agency 2) Advisory service was carried out through: non-governmental agency; Extension staff: Government & NGO 3) Target groups for extension: land users, politicians/decision makers; Activities
The extension system is quite adequate to ensure continuation of activities. They have the staff.
Research: No research.

External material support / subsidies

Labour: Paid in cash
Inputs: - Equipment (machinery, tools, etc) - machinery, hand tools. Fully financed
Credit: Credit was not available.
Support to local institutions: Yes, great support with financial, training, equipment

Monitoring and evaluation

Changes as result of monitoring and evaluation: There were few changes in the approach. Involvement of the community in the project from the beginning to a great extent. Reduction of animal numbers.

Impacts of the Approach

Improved sustainable land management: Yes, moderate
Adoption by other land users / projects: Yes, some; Personnel, some was transferred to other Departments and localities
Land/water use rights: Help - moderately in the implementation of the approach. Communal land if supported from tribal chief hinder: moderate: communal land if no ownership, a lot of people.
Long-term impact of subsidies: Positive long-term impact - Greatly The government had given game to the new Nature Reserves.

Concluding statements

Sustainability of activities:
It is uncertain whether the land users will be able to sustain the approach activities.

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Involvement of community	Smaller reserves are overstaffed and poor management → transfer to the community and then employ a manager from outside (may be a solution).
Ownership of the land	Nature reserves are still regarded as government Nature Reserves (financial and run). Only if community is to some extent involved in the management, people take ownership.
Little damage & high potential	Would like to have more influence in the management
Get financial benefits - uplifting living-standard	
Sustainable jobs, protection	
If transferred to community - can be financed from outside e.g. Development Bank, this is only possible if fully transferred to the community	
Financial	
Job opportunities	
Are part of the management	

left: Gully after 3 years, silting up

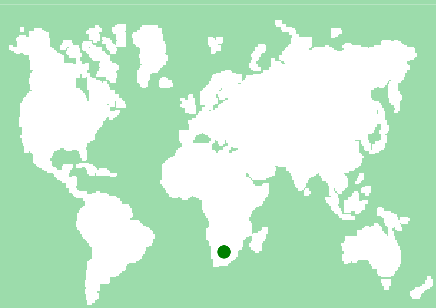
right: Stopping a gully head with tyres, local people, mainly women

Gravity Type Inverted Tyre Structure

North West Province, South Africa

Stabilising of gully erosion by means of gravity type inverted tyre structures filled with stone.

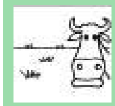
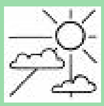
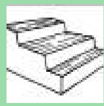
A gravity type inverted tyre structure is bound together with wire and filled with stone. The valley floor gully head drop is protected to prevent further erosion. Survey planning and design are important for the construction of the structure. Maintenance includes prevention of leakage alongside the structure. The walls to prevent the erosion of soil are filled in. Ensure that the top layer stones are not washed away. The structure is situated in a semi-arid area which is highly degraded through overgrazing. Due to the location of the structure, further erosion was stopped that would have endangered some of the homesteads.



Location: Marico District
Technology area: 12 km²
Conservation measure(s): structural measure
Land use type: Grazing land: extensive grazing
Stage of intervention: mitigation / reduction of land degradation
Origin: externally introduced through project, recently (< 10 years ago)
Climate: semi-arid
WOCAT database reference: QT RSA14
Related approach: Community driven protection of the Molatedi Dam Catchment area
Compiled by: Boeta P. du Toit and C.H. Meiring, Marico Bushveld Soil Conservation Committee, South Africa
Date: updated 12/12/2003 by Rinda van der Merwe

Classification

Land use problems: Lack of land use planning. Overgrazing. Overpopulation. In land users' view: Lack of grazing land, frequent occurrence of droughts.

Land use	Climate	Degradation	Conservation measure(s)
			
grazing land: extensive grazing	semi-arid	erosion by water: gully erosion / gullying	structural

Stage of intervention

□	Prevention
■	Mitigation/reduction
□	Rehabilitation

Origin

□	Land user's initiative:
□	Experiments/research:
■	Externally introduced: recent (<10 years)
□	Other's (specify):

Level of technical knowledge

□	Low:
■	Medium:
■	High: Field staff/agricultural advisor

Main causes of land degradation: Overgrazing (Cattle and goats)

Main technical functions: ·

- control of concentrated runoff (impede/retard)

Environment

Natural Environment

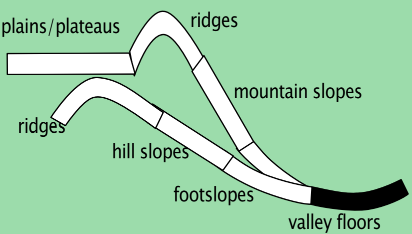
Average annual rainfall (mm)

□	>4000
□	3000-4000
□	2000-3000
□	1500-2000
□	1000-1500
□	750-1000
■	500-750
□	250-500
□	<250

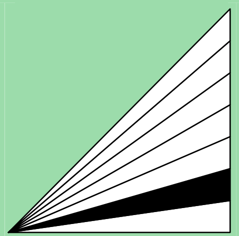
Altitude (m a.s.l.)

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

Landform



Slope (%)



Soil depth (cm)

□	0-20
□	20-50
□	50-80
□	80-120
■	<120

Growing season(s): 240 days (September to April)

Soil texture: Medium (loam): most common

Soil fertility: High: most common

Topsoil organic matter: Low (<1%): most common

Soil drainage/infiltration: Medium: most common

Soil water storage capacity: Medium

Human environment

(*Type of) land per household (ha)

□	<0.5
□	0.5-1
□	1-2
□	2-5
□	5-15
□	15-50
□	50-100
□	100-500
□	500-1000
□	1000-10000
□	>10000

Land ownership: Communal/village: most common

Importance of off-farm income: > 50% of all income. State pensions - head of family works elsewhere

Access to service and infrastructure: Open access (unorganised)

Implementation activities, inputs and costs

Establishment activities

Establishment inputs and costs per ha

Inputs	Costs (US$ or local currency)	% met by land user
Labour (110 person days)	9400	%
Equipment		
- tyre averting toll machine	100	%
- tools (50)	600	%
Materials		
- fully galvanised ironposts (30)	50	%
- wire 2 mm (6x 50 kg rolls)	330	%
- geotextile membrane	2000	%
- earth (200 qm)		%
- stone (200 qm)		%
Agricultural		
-		%
TOTAL	**12480**	**100%**

Assessment

Impacts of the Technology

Production and socio-economic benefits

+ + + Job creation

Production and socio-economic disadvantages

Socio-cultural benefits

+ + Improved conservation / erosion knowledge

+ + Community institution strengthening

Socio-cultural disadvantages

Ecological benefits

+ + + Reduced soil loss

Ecological disadvantages

Off-site benefits

+ + + Increase spending on consumer goods in shops in area

+ + + Reduced downstream siltation

+ + + Reduced downstream flooding

Off-site disadvantages

Contribution to human well-being/livelihoods

Benefits/costs according to land user

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

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Low cost material	Costly if manual labour is unproductive → Maintain high productivity. Train workers, work smart, contract work
Labour intensive → can be utilised without machinery	Transport cost of tyres is a big factor. → Utilise tyres from nearby areas. Utilises big transport trucks with big loading capacity.
Mostly unskilled labour can be used	Need machine to invert tyres → Tool well and practically constructed - operators trained.
Labour intensive, job creation	Must technically be well planned and constructed. → Use skilled technician for planning and to assist workers during construction.
Received training	Stormwater walls are in the way of motor vehicles, traveling in the village → Plan roads properly - construct alternative road around wall

left and right: Measures need to be implemented to prevent topsoil losses through erosion

Community-driven Protection of the Molatedi Dam Catchment Area

North West Province, South Africa

Development and Capacity building in participating communities through the implementation of measures to prevent topsoil losses through erosion in the Molatedi dam catchment area.

Aim / objectives: Initiated by Welkom Farmers' Association through the Marico corridor sub-regional soil conservation committee. The aims were: 1) development and capacity building in participating communities and 2) implementation of measures to prevent topsoil losses through erosion in the Molatedi Dam catchment area.

Location: North West Province
Approach area: 5 000 km^2
Type of Approach: project/programme based
Focus: mainly on conservation with other activities
WOCAT database reference: AQ RSA14
Related technology (ies): Gravity type inverted tyre structure
Compiled by: Boeta P. du Toit, Marico Bushveld Soil Conservation Committee, South Africa
Date: 18/05/1999

Problem, objectives and constraints

Problems

Unemployment. Lack of training. Erosion - loss of topsoil. Rehabilitation of natural resources.

Aims/Objectives

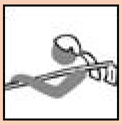
Help the community, work together.

Constraints addressed

Major	Constraint	Treatment
Financial	Grant from DBSA. Contribution by participating farmers associations	Farmers associations
Technical		Soil conservation technician and soil conservation committee support
Minor	**Constraint**	**Treatment**
Other	Knowledge	Training

Participation and decision making

Stakeholders / target groups



land user/ individual

land users/ groups

Approach costs met by:

Government	60%
Local community / land user(s)	40%
TOTAL	100%

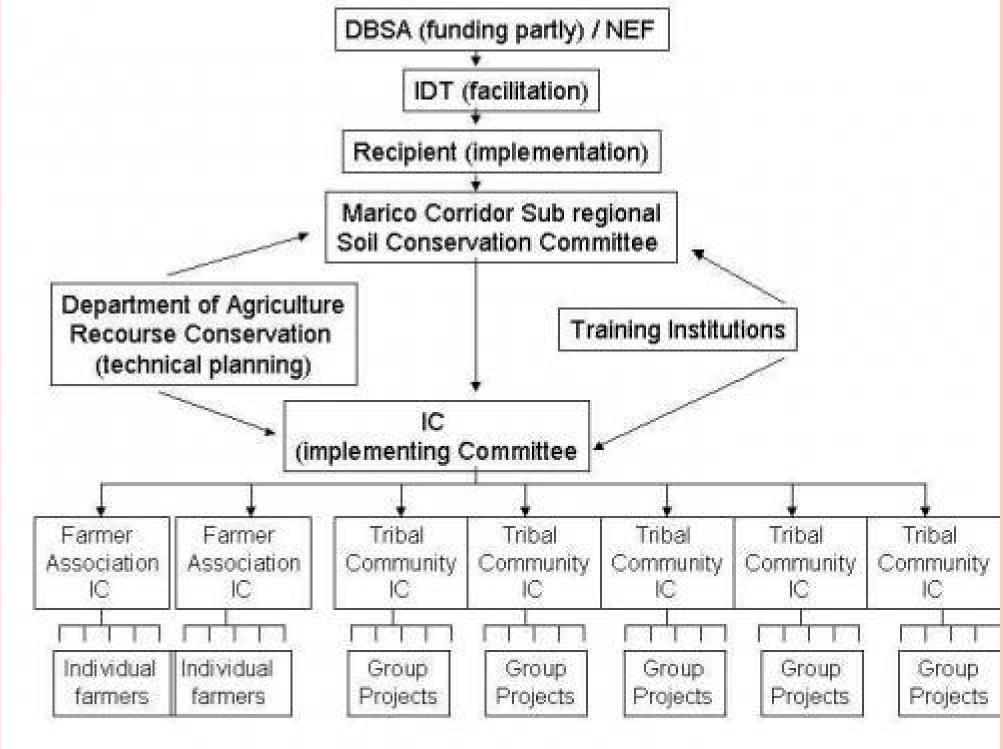
Annual budget for SLM component: US$ 100.000-1,000,000

Decisions on choice of the Technology (ies): mainly by land users supported by SLM specialists
Decisions on method of implementing the Technology (ies): mainly by SLM specialists with consultation of land users
Approach designed by: national specialists, land users
Implementing bodies: government, local government (district, county, municipality, village etc), other

Land user involvement

Phase	Involvement	Activities
Initiation/motiviation	Interactive	Public meetings; Monthly - special meetings as need aro
Planning	Interactive	Public meetings; Monthly - special meetings as need arose
Implementation	Interactive	Mainly: responsibility for major steps; partly: responsibility for minor steps; Monthly - special meetings as need arose
Monitoring/evaluation	None	
Research	None	

Differences between participation of men and women: No
Involvement of disadvantaged groups: Yes, great
Every community involved in project through their participation in the implementing committee.



Organogram

Technical support

Training / awareness raising:

Training provided for land user
Training was on-the-job, site visits / farmer to farmer, demonstration areas, courses
Training focused on Description of training component

Research:

Yes, little research. Topics covered include technology
Mostly on-farm research.
Observation with everted tyre structure

External material support / subsidies

Labour: Paid in cash
Inputs: - Equipment (machinery, tools, etc) - machinery, hand tools, training. Fully financed
Credit: Credit was not available.
Support to local institutions: Yes, great support with training

Monitoring and evaluation

Changes as result of monitoring and evaluation:
There were few changes in the approach. Project period was only 6 months. Very strict procedures had to be followed in all events, e.g. wage sheets - full particulars of workers. External audit concerning finances.

Impacts of the Approach

Improved sustainable land management: Yes, moderate; Lessons learnt from this project can be adapted and be implemented in new projects.
Adoption by other land users / projects: No
Training, advisory service and research:

- Training effectiveness

Land users* - good

Land/water use rights:

Help - greatly in the implementation of the approach. Hinder: great Private ownership helps implementation. Communal land - hindrance because no individual accepts responsibility.
The approach did not at all reduce the land/water use rights problem.

Long-term impact of subsidies:

Positive long-term impact - Greatly
Negative long-term impact - Greatly
People expect more paid job creation. The land is now in better condition.

Concluding statements

Sustainability of activities: No the land users can't sustain the approach activities. No funding available.

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Project initiated by land users (bottom-up approach) Necessary support from institutions (financial, technical - provide research, information, training etc.)	The budget was unbalanced and not drawn up with all stakeholders involved Involve specialists and all the role players in the project
Equal rights and participation for all participants Ensure equal representing on a joint implementing committee	Payment of daily wages as opposed to paying for task executed well. Develop contractors that is paid according to work done and productivity.
Adequate technical assistance Ensure that capable technicians are involved with planning and execution of project	The budget was inadequate for material needed for conservation works Draw up a budget with SWC specialists input to ensure funds for conservation works
Adequate financial assistance Budget to be draw-up by all specialists and land users	The facilitator was not capable to do facilitation Use well trained proven facilitator acceptable to participation communities
Job creation Project planning must be done carefully and job creation planned according to sustainability	Project was not long enough
Improvement of natural resources Plan additional new projects	

TERRACES

Terraces are man-made structures to reduce erosion by controlling and managing surface run-off. In certain parts of the world, in extremely steep areas, the construction of terraces are used to increase the area of arable agricultural land, to control run-off in a scientific way and in the process to harvest water for successful crop production. A terrace is a channel with a supporting down-slope ridge constructed across the slope. Terraces break up long slopes into a series of short ones, each terrace collecting excess water from the one above it. The water that does not infiltrate into the soil is then removed from the terrace safely.

Terraces are the most expensive conservation practice. However, they allow for more intensive row cropping while keeping erosion in check. Terraces make more economic sense when combined with other conservation practices such as contouring, strip cropping, and or conservation tillage.

Steepness of slope, soil type (depth, erodibility, etc.), crop type, management and rainfall, all determine terrace spacing. Where more than one terrace is planned, care must be taken to ensure the ridges are parallel. Conservation tillage and contouring are necessary to maintain terrace systems.

There are a number of different terrace designs:

- **Broad base**

The entire terrace is farmed and is restricted to field slopes under 8%. Care must be taken not to work down the ridges during field operations. Costs are twice that of narrow base terraces.

- **Backslope**

Suited to steeper land, the backslope is usually seeded to permanent vegetation.

- **Narrow base**

Both front and back slopes are steep and seeded to permanent vegetation. This is the most expensive structures to build. It also requires the most attention to ensure successful implementation.

- **Water and sediment control basin**

These structures are built across drainage ways and work like small dams. They intercept concentrated run-off temporarily and release it through drain. Relatively inexpensive to install, these terraces will complement a conservation management system on land with irregular and non-uniform slopes.

- **Diversion terrace**

A diversion is a channel with a supporting ridge on the lower side, constructed across the slope to intercept surface run-off, carrying it safely to an outlet.

Diversions will carry substantial amounts of water and should be permanently vegetated.

- **Grass waterways**

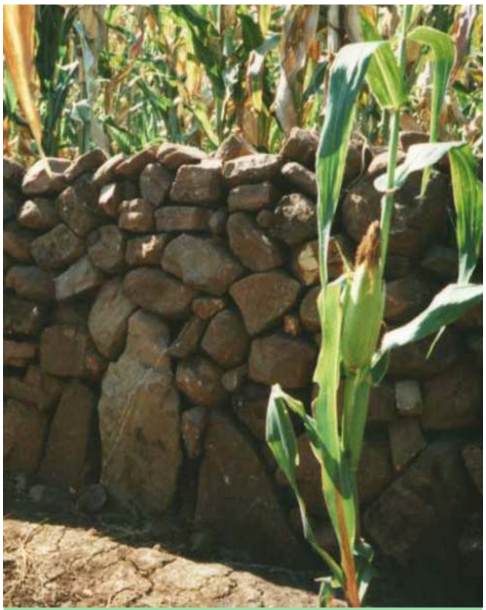
Grass waterways are broad, shallow channels protected against erosion by grass cover. They serve as outlets for terraces, diversions, contour rows or as passageways for surface flows entering the farm from other land. The waterway must be well-drained to encourage vigorous grass growth and to protect the waterway from rutting when farm machinery crosses it.

- **Stone terrace walls**

Stone terrace walls are built when clearing new land of stone to bring it into cultivation. These walls are added to each year from further loose stone which is uncovered. The dimensions of the walls and the spacing between depend on various factors including the amount of stone in the field.

- **Natural terracetts**

Terracettes occur in the high-lying and steep areas in the Drakensberg. These are not man-made but occur naturally and are the result of the influence of gelifluction (a combination of frost creep and solifluction). Terracettes appear to move as a result of frost creep, processes associated with needle ice, and slope wash.



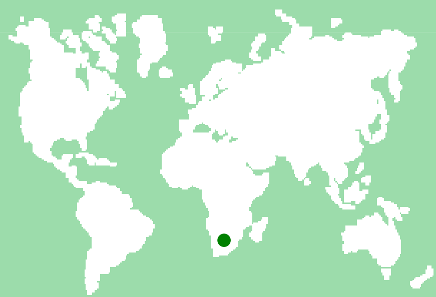
left and right: Rehabilitation of badlands - but at what cost?

Traditional Stone Terrace Walls

Limpopo Province, South Africa

Stone terrace walls (or bunds) on sloping along the (approximate) contour.

Stone terrace walls are built when clearing new land of stone to bring it into cultivation. These walls are added to each year from further loose stone which is uncovered. The dimensions of the walls and the spacing between depend on various factors including the amount of stone in the field. The walls may be up to 1.25 m high, about 1.5 m maximum base width and from 20 to 50 m in length. Spacing is from 3 - 10 m apart and depends on the slope of the land: stone terracing is generally confined to slopes between 12° and 26°. Between 7° and 12° contour grass strips are generally used: below 7° land is not terraced. Design varies. Some terrace walls are very neatly built; others are merely piles of stone across the slope. The purpose, apart from clearing the land, is to guard against erosion and help keep soil fertility in place, on sloping cropland in a sub-humid area, where rainfall is around 1 000 mm per annum. Maize is the most common crop, but various other annuals and perennials are also grown.



Location: Thononda Ward (Thohoyandou district)
Technology area: 8 km²
Conservation measure(s): structural measure
Land use type: Cropland: annual cropping Cropland: tree and shrub cropping
Stage of intervention: prevention of land degradation
Origin: through land user's initiative (innovation, traditional), traditional (> 50 years ago)
Climate: subhumid
WOCAT database reference: QT RSA03
Related approach: Traditional (institutionalised in community)
Compiled by: William Critchley, Centre for International Cooperation, Netherlands
Date: 16/08/1997, updated 01/04/2004 by Will Critchley

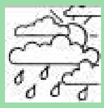
Classification

Land use

cropland: annual cropping

cropland: tree and shrub cropping

Climate

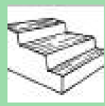


subhumid

Degradation

erosion by water:loss of topsoil by water

Conservation measure(s)



structural

Stage of intervention
- Prevention
- Mitigation/reduction
- Rehabilitation

Origin
- Land user’s initiative: traditional
- Experiments/research:
- Externally introduced:
- Other’s (specify):

Level of technical knowledge
- Low:
- Medium: land user
- High:

Main causes of land degradation: Natural causes (Slope/rainfall)

Main technical functions: ·
- Control of dispersed runoff (impede/retard)

Secondary technical functions: ·
- Reduction of slope length
- Reduction of slope angle

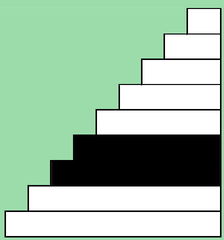
Environment

Natural Environment

Average annual rainfall (mm)

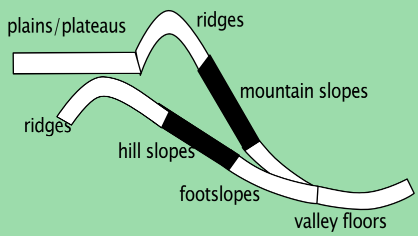
>4000
3000-4000
2000-3000
1500-2000
1000-1500
750-1000
500-750
250-500
<250

Altitude (m a.s.l.)

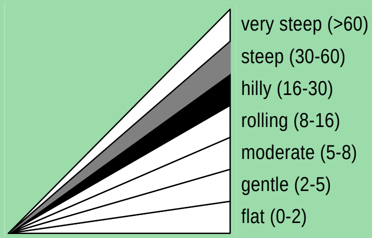


>4000
3000-4000
2500-3000
2000-2500
1500-2000
1000-1500
500-1000
100-500
<100

Landform



Slope (%)



Soil depth (cm)

0-20
20-50
50-80
80-120
<120

Growing season(s): 150 days (November to March)

Soil texture: Medium (loam): Most common

Soil fertility: Medium: Most common

Topsoil organic matter: Medium(1-3%): Most common

Soil drainage/infiltration: Good: Most common

Soil water storage capacity: Medium to high

Human environment

Cropland land per household (ha)

<0.5
0.5-1
1-2
2-5
5-15
15-50
50-100
100-500
500-1000
1000-10000
>10000

Land ownership: Individual, not titled: Most common

Access to service and infrastructure: Open access (unorganised): Most common; Individual: Common

Market orientation: Cropland: partly subsistence, mainly mixed (Subsistence/Commercial)

Implementation activities, inputs and costs

Establishment activities

1. Structural measure
2. Initial construction of terrace walls (NB no surveying done)

Establishment inputs and costs per ha

Inputs	Costs (US$ or local currency)	% met by land user
Labour (375 person days)	1200	100%
Equipment		
- pickaxes/crowbars/tools	20	100%
Materials		
- stones (qm)	0	%
Agricultural		
-		%
TOTAL	**1220**	**100%**

Maintenance/recurrent activities

1. Structural measure
2. Building the walls higher

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$ or local currency)	% met by land user
Labour (50 person days)	160	100%
Equipment		
- pickaxes		%
Materials		
- stones (qm)	0	%
Agricultural		
-		%
TOTAL	**160**	**100%**

Assessment

Impacts of the Technology

Production and socio-economic benefits

++	Increased farm income
++	Increased crop yield

Production and socio-economic disadvantages

-	Increased labour constraints

Socio-cultural benefits

++	Improved conservation / erosion knowledge

Socio-cultural disadvantages

Ecological benefits

+++	Reduced soil loss
++	Increase in soil fertility
++	Increased soil moisture

Ecological disadvantages

Off-site benefits

+	Reduced groundwater / river pollution
+	Reduced downstream siltation

Off-site disadvantages

Contribution to human well-being/livelihoods

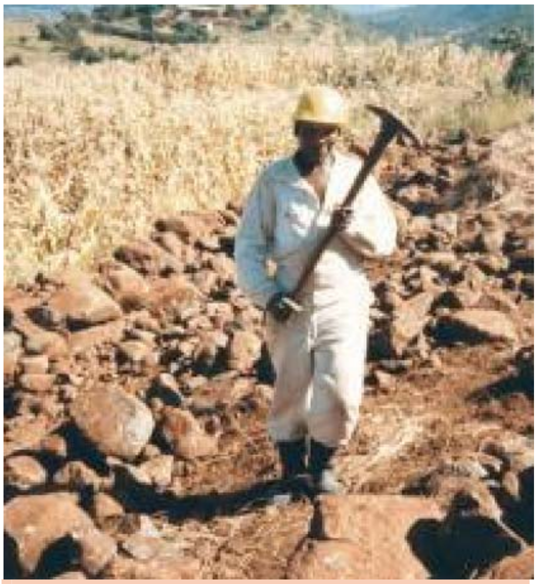
Benefits/costs according to land user

Benefits compared with costs	short-term:	long-term:
Establishment	very negative	positive

Maintenance/recurrent	slightly postive	slightly positive

Concluding statements

Strengths and → how to sustain/improve	**Weaknesses and → how to overcome**
Traditional and importantly living tradition → Encourage/acknowledge and use as training sites for others!	Labour/construction cost → Supply of limiting tools (pickaxes, crowbars) if introduced to other areas
Stone: low maintenance and not so sensitive to precise layout	Labour cost
Technical benefit	Land lost (but equally gained by removal of surface stone)
Maintains soil and soil fertility	
Stops crops being washed away	
Reduces spread of weed species	
Maintains ploughability	



left and right: A retired miner, Elias, expanding his field and making new terrace walls as he proceeds: at this stage the stones are loosely arranged before construction of the walls takes place.

Community Tradition

Limpopo Province, South Africa

Inherited, and still practised, tradition of stone terracing - passed down from generation to generation.

Aim / objectives: The VhaVenda people of Limpopo Province in South Africa have a tradition of building with stone which has been passed down from generation to generation. They construct stone walls around their houses, for example, taking a pride in the appearance of their homesteads. There is a historical monument nearby, the stone-built kraal at Dzata, the ruins of which are situated within a few kilometres of the study location. There may even be some evidence that the VhaVenda came originally from the area of the Great Zimbabwe (the famous stone-built fortress in Zimbabwe). It is not surprising therefore that the VhaVenda have used their masonry skills to build terraces in fields to counter erosion and simultaneously to make cultivation - along the contour by oxen - possible. This tradition has been passed down through the ages: it is institutionalised in the community and is practised together by men, women and children on a family basis. It is encouraged by community leaders: a particular example of this was in the 1960s when local chiefs were concerned at the sacred Lake Fundudzi 'turning red' - with sediment eroded from the land - and as a result they launched a conservation campaign to prevent soil wash into the lake. There has been modest and occasional support by the Department of Agriculture, in the form of *ad hoc* drought relief funds. There is quite a range of technical ability/care taken in terracing. Some walls are meticulously built; others are merely piles of stones across the slope. One of the reasons for this is that work tends to be done on an individual basis. Another result is that fields may take two years or more to be fully terraced. What is evident is that the land users - as well as being experienced masons - appreciate the benefits of the terraces they construct. An investigation of local environmental knowledge and conservation practices has demonstrated this clearly (see reference).

Methods: The causes of erosion were explained by the interviewees as being part natural (rainfall, slope etc) and part anthropogenic (poor road building, up and down ploughing, burning of grassland etc). The main negative impact of erosion was considered to be loss of soil fertility: hence terracing for protection. This indigenous knowledge also extends to soils: eight local soil types and their differences in terms of texture, fertility and erodibility are recognised in the study area.

Location: Limpopo Province
Approach area: 8 km^2
Type of Approach: Traditional/Indigenous
WOCAT database reference: QA RSA03
Related technology (ies): Traditional stone walls
Compiled by: William Critchley, Centre for International Cooperation, Netherlands
Date: 01/05/1997

Problem, objectives and constraints

Problems

The tradition presumably arose as a spontaneous local response to degradation: it remains well entrenched - underlying problems of no flat land to cultivate, soil erosion/fertility decline on sloping fields, and loose stones and rocks impeding animal-drawn ploughs.

Aims/Objectives

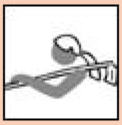
The objective of the local people is simply to continue making cultivation possible and sustainable, through the local tradition of using stone walls to create terraces and to remove abundant stones from the field.

Constraints addressed

Major	Constraint	Treatment
Other	Labour: High labour demand to remove stones from inhibiting cultivation	Traditional teaching that such stones can be used constructively to improve conservation and yield benefits.

Participation and decision making

Stakeholders / target groups



Land user, individual

Approach costs met by:

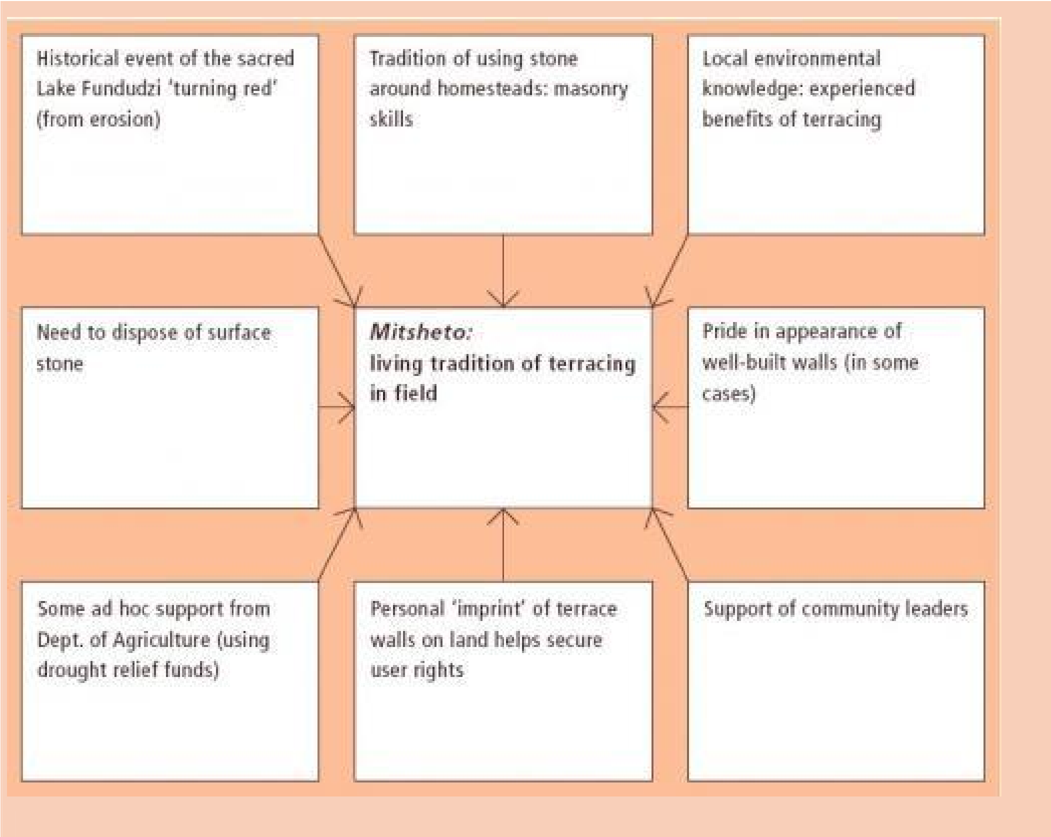
Government	5%
Local community/land user(s)	95%
TOTAL	100%

Decisions on choice of the Technology (ies): by land users* alone (self-initiative / bottom-up)
Decisions on method of implementing the Technology (ies): by land users* alone (self-initiative / bottom-up)
Approach designed by: land users

Land user involvement

Phase	Involvement	Activities
Initiation/motiviation	Self-mobilisation	passing on knowledge; passing on of knowledge from generation to generation
Planning	Self-mobilisation	
Implementation	Self-mobilisation	family-based (or individual) construction
Monitoring/evaluation	None	
Research	None	

Differences between participation of men and women: No
Involvement of disadvantaged groups: No



Organogram: Enabling environment: Factors supporting the terracing tradition

Technical support

Training / awareness raising: No
Advisory service:
Key elements:
Some encouragement from Department of Agriculture especially during soil and water conservation campaigns/drought relief periods.
Research: No research

External material support / subsidies

Labour: Voluntary. Almost entirely voluntary: some small support (approx 5% of the sample monitored) through Government during times of food scarcity with paid relief work.
Credit: Credit was not available
Support to local institutions: Yes, little support with support for SWC campaigns from local leaders.

Monitoring and evaluation

Changes as result of monitoring and evaluation: There were no changes in the approach.

Impacts of the Approach

Improved sustainable land management: the fact that the stone lines are on the contour, making this type of ploughing easier.
Adoption by other land users / projects: No; only within this small pocket of Thohoyandou District (as far as is known).
Long-term impact of subsidies: There are no negative impacts as virtually no incentives have been used here.

Concluding statements

Sustainability of activities: Yes the land users can sustain the approach activities.

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Traditional approaches have the potential to endure Acknowledgement and encouragement by the Government and/or NGOs will help this.	This tradition was largely unrecognised until recently: therefore an opportunity was lost to encourage people and help the approach spread. Publicise widely and carry out farmer-to-farmer/community-to-community visits to further its spread and the spread of local SWC knowledge more generally.

RAIN WATER HARVESTING

South Africa will be a water scarce country by 2025. In order to maintain agricultural production and sustainable livelihoods, water available for agriculture must be used more productively. Urgent innovative and pro-active actions need to be taken to increase water use efficiency (WUE) by the agricultural sector. The basic principle to achieve WUE for crop production is to maximize the gains and minimize the losses of water in the field soil water balance. Under semi-arid climatic conditions the two largest losses of water are through runoff (8-32% of annual rainfall) and evaporation from the soil surface (60-75% of annual rainfall). Both these losses can be reduced and soil water storage increased with rainwater harvesting and water conservation practices. A universal definition of rain water harvesting is: "*The collection of runoff (from a catchment area) and storing it (in a target area) for beneficial use*" (Oweis *et al*., 1999). The catchment area, which can vary in size from only a few square metres to as large as several square kilometres and can be agricultural land (in-field), rocky or marginal land (ex-field), as well as rooftops or road surfaces (non-field). Storage facilities can be in the form of surface reservoirs, subsurface reservoirs, the soil profile, and groundwater aquifers. In agricultural production the target is the plant or animal, while in domestic use the human or the enterprise is the target.

Several techniques are used for **in-field** rain water harvesting such as contour ridging, tied ridging along contours, tied furrows, strip catchment tillage, run-off strips, conservation bench terraces, contour bench terraces, bunds, semi-circular basins (demi-lunes) and pitting (zay/zai) (Munyuli, 2003). A unique in-field rainwater harvesting (IRWH) technique was introduced in South Africa by Hensley *et al*. (2000). By combining the advantages of water harvesting, no-till, basin tillage and mulching on high drought-risk duplex and clay soils, this technique has proved to considerably reduce runoff and evaporation, leading to high soil water storage and, consequently, improved crop growth and yield. According to Botha *et al*. (2003) the IRWH technique. has been implemented with great success by smallholder farmers on marginal duplex and clay soils in the Free State Province of South Africa, where it has proved to: (1) be agronomically sustainable (higher crop yields), (2) reduce the risk of crop failures, (3) conserve the natural resources (no soil erosion), and (4) be economically viable and socially acceptable. Botha *et al*. (2003) claim that the IRWH technique is a tool to empower people to fight food insecurity and poverty.

Basin tillage has been shown to be a very effective technique of water conservation on high-clay soils. Several implements have been developed in South Africa to mechanize this technique for large scale implementation. Some of these basin techniques incorporate run-off (Anderson *et al*., 2009), while others collect and store rain water *in situ* (Van der Merwe & Beukes, 2006).

- **Ex-field** rain water harvesting is characterized by having runoff water collected from a relatively large catchment, which is often natural rangeland, or mountainous areas. Various ratios of catchment to crop land area are used, depending on rainfall amount and intensity, slope and the water storage capacity of the reservoirs. Water is stored in surface or subsurface reservoirs and can also be stored in the soil profile for direct use by crops. Various designs are used, for example, *wadi*-bed, off-*wadi* and *jessour* systems, large semi-circular, trapezoidal or open V-shaped earthen bunds, and hillside-runoff systems. The latter system is ideal for using runoff from bare or sparsely vegetated hilly or mountainous areas. The hillside conduits that direct runoff require proper design, high labour input, and engineering assistance. A disadvantage of ex-field rain water harvesting is that the catchments are usually situated outside the farm boundary where the farmer has little control over them. An important issue associated with these systems are water rights affecting the distribution between the catchment and the cultivated land areas and to the various users in the upstream and downstream areas of the watershed. All the stakeholders must be involved when planning interventions using integrated watershed development approaches (Oweis *et al*., 2001).

- **Non-field** rain water harvesting implies the collection and storing of rainwater from the roofs of houses and buildings, as well as from other impermeable surfaces such as roads. Most of the rain collected in this way is stored in above- or below-ground tanks. The use of this stored water will depends on the surface it was obtained from. Modern roofing materials and gutters can produce clean water for human consumption and other domestic uses. Runoff after the first rain is usually not stored and a settling basin is used before storage where the collection area contains soil and plant debris. Water not suitable for drinking purposes may be used to support home gardens (Oweis *et al*., 2001).

The contribution of highway drainage to soil erosion has long been recognized. By tradition the highway should drain to natural creeks or gullies where possible, but otherwise should discharge down slopes, along prepared drains which are long enough to protect the road from erosion damage. Some of the worst soil erosion to be seen in Africa starts from new highways built with modern equipment. The funds should be sufficient to improve the drainage channels to take the increased flows without severe soil damage. Pollution from oil residues and heavy metals (such as lead from petrol and cadmium from tyres) can be a problem when using this water, although tests have shown that pollutants do not move far, and are effectively trapped by the reed beds which have been constructed for the purpose (Smith *et al.*, 2008).

The choice of a water harvesting technique for croplands should integrate socio-economic principles with environmental concerns. Consideration must also be given to the social and cultural aspects prevailing in the area of concern as they are paramount and will affect the success or failure of the technique implemented. This is important in the arid and semi-arid regions of Africa as these communities exhibit strong cultural traditions. The lack of this consideration may help to explain the failure of so many projects (Smith *et al.*, 2008).

An estimated 66% of the rangelands of South Africa is in a moderate to serious phase of degradation according to rangeland scientists, while the continent of Africa has the biggest area of land degraded by overgrazing, contributing 36% of the world total. A major contributing factor for this degradation is the ignorance of a simple management principle namely that the way in which rangeland is rested is more important than the way in which it is utilized. Apart from vegetation structure and composition, the quantity and rate of energy flow through the rangeland ecosystem are limited by certain environmental factors, such as water and nitrogen, especially in the arid and semi-arid areas. Therefore, one of the most important requirements of sustainable rangeland production in arid and semi-arid areas is efficient soil water management. In an ecosystem the latter is based on the principle that low and variable rainfall can be optimally utilized under conditions of high atmospheric evaporative demand. Rangeland management practices ensuring optimal rainfall utilization and effective soil water management should be applied. Approximately 65% of South Africa's rangeland is in the arid and semi-arid areas, with a mean annual rainfall of 500 mm or less. These ecologically sensitive areas require special expertise for sustainable utilization and management. An increase in surface runoff and sediment loss with rangeland degradation results in increased drought risk and facilitates so-called man-made droughts. The magnitude of direct evaporation from the soil surface in arid and semi-arid rangelands may range from 20% to 70% of the infiltrated rain. The highest water use (evapotranspiration) in a grass community in arid and semi-arid areas usually occurs during the reproductive development phase. Most aspects of nutrient cycling have been all but ignored in southern African rangeland. Soil biota, by affecting the spatial and temporal distribution of essential resources (water and nutrients), are essential to the maintenance of the integrity of rangeland ecosystem in arid and semi-arid areas (Smith, 2008).

In certain rangeland areas of South Africa, natural vegetation degraded to such an extent that the application of management practices or even total withdrawal of grazing will not have the desired effect on recovery cover and density. In these cases, more drastic restoration measures must be applied to help the re-establishment of vegetation, so that the rangeland ecosystem can ensure sustainable animal production once again. These measures should strive towards increasing water infiltration into the soil, improving vegetation composition, cover and density; decreasing runoff, creating a better microclimate and sustainable water balance for the plants and eventually control soil erosion. There are many approaches to rangeland restoration. The most suitable methods will largely be determined by soil type, climatic conditions, as well as the causes and degree of rangeland deterioration (Smith, 2008). The survey of Van der Merwe (1997) of restoration techniques has revealed that all these techniques has one common goal, namely to capture runoff in ripper furrows, or collect *in situ* rainwater through shallow basins/pitting, for increased infiltration and soil water storage. In actual fact, the basin plough used by Van der Merwe & Beukes (2006) was originally designed for rangeland restoration through increased rainwater conservation.

left and right: Reduce water runoff and evaporation losses by applying mulching (stoned and reeds) on the runoff strips and in the basins

Water Harvesting and Basin Tillage (WHB) through Demonstrations

Free State Province, South Africa

Optimising rainwater use, reduce runoff by use of basins and reduce evaporation losses by applying mulch (stones/reeds) on the runoff strip and in the basins.

Aim / objectives: Given the marginal soils of a clayey nature and/or slope terrain, coupled with erratic rainfall events, the technology aims to harvest available rain water and prevent runoff and soil loss. At present, PRAs are conducted in target areas and, so far, people are eager to adopt the technology. The aim is to train them and assist in constructing the basins so that after a year they will be able to take over the project entirely even though the team will still be around to provide advice should the need arise.

Location: Free State Province
Approach area: 0 km^2
Type of Approach: project/programme based
Focus: on conservation only
WOCAT database reference: QA RSA45
Related technology (ies): Water Harvesting and Basin Tillage
Compiled by: Cobus Botha, Agricultural Research Council, Institute for Soil, Climate and Water, South Africa
Date: 04/12/2001

Problem, objectives and constraints

Problems

Low yields because of high water losses due to runoff and evaporation from the soil surface.

Aims/Objectives

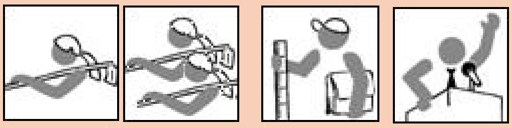
To make optimal use of pre-plant water that collects in basins from summer rains that fall during the fallow period. Saved water is very beneficial during the reproductive growth of plants which often occurs when there is no rain. Prevention of soil and water loss through water erosion and runoff by the use of basins.

Constraints addressed

Major	Constraint	Treatment
Social / cultural / religious	People are resistant to change. Had to convince that they can get better yields with new technique	Interacting with people as much as possible and comparing yields on farmers days after harvest
Financial	Most can't afford inputs and to hire labour for construction of basins	Team will ask for discounts from providers and encourage team work amongst community

Participation and decision making

Stakeholders / target groups



land users / individual; land users / groups; SLM specialists / agricultural advisors; politicians / decision makers

Approach costs met by:

National non-government	100%
	%
TOTAL	100%

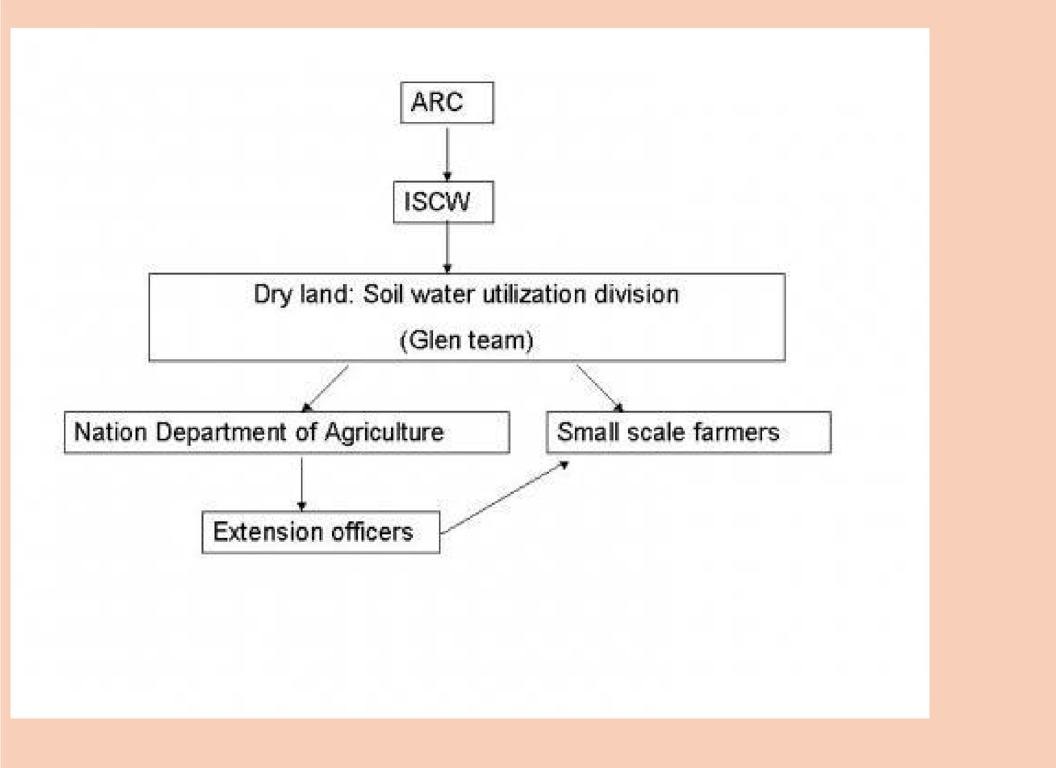
Annual budget for SLM component: US$100,000-1,000,000

Decisions on choice of the Technology (ies): by SLM specialists alone (top-down)
Decisions on method of implementing the Technology (ies): mainly by land users supported by SLM specialists
Approach designed by: mainly by land users supported by SLM specialists
Implementing bodies: international, local community / land users

Land user involvement

Phase	Involvement	Activities
Initiation/motivation	None	Rapid/participatory rural appraisal
Planning	None	
Implementation	Passive	Casual labour
Monitoring/evaluation	Interactive	On-farm; On-station experiments are conducted at Glen to evaluate different SWC techniques. The new technology is transferred by means of on-farm demonstration plots and information days
Research	None	

Differences between participation of men and women: Yes, great. Women tend to be submissive and docile. They look to the men for decision making.
Involvement of disadvantaged groups: Yes, great. Land owners and local chiefs. Approach can only be implemented with their acceptance and approval.



Organogram

Technical support

Training / awareness raising:
Training provided for land user, extensionists/trainers
Training was demonstration areas, public meetings
Training focused on Construction of basins; better understanding of the system in simple terms; the concept of infiltration, evapotranspiration; erosion and runoff.

Advisory service:
Name: NDA Extension
Key elements:
1. Assistance in technology transfer
2. Organising public meetings
3. Establishing a link between specialists and land users

1) Advisory service was carried out through: government's existing extension system 2) Advisory service was carried out through: government's existing extension system; Extension staff: mainly government employees 3) Target groups for extension: land users; Activities: Technology transfer
The extension system is quite adequate to ensure continuation of activities. With a little persuasion, they assist completely.

Research: Yes, great research. Topics covered include sociology, economics / marketing, technology
Mostly on station and on-farm research.

External material support / subsidies

Labour: Paid in cash
Inputs: - Equipment (machinery, tools, etc) - machinery, hand tools. Fully financed
- Agricultural (seeds, fertilizers, etc) - seeds, fertiliser, biocides. Fully financed
Support to local institutions: Yes, little support with training

Monitoring and evaluation

Changes as result of monitoring and evaluation: There were few changes in the approach. An organic mulch can be placed in the basins and on the runoff strip to stop evaporation losses. However, cattle are allowed to graze in the land after the crop has been harvested. Thereafter there is almost no organic mulch left to cover the soil surface. Stones were then suggested as an alternative mulch.

Impacts of the Approach

Improved sustainable land management: Yes, great
Adoption by other land users / projects: No; team about to start a food security project adopting the WHB.
Training, advisory service and research:
- Training effectiveness
Land users* - good
SLM specialists - good
Agricultural advisor / trainers - good
- Advisory service effectiveness
Land users* - good

Technicians / conservation specialists - good

<u>- Research contributing to the approach's effectiveness</u>

- Moderately

Land/water use rights: N/A

Concluding statements

Sustainability of activities: Yes the land users can sustain the approach activities.

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Success of the WHB technique depends on suppressing water losses by runoff (R) and evaporation from the soil surface (Es). Measurements show that R has been reduced to zero and that Es has been reduced considerably, but still remains a serious avenue for water loss. Future experimentation needs to focus on suppressing Es by any possible means.	There is some soil movement from the runoff area into the basins, and basins may silt up over time
The WHB treatment gives considerably better yields than the conventional treatment. Results from more seasons are needed to quantify the extent of this difference in a reliable way.	Huge storms may overflow and break basin walls; and basins may need some maintenance
Save on cultivation costs since no-till is employed	In the case of small rainfall events all the water may not reach the basins
The WHB technique is ell suited for use on very small pots, and even in townships. Many people in semi-arid areas could be usefully employed if this technique was widely adapted, and food security could be increased at the same time: Extension work in this connection by the PDA needs to be encourage	Organic mulch may act as a sponge and absorb some of the rainwater
Soil loss from the land as a whole is zero. This is an important advantage over the conventional tillage in terms of sustainability.	It is labour intensive to initially construct the basins by hand
Produced higher yields	

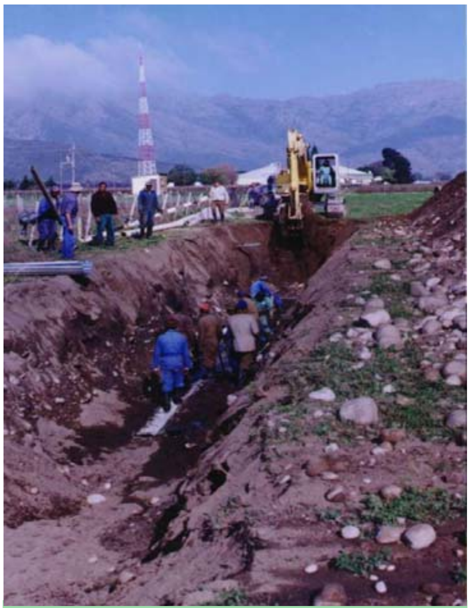
GROUNDWATER/SALINITY REGULATION/WATER USE EFFICIENCY

South Africa is a semi-arid country and water is of critical importance to development in all sectors of the economy. Water as a natural resource therefore needs to be optimally utilized in order to benefit both current and future users. The water cycle is driven by climate and naturally purifies water through evaporation, condensation and precipitation. Water conservation or the sustainable use thereof can be obtained in various ways such as improved regulation of the water cycle, reducing flood flows, improving water infiltration in the soil and the recharge of groundwater tables.

Most groundwater in South Africa occurs in secondary aquifers, fractured rock and dolomite, with the dolomite sources being for attractive for irrigation (Backeberg *et al*., 1995). Groundwater sources need to be recharged with rainwater in order to be sustainable. In 1980, South Africa's groundwater use constituted almost 15% of its total annual water consumption. Groundwater use for irrigation constituted 78.2% with 6.7% for rural domestic use, 5.6% for stock water, 5.6% for mining and quarries and 3.9% for urban use which (Ghassemi *et al*., 1995).

Salinisation may occur is areas in South Africa, especially in some areas under irrigation, but nationally, the situation seems to be fairly under control. When salinisation does occur, it is largely due to over irrigation of soils with impervious subsurface layers, poor drainage and excessive salt content in the subsoils (Ghassemi *et al*., 1995). Salinisation occurs with overirrigation and poor drainage, especially if the quality of irrigation water has been reduced by mineralization as a consequence of industrial, mining or sewage effluent.

Increasing water use efficiency is a solution to scarce water resources and entails several actions. It entails an increase in the output of a given crop per unit volume of water used and also that the economic productivity of irrigated agriculture can be increased by changing to crops that are able to use water more efficiently (e.g. higher benefit per unit volume of water applied. An increase in water use efficiency will eventually lower the pressure scarce water resources, aid in securing household food security, and help to prevent environmental degradation. Increasing water use efficiency is particularly important in arid and semi-arid environments such as South Africa where water scarcity is very high (Ghassemi *et al*., 1995).

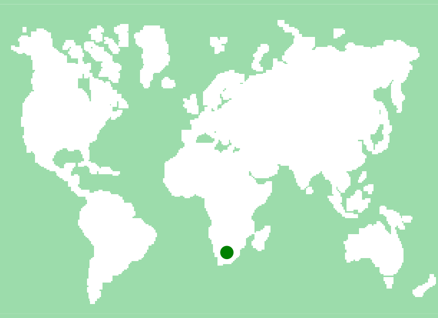


left: Drainage

right: Drainage, on commercial farm

Sub-Surface Drainage on Irrigated Lands

Western Cape Province, South Africa



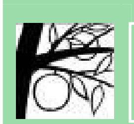
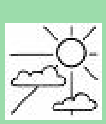
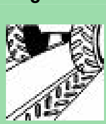
Location: Southern Cape, Boland, Swartland
Technology area: 240 km²
Conservation measure(s): structural measure
Land use type: Cropland: tree and shrub cropping
Stage of intervention: prevention of land degradation, rehabilitation / reclamation of denuded land
Origin: externally introduced through project, recently (< 10 years ago)
Climate: semi-arid
WOCAT database reference: QT RSA10
Related approach: Deliver service on demand
Compiled by: Hans E. King, Francois Richter, Jan Smit, Francis Steyn and Gert Oliver, Department of Agriculture, South Africa
Date: 13/03/2000, updated 12/12/2003 by Rinda van der Merwe

Drainage of saturated and salinised soils by means of sub-soil drainage pipes.

There is a lot of soil, wind and water erosion in this area. River erosion, not related to this SWC, is a problem over the whole area (on average 20 t/ha/y). Sheet and gully erosion occurs on commercial land. The whole area along the rivers varies up to 50 km. In some places drainage is inadequate and waterlogging occurs. A system of subsoil perforated pipes with surrounding filters was installed. Pipes were laid at spacing determined according to the site conditions. The overall purpose was to limit the level of the water table in the soil profile and remove salts, to provide an adequately aerated zone in the soil for a crop's root system. The system must be planned by a suitably trained person and constructed by an expert. Drainage pipes must be flushed at least annually and roots removed whenever present.

Classification

Land use problems: Bad management (over irrigation). The washing of soil from one land to the other. High winter rainfall. In land users's view: Loss of crop production due to saturation/salinisation of soil. Not putting money back what would be expected, because not enough growth, reduced crop roots deeper in soil and no growth in the area, slanted growth - salinised soils.

Land use	Climate	Degradation	Conservation measure(s)
			
cropland: tree and shrub cropping	semi-arid	physical degradation: waterlogging	structural

Stage of intervention
- Prevention
- Mitigation/reduction
- Rehabilitation

Origin
- Land user's initiative:
- Experiments/research:
- Externally introduced: resent (<10 years)
- Other's (specify):

Level of technical knowledge
- Low:
- Medium: land user
- High: field staff/agricultural advisor

Main causes of land degradation: Rising water tables (As result of over irrigation, leaking dams and canals)

Main technical functions: ·
- decrease water table
- removal of salts from soils
- increase of soil aeration

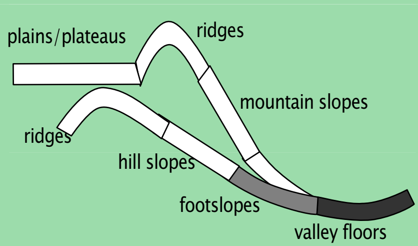
Environment

Natural Environment

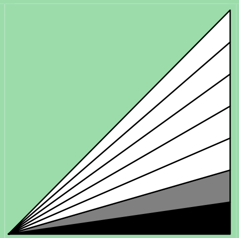
Average annual rainfall (mm)
- >4000
- 3000-4000
- 2000-3000
- 1500-2000
- 1000-1500
- 750-1000
- 500-750
- 250-500
- <250

Altitude (m a.s.l.)
- >4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 500-1000
- 100-500
- <100

Landform



Slope (%)



Soil depth (cm) (2.7.9)
- 0-20
- 20-50
- 50-80
- 80-120
- <120

Growing season(s): 120 days (September to March)

Soil texture: Coarse (sandy): most common; medium (loam): common

Soil fertility: Medium: most common; low: common

Topsoil organic matter: Low (<1%): most common

Soil drainage/infiltration: Medium: most common

Soil water storage capacity: Low

Human environment

Cropland per household (ha)
- <0.5
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1000
- 1000-10000
- >10000

Importance of off-farm income: < 10% of all income. Most of them are only farmers.

Implementation activities, inputs and costs

Establishment activities

1. Construction activities for structural measures
   - dig trench
   - lay pipe
   - place filter material
   - build manholes
   - back-fill trench

Establishment inputs and costs per ha

Inputs	Costs (US$ or local currency)	% met by land user
Labour (__person days)	150	75%
Equipment		
- machine hours	450	75%
Materials		
- stones (10 qm)	100	75%
Agricultural		
-		%
Other		
- contractor overheads	200	75%
- manholes	250	75%
- pipes (150 m)	240	75%
TOTAL	**1390**	**75%**

Maintenance/recurrent activities

1. Structural measures
   - flush pipes with water
   - cut root in pipes
   - clean manholes

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$ or local currency)	% met by land user
Labour (__person days)		%
Equipment		
-		%
Materials		
-		%
Agricultural		
-		%
Other		
- Contractor	25	100%
TOTAL	**25**	**100%**

Remarks: Duration of establishment phase: 12 months

Assessment

Impacts of the Technology

Production and socio-economic benefits

- +++ Increased crop yield
- ++ Increased farm income
- ++ Increased on farm employment

Production and socio-economic disadvantages

- \- Increased input constraints

Socio-cultural benefits

- + Community institution strengthening

Socio-cultural disadvantages

Ecological benefits

- +++ Increase in soil fertility
- +++ Improved excess water drainage
- ++ Restoration of original topsoil aeration
- + Improved soil cover

Ecological disadvantages

Off-site benefits

- ++ Reduced downslope salinisation

Off-site disadvantages

Contribution to human well-being/livelihoods

Benefits/costs according to land user

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

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Greatly improved crop yield	Initial capital outlay
Improved access for mechanisation	Slight decrease in runoff water quality
	Insufficient information on soil properties

STORMWATER CONTROL

The traditional approach to stormwater control is to drain runoff into a pipe as quickly as possible to prevent ponding. This approach does not attempt to minimize the generation of runoff or prevent or control stormwater pollution. This often results in downstream flooding and water quality problems. The current trend is toward a more comprehensive "systems approach" to managing stormwater runoff. An integrated system of preventive and control practices is used to accomplish stormwater management. The first principle is to minimize the generation of runoff and possible pollutants through a variety of techniques. The second principle is to manage any runoff with its associated pollutants to minimize its impacts on the environment in a cost effective manner. This "soft approach" can often reduce the cost of stormwater control practises.

Preventive Measures
Preventive measures include non-structural practices that help prevent the generation of runoff and the contamination of runoff by pollutants. Preventive measures are considered the first step in an integrated stormwater management system. Examples of preventive measures include:

- **Land Use Planning and Management Techniques**

All development should be planned and managed to minimize the quantity and quality impacts of runoff. Sensitive areas such as floodplains, wetlands, water supply catchments, etc., deserve special planning and protection measures. Specific techniques include establishing greenways along waterways, limiting the amount of impervious surfaces and vegetative buffers along streams, discharging downspouts from roof gutters into vegetated areas.

- **Pollution Prevention Techniques**

There are many ways to prevent the generation of pollutants or their entry into stormwater. Everyone can practice preventive maintenance to reduce leaks, breakdowns, spills and accidents that could result in contaminated runoff.

- **Public Education and Involvement Programs**

Educating employees and the public about stormwater problems, best management practices and the individual's role in minimizing runoff and protecting water quality is a very cost effective preventive practice.

- **Erosion and Sedimentation Control Programs**

Sediment is a major pollutant in stormwater runoff. Local erosion control programs may be the most effective means of preventing the contamination of stormwater runoff and protecting waterbodies in developing areas.

- **Illicit Connection Elimination Programs**

Illicit connections such as sanitary sewer interconnections, floor drains, washing machines, and other inappropriate discharges of non-stormwater, represent another significant source of pollutants entering storm sewers.

Control Measures
Control measures are structural practices that control the volume and peak discharge rate and/or reduce the pollutant concentration of stormwater runoff. They utilize the processes of detention/retention, settling, percolation, evaporation, evapo-transpiration, filtration, absorption and biological uptake to reduce flows and remove pollutants.

- **Vegetative Practices**

Filter strips and grassed areas are vegetative practices that act as nature's biofilters to reduce stormwater flows and pollution.

- **Detention/Retention Practices**

Detention/Retention practices use the processes of detention and retention to reduce peak discharge rates and pollutant loadings. Examples include dry detention basins, wet retention ponds, and artificial wetlands.

- **Infiltration Devices**

Infiltration devices capture and retain a portion of runoff onsite and allow it to infiltrate into the soil, and in the case of surface basins, evaporate into the air. If properly sited, designed, constructed and regularly maintained, these devices can be very effective in reducing peak discharge rates and stormwater volumes and removing pollutants from the first flush of runoff. Examples include infiltration trenches, infiltration basins, dry wells and leaching catch basins

- **Other Control Practices**

Sand filters are used to filter pollutants from runoff from large buildings, access roads and parking lots.

Early planning is critical. Preventive measures should be given a high priority as they are often the most cost-effective and efficient means of managing stormwater runoff.

left: Aerial photo of area indicating the position of the contour banks and watercourses

right: Contour bank with watercourse build according to specific specifications namely 2 meters wide and 300 millimeters deep

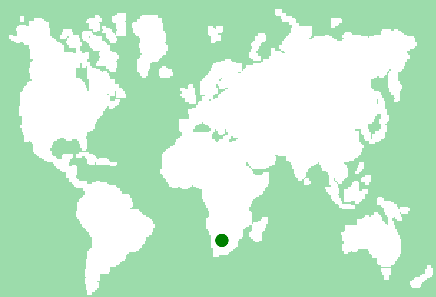
Water Runoff Control Plan on Cultivated Land

North West Province, South Africa

Artificially built watercourses with contour banks with a specific gradient - Watercourses and Contours.

<u>Watercourse:</u> According to the topography, one or two watercourses are needed to drain any excess runoff water during high rainfall intensities. A watercourse is built directly downhill. A perennial grass adapted to the specific environment is established in the watercourses. Maintenance requires that the grass must be fertilized according to the climate of the area. Regular (once or twice a year) cutting of the grass is very important to maintain a good grass cover, through which soil erosion in the watercourse can be prevented.

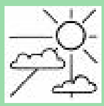
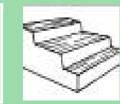
<u>Contour banks:</u> These are built with a gradient to spill the excess water into the watercourse. The purpose of contour banks is to shorten the slope so as to reduce the speed of the water and prevent soil erosion. The maintenance requires keeping the canal in good shape and maintaining the height of the banks.



Location: Lichtenburg
Technology area: 3 km^2
Conservation measure(s): structural measure, agronomic measure
Land use type: Cropland: annual cropping
Stage of intervention: prevention of land degradation, mitigation / reduction of land degradation
Origin: externally introduced through project, 10-50 years ago
Climate: semi-arid
WOCAT database reference: QT RSA11
All participants: Law enforcement
Compiled by: Pieter J.Theron and Gys Kriel, Department of Agriculture, DLRM, South Africa
Date: 01/06/1999, updated 01/04/2004 by Rinda van der Merwe

Classification

Land use problems: Cultivating lands without the necessary soil conservation works to prevent soil erosion. In land users's view: Cultivating the lands preventing soil erosion through plant directions.

Land use	Climate	Degradation		Conservation measure(s)
				
cropland: annual cropping	semi-arid	erosion by water: loss of topsoil by water gully erosion / gullying	physical degradation	structural

Stage of intervention

- ■ Prevention
- ■ Mitigation/reduction
- □ Rehabilitation

Origin

- □ Land user's initiative:
- □ Experiments/research:
- ■ Externally introduced:
- □ Other's (specify):

Level of technical knowledge

- □ Low:
- ■ Medium: land user
- ■ High: field staff/agricultural advisor

Main causes of land degradation: Agricultural causes (cultivating land on a steep slope without proper conservation practices)

Main technical functions: ·
- reduction of slope length
- control of concentrated runoff (drain/divert)
- control of dispersed runoff (impede/retard)

Secondary technical functions: ·
- maintain soil fertility as less fertilizer is lost by water runoff
- increase of infiltration
- control of dispersed runoff (retain/trap)
- increase/maintain water stored in soil

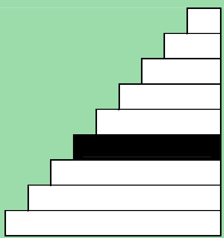
Environment

Natural Environment

Average annual rainfall (mm)

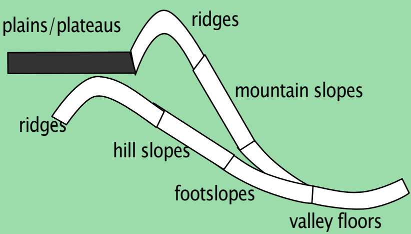
- □ >4000
- □ 3000-4000
- □ 2000-3000
- □ 1500-2000
- □ 1000-1500
- □ 750-1000
- ■ 500-750
- □ 250-500
- □ <250

Altitude (m a.s.l.)

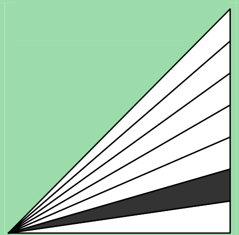


- >4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- ■ 1000-1500
- 500-1000
- 100-500
- <100

Landform



Slope (%)



Soil depth (cm)

- □ 0-20
- □ 20-50
- □ 50-80
- ■ 80-120
- □ <120

Growing season(s): 180 days (October to March)

Soil texture: Medium (loam): most common

Soil fertility: Medium: Most common; high: common

Topsoil organic matter: Low (<1%):most common

Soil drainage/infiltration: Medium: most common; good: common

Soil water storage capacity: Medium to low

Human environment

Cropland per household (ha)

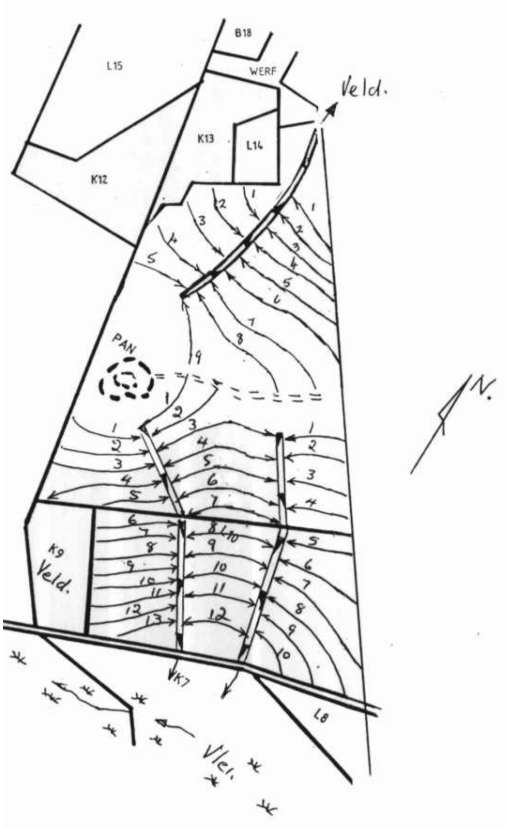
- □ <0.5
- □ 0.5-1
- □ 1-2
- □ 2-5
- □ 5-15
- □ 15-50
- □ 50-100
- ■ 100-500
- ■ 500-1000
- □ 1000-10000
- □ >10000

Land ownership: Individual (titled): most common

Importance of off-farm income: < 10% of all income, farmers are dedicated to make a living out of farming, although there are some farmers with an off-farm income such as transport.

Access to service and infrastructure: Individual: most common

Market orientation: Cropland, mainly commercial



Technical drawing of water runoff control plan (Pieter J. Theron)

Implementation activities, inputs and costs

Establishment activities

1. Field activities: Agronomic measures
   - building contours and watercourse
   - maintenance
   - cultivation between contours
2. Vegetative measures
   - established grass in the watercourse
3. Construction activities of structural measures
   - surveying
   - construction of contours
   - construction of watercourse

Establishment inputs and costs per ha

Inputs	Costs (US$ or local currency)	% met by land user
Labour (__person days)		%
Equipment		
-		%
Materials		
-		%
Agricultural		
-		%
Other		
- establish grass (2.8 ha)	840	%
- construction of watercourse (4100 m^3)	1660	30%
- contours/km (26.7)	2000	30%
TOTAL	**4500**	**30%**

Maintenance/recurrent activities

1. Vegetative measures
   - maintaining a good grass cover
   - fertilization of the grass in the watercourse
2. Structural measures
   - contour opening ditches
   - watercourse, cutting the grass
   - contours repairing flood damage

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$ or local currency)	% met by land user
Labour (__person days)		%
Equipment		
-		%
Materials		
-		%
Agricultural		
-		%
TOTAL		**100%**

Remarks: Duration of establishment phase: 24 months

Assessment

Impacts of the Technology

Production and socio-economic benefits		Production and socio-economic disadvantages	
+ +	Increased crop yield	-	Hindered farm operations

Socio-cultural benefits		Socio-cultural disadvantages	
+ +	Improved conservation / erosion knowledge		

Ecological benefits		Ecological disadvantages	
+ + +	Reduced soil loss		
+ + +	Improved excess water drainage		
+ +	Increased soil moisture		
+	Increase in soil fertility		

Off-site benefits		Off-site disadvantages	
+ +	Reduced downstream siltation		
+ +	Dam siltation		
+ +	Reduced groundwater / river pollution		

Contribution to human well-being/livelihoods

Benefits/costs according to land user

Benefits compared with costs	short-term:	long-term:
Establishment	neutral / balanced	neutral / balanced
Maintenance/recurrent	neutral / balanced	neutral / balanced

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Effective erosion control → Regular maintenance	Hampers cultivation → Adapt change in cultivation practices
Improve water infiltration → Good cultivation practices and maintenance of contours	
Increase crop yield → Good cultivation practices and maintenance of contours	
Prevent off-site siltation → Good maintenance	
Prevent soil erosion → Good regular maintenance	
Building up a good layer of topsoil	
Effective runoff control of excess rainwater	

left: Incorrect construction of contour bank and watercourse

right: Newly constructed contour bank and watercourse according to specified requirements

All Participants – Law Enforcement

North West Province, South Africa

Location: North West Province
Approach area: 3 km²
Type of Approach: project/programme based
Focus: on conservation only
WOCAT database reference: QA RSA11
Related technology (ies): Water run-off control plan on cultivated lands
Compiled by: Pieter J. Theron, Department of Agriculture, DLRM, South Africa
Date: 16/06/1999

Ordering a land user through the act to implement the SWC.

Aim / objectives: The overall purpose of this approach was (and still is) to make the land user aware of SWC, as it was obvious that he does not intend to solve the problem of soil erosion by himself. The objective was to convince the land user to implement the technology (water runoff control planning) by building the necessary soil conservation works (via watercourses and contours) and explaining in detail to him what this technology comprises:

Stages of implementation: first to make the necessary surveys from which the watercourses could be designed, then to construct the watercourse. Thirdly the watercourses must be established with a perennial grass, and lastly the land user must see to it that the necessary contours are surveyed, constructed and maintained. It was also explained to the land user (farmer) that the Provincial Department of Agriculture Technical Division could provide him with services regarding the planning surveying and design of the soil conservation works. The major objective was to convince the farmer that if he did not comply with the directive, legal steps could be taken against him. Fortunately, he was convinced and put in an application for a water runoff control plan after he harvested his crop in 1992. Due to a shortage in personnel, surveying only started in November 1993.

Problem, objectives and constraints

Problems

The attitude of the farmer and to prevent conflict. To convince the farmer to give his co-operation without threatening him with legal steps.

Aims/Objectives

- Construction of watercourses
- Establish grass in the watercourses
- Construction of contours

Constraints addressed

Major	Constraint	Treatment
Social / cultural / religious	Poor conservation ethic, resistance to change	Discussions
Technical	Lack of technical knowledge on how to solve the problem	
Minor	**Constraint**	**Treatment**
Financial	This technology can be expensive although is being subsided by government	Subsidies

Participation and decision making

Stakeholders / target groups

Approach costs met by:

Government	70%
Other	30%
TOTAL	100%

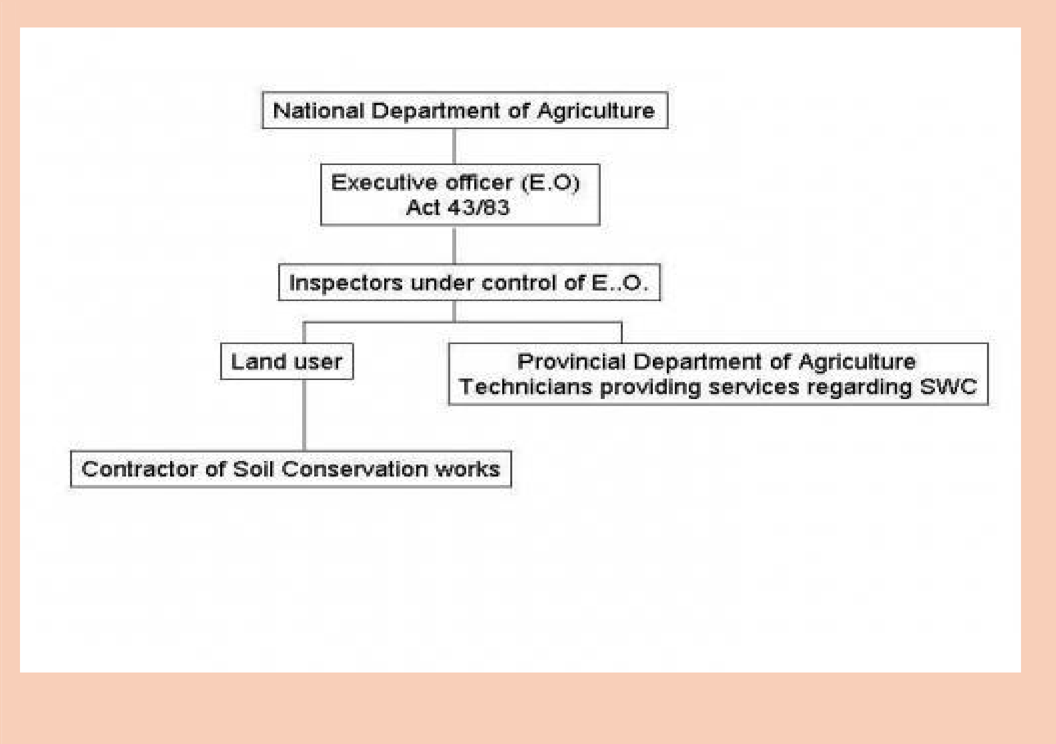
Annual budget for SLM component: US$2,000-10,000

Decisions on choice of the Technology (ies): by SLM specialists alone (top-down)
Decisions on method of implementing the Technology (ies): by SLM specialists alone (top-down)
Approach designed by: national specialists
Implementing bodies: government, other

Land user involvement

Phase	Involvement	Activities
Initiation/motiviation	None	
Planning	None	
Implementation	None	
Monitoring/evaluation	None	
Research	None	

Differences between participation of men and women: No
Involvement of disadvantaged groups: No



Organogram: Law enforcement
Water runoff control plan

Technical support

Training / awareness raising:
Training was site visits / farmer to farmer.
Training focused on Informal regarding how to maintain the soil conservation works and how to cultivate the lands with contours.

Advisory service:
Name: Convincing and persuasion
Key elements:

1. Understanding how the technology functions
2. Important aspects of maintenance
3. Technical support free of charge

1) Advisory service was carried out through: government's extension system 2) Advisory service was carried out through: government's existing extension system; Extension staff: mainly government employees 3) Target groups for extension: land users (one); Activities: Explaining how the technology functions.
The extension system is totally inadequate to ensure continuation of activities. A huge amount of cultivated land needs protection through this technology. The government cannot offer enough personnel to deliver the service.

Research: No research

External material support / subsidies

Labour: Paid in cash. Contractor
Credit: Credit was not available.

Monitoring and evaluation

Changes as result of monitoring and evaluation:
There were several changes in the approach. The farmer is well informed on how the technology functions as well as how to maintain it.

Impacts of the Approach

Improved sustainable land management:
Yes, great; The farmer experienced that normal rainfall is evenly spread. In cases of heavy rain storms the soil is effectively protected against erosion.

Adoption by other land users / projects: Yes, few; This approach is also applied on overgrazing deduced weeds and other problems regarding resource conservation.

Training, advisory service and research:

- Advisory service effectiveness
- Maintaining the soil conservation works quite well
- Land users* - fair
- Research contributing to the approach's effectiveness
- Not at all Existing technology is used. This approach was actually developed through experience in the past.

Land/water use rights:
Help - greatly in the implementation of the approach. The importance of the owners responsibility to contribute towards sustainability for the benefit of descendants.

Long-term impact of subsidies:
Positive long-term impact - Low
Negative long-term impact - Low

Financial matter only relevant at the construction phase. The incentives do not cover the maintenance. Not the incentives *per se* but the soil conservation works will have a long-term impact.

Concluding statements

Sustainability of activities:
No the land users can't sustain the approach activities.
Not the approach itself but the effect of the approach.

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Supported by legislation - Sound persuasion skills	Great possibility for confrontation - Sound persuasion skills
Trigger what he already planned to do and implement the technology - Sound maintenance	Dislike of law enforcement - Sound persuasion skills from inspector
	Resistance to cooperate - Sound persuasion skills from inspector

OTHER

South Africa is a land with a variety of landscapes, dominated by a geological history dating back more than 3.8 billion years. This complex geology and associated diverse geomorphology has shaped the South African landscape and gave expression to different eco-regions where one discovers a diversity of wetlands. This is unexpected because the country is in general located in an arid region where evaporation exceeds precipitation up to 200% in places. Wetlands occur mostly along the relatively well watered regions located on the eastern and southern coastline and the eastern parts of the central plateau and escarpment. These same regions are prone to high intensity rainfall events generating regular flooding. Wetlands in these regions are naturally adapted to handle these flooding events in being covered with dense wetland vegetation protecting the soil against erosion. However, wetlands, compromised by land uses such as draining, cultivation, overgrazing and flow concentrating infrastructure such as culverts beneath road crossings are prone to erosion (Grundling and Grobler, 2005).

The South African government has acknowledged that wetlands provide valuable ecosystem services, but that a high level of wetland loss and degradation occur in the country. Draining and erosion were identified as some of the main threats to wetlands in South Africa. Working for Wetlands (an Expanded Public Works Programme) within the South African National Biodiversity Institute (SANBI, 2009), combines proactive preventative measures with remedial interventions. It also raise awareness and influence behaviour and practices impacting on wetlands, rather than focusing exclusively on engineering solutions, and seeks to optimise opportunities with respect to ecological integrity, water and food security, human well-being and poverty alleviation. Various technologies, as compiled in the WRC publication – Wet Roadmap (Kotze et al., 2008), were developed in support of wetland rehabilitation and conservation in South Africa (Grundling and Grobler, 2005).

Definition of wetlands, rehabilitation and restoration

A common and accepted general definition sees a wetland as an area that has water at or near the surface of the ground during the growing season (wetland hydrology). It supports or is capable of supporting plants that are adapted to wet habitats (hydrophytic vegetation) and has soils that have developed under wet conditions (hydric soils). The Ramsar Convention on Wetlands (2009) takes a broad approach in determining the wetlands which come under its aegis. Under the text of the Convention (Article 1.1), wetlands are defined as:

> *"Areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters"*.

In the South African context all watercourses are also considered as wetland areas and the National Water Act (No. 36 of 1998) (DWAF, 2009) recognises wetlands as a water resource and defines them as:

> *"Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."*

Restoration means "repair, rebuild, renew" in Latin and wetland restoration is the process of assisting the recovery of a wetland that has been degraded, damaged or destroyed (IPS/IMCG, 2009). However, both the rehabilitation and restoration concepts share their fundamental focus on past or pre-existing ecosystems as models or references. According to the Society of Ecological Restoration the two activities differ in their goals and strategies (SER, 2009). Grenfell et al (2007) define 'wetland rehabilitation' as the process of reinstating natural ecological driving forces within part or the whole of a **degraded wetland** to recover former or desired ecosystem structure, function, biotic composition and ecosystem services. On the other hand 'wetland restoration' is defined as the process of reinstating natural ecological driving forces within part or the whole of a completely and permanently **altered wetland** to recover former or desired ecosystem structure, function, biotic composition and ecosystem services (Grenfell et al., 2007).

Wetlandlink (2009) explain that wetland rehabilitation should consider the natural processes of the wetland and decrease the threats that have an impact on the wetland's function. Active works could include the combating erosion and blocking drains and channels that dries out the wetland area (e.g. Working for Wetlands Programme) or the removal of alien invasive species (e.g. Working for Water Programme).

Working for Wetlands Programme (Approach)

The South African government has acknowledged that wetlands provide valuable ecosystem services, but that a high level of wetland loss and degradation occur in the country. These impacts vary from mine water pollution, to draining and erosion. The Working for Wetlands Programme – at first as a sub-programme of Working for Water (eradicating alien invasive plants) that falls within the Expanded Public Works Programme was created. The Working for Wetlands Programme, now a Department of Environmental Affairs and Tourism (DEAT) programme that is housed at SANBI (SANBI, 2009), combines proactive preventative measures with remedial interventions focused on past degradation. It needs to raise awareness and influence behaviour and practices impacting on wetlands, rather than focusing exclusively on engineering solutions. The vision of the Working for Wetlands Programme is to facilitate the conservation, rehabilitation and sustainable use of wetland ecosystems, in accordance with South Africa's national policy and commitment to international conventions and regional partnerships. In so doing, Working for Wetlands seeks to optimise opportunities with respect to ecological integrity, water and food security, human well-being and poverty alleviation.

Working for Wetlands combines the provision of work, training and opportunities to the poorest of the poor with the rehabilitation of wetlands (Figure. 1).

The Working for Wetlands programme comprises 5 key areas:

- Rehabilitation
- Partnerships
- Communication, education and public awareness
- Capacity building
- Research and planning

Figure 1: Blocking drains in wetlands and revegetate bare soil to stop erosion.

left: Heddlespruit Wetland: Fixed point photographs to illustrate rehabilitation sites during and directly after the construction phase. After construction: This photograph shows the Heddlespruit head cut gabion after completion. Vehicle movement had quite an impact on the surface during the construction phase. A route for the transport of filling material to the site was, however, essential. This route was chosen because it is situated upstream of the gabion wall and any soil loosened by vehicles should be trapped by it. In the top right-hand corner of the picture a re-shaped mining trench is visible.

right: Heddlespruit Wetland: Fixed point photographs to illustrate construction sites during and directly after the construction phase. During construction: Disturbed portions of the Heddlespruit wetland were cleared of alien vegetation such as wattle and blue-gum trees before rehabilitation construction work could commence. This photograph shows excavations for the construction of one of the gabions that has be constructed in the erosion gully caused by the head cut.

Wetland Rehabilitation

Mpumalanga Province, South Africa

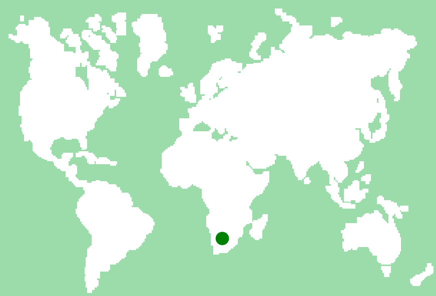
To rehabilitate/stabilise distorted wetland as close as possible to its original state/function.

Two wetland rehabilitation sites(15 and 10 ha respectively) part of a larger wetland area.

The purpose of the rehabilitation work was to stabilise, landscape and re-vegetate degraded areas to regain their original function in the catchment.

Maintenance included follow-up on re-seeding dedraded areas and alien plant control (cut down plants and treat stumps strips with RoundUp). Structure maintenance (such as gabions, roads) is also done.

Fire management to protect and manage the area of rehabilitation until such time as it has proved to be stabilised. Leave for ± 3 years before considering burning.



Location: Mpumalanga
Technology area: 0.3 km²
Conservation measure(s): management measure, structural measure, vegetative measure
Stage of intervention: rehabilitation / reclamation of denuded land
Origin: externally introduced through project, recently (< 10 years ago)
Climate: humid
WOCAT database reference: QT RSA27
Related approach: Working for Wetland rehabilitation
Compiled by: Bronkhorst Frik, Mpumalanga Parks Board, South Africa
Date: 07/07/1999, updated 01/04/2004 by Rinda van der Merwe

Implementation activities, inputs and costs

Establishment activities

1. Vegetative measures
   - hydro-seeding
   - hand-seeding
   - harvesting and replanting of vlei grass
   - scarifying forming
   - horizontal rills
2. Structural activities
   - gabion building
   - landscaping
   - mutt rocking/rock packing
   - replanting grasses
   - hydro-seeding
3. Management measures
   - trackers and firebreaks (to secure rehabilitation work)

Establishment inputs and costs per ha

Inputs	Costs (US$ or local currency)	% met by land user
Labour (_person days)	56000	80%
Equipment		
-		%
Materials		
-		%
Agricultural		
-		%
TOTAL	**70000**	**100%**

Maintenance/recurrent activities

1. Vegetative measures
   - fire protection
   - gabion maintenance
2. Structural measures
   - hydro-seeding
   - gabion maintenance
   - road maintenance
3. Management measures
   - trackers and firebreaks

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$ or local currency)	% met by land user
Labour (__person days)		%
Equipment		
-		%
Materials		
-		%
Agricultural		
-		%
TOTAL		**100%**

Remarks: Duration of establishment phase:12 months

Assessment

Impacts of the Technology

Production and socio-economic benefits		Production and socio-economic disadvantages	
+++	Employment		
+	Water		

Socio-cultural benefits		Socio-cultural disadvantages	
+	Improved conservation / erosion knowledge		

Ecological benefits		Ecological disadvantages	
++	Reduced soil loss		
++	Improved excess water drainage		
++	Increased soil moisture		
++	Improved soil cover		
+	Biodiversity enhancement		
+	Increase in soil fertility		

Off-site benefits		Off-site disadvantages	
++	Reduced downstream siltation	-	Access routes
++	Increased stream flow in dry season / reliable and stable low		

flows

Contribution to human well-being/livelihoods

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Hydro-seeding → Provides quick basal cover to limit erosion	Landscaping of stabilised areas → Must be done to re-shape area - no solution
Cement strip-road → Almost no maintenance necessary	Access roads → Correct choice of season for construction phase
Stabilisation of erosion → Gabions well built, minimal maintenance Althought all the original soil filled gabions had to be replaced by rock packed gabions,	

left and right: Wetland rehabilitation – reinstatement of the previous water table and vegetation by slowing down runoff though the building of gabions

Working for Wetlands Rehabilitation

Mpumalanga Province, South Africa

To improve the quality and quantity of water production and biodiversity in the Blyde River catchment area.

Aim / objectives: Stabilise, landscape and re-vegetate degraded wetlands in the upper Blyde River catchment. The objective was to re-instate the previous water table and vegetation by slowing down run-off through the building of gabions, landfills, reshaping and hydroseeding.

Participants: Government funding.

Location: Mpumalanga Province
Approach area: 0 km^2
Type of Approach: project/programme based
Focus: mainly on conservation with other activities
WOCAT database reference: QA RSA27
Related technology (ies): Wetland rehabilitation
Compiled by: Frik Bronkhorst, Mpumalanga Parks Board, South Africa
Date: 1999-07-07

Problem, objectives and constraints

Problems

Stopping head-cut erosion, landscape old mine trenches, re-vegetate area of bare soil, re-visit burning programme.

Aims/Objectives

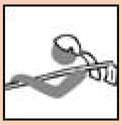
To rehabilitate degraded wetlands in the upper Blyde River catchment area To employ jobless people in adjacent local community.

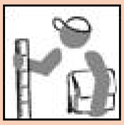
Constraints addressed

Major	Constraint	Treatment
Social / cultural / religious	Ignorance of forestry, mining and local communities about the importance of these natural systems	Capacity building and extension work
Financial	Rehabilitation is an 'extra' workload. Current budget does not allow for this	External funding: Working for Water, Landcare
Legal / land use and / water rights	Powerless to address illegal activities	Inadequate policing
Minor	**Constraint**	**Treatment**
Technical	Not much is known on rehabilitation in this veld type	Use this as an opportunity to build up information

Participation and decision making

Stakeholders / target groups


land user/ individual


SLM specialists/ agricultural advisors


politicians/ decision makers

Approach costs met by:

Government	100%
	%
TOTAL	100%

Annual budget for SLM component: US$10,000-100,000

Decisions on choice of the Technology (ies): mainly by land users supported by SLM specialists
Decisions on method of implementing the Technology (ies): mainly by land users supported by SLM specialists
Approach designed by: national specialists

Land user involvement

Phase	Involvement	Activities
Initiation/motivation	None	Survey; Wetland condition survey identified these two wetlands as priorities for rehabilitation work
Planning	None	Consultation; Inputs of various specialists were used to draw up a business plan
Implementation	Payment/external support	Contractor, casual labour; Landscaping contractor was employed to implement business plan
Monitoring/evaluation	Passive	Reporting, measurements/observations; Fixed point photography and vegetation transects, water quality tests. Report is available
Research	None	

Differences between participation of men and women: Yes, little. Specialists in this field are mainly men.

Technical support

Training / awareness raising:
Training provided for SWC specialists
Training was on-the-job, demonstration areas
Training focused on Rehabilitation and importance of the wetland ecosystem in water management

Advisory service:
Name: Mpumalanga Wetland Project, Mpumalanga Parks Board
Key elements:
1. Capacity building among land users
2. Wetland conservation
3. Wetland rehabilitation

1) Advisory service was carried out through: government's existing extension system 2) Advisory service was carried out through: government's existing extension system; Extension staff: mainly government employees 3) Target groups for extension: land user. The extension system is quite adequate to ensure continuation of activities. Got the expertise and gained much from this activity to contribute.

Research:
Yes. Topics covered include ecology. Mostly on station and on-farm research. Vegetation transects to monitor dynamics, fixed point photographs, water quality tests.

External material support / subsidies

Labour: Voluntary. Parks Board officials/advisory, supervision & monitoring
Inputs: Contractor - Fully financed
Credit: Credit was not available.
Support to local institutions: Yes, little support with training

Monitoring and evaluation

Changes as result of monitoring and evaluation: There were no changes in the approach.

Impacts of the Approach

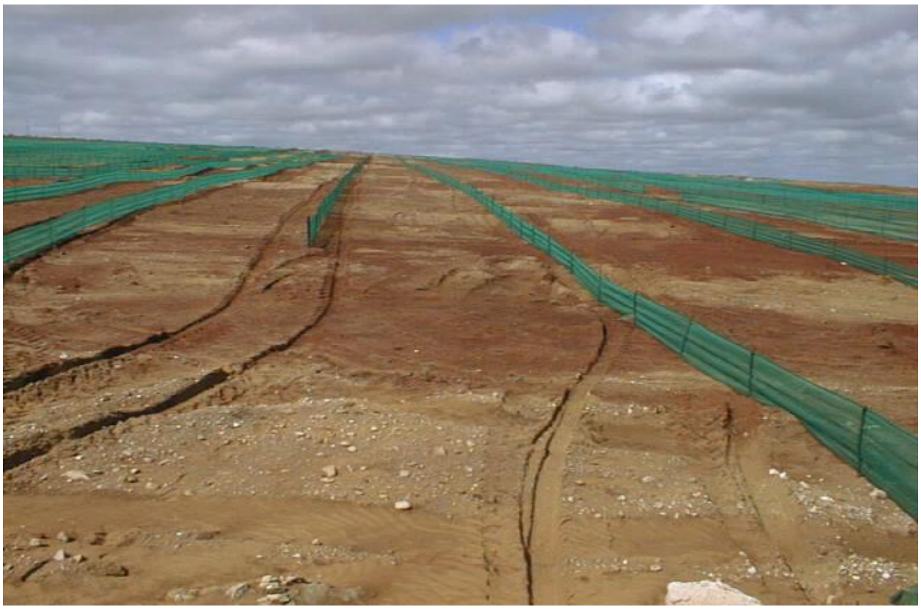
Improved sustainable land management: Yes, little; Too early to comment. Project has only just finished
Training, advisory service and research:
- Training effectiveness - Too early to comment on what effect the rehabilitation work is going to have on numerous institutions.
    Land users* - good
    SLM specialists - good
    Agricultural advisor / trainers - good
    Planners - good
    Politicians / decision makers – good
- Advisory service effectiveness - Being exposed to this rehabilitation activity it is already clear that the importance of wetlands gets its rightful place in all planning activities.
    Land users* - good
    Politicians / decision makers - fair
    Planners - fair
    Technicians / conservation specialists - good
- Research contributing to the approach's effectiveness - Greatly
    Both sites where work has been done is on conservation land

Land/water use rights:
Help - greatly in the implementation of the approach. Both sites where work has been done is on conservation land

Concluding statements

Sustainability of activities: Yes the land users can sustain the approach activities.

Strengths and → how to sustain/improve	**Weaknesses and → how to overcome**
Job creation: Governmental funding	No action from a steering committee Get steering committee up and going
Working for Water principle: Governmental funding	Lack of practical experiences on wetland rehabilitation Get more experiences
Opportunity to be exposed to the practical side of wetland rehabilitation. Rehabilitation of others wetlands and monitoring the present situation	
Contribute towards the natural hydrological regime of the catchment - Monitoring	
Opportunity for land users to combine ideas and to improve relationships. Work towards a better environment	



left: Rehabilitation in 2000

right: Rehabilitation in 2002

Strip Mine Rehabilitation by Plant Translocation

South Africa

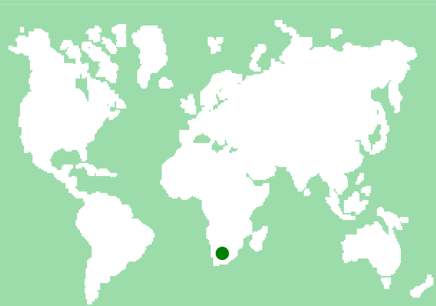
Rehabilitation of areas degraded by strip mining, through the translocation of indigenous plants in arid areas of the Namaqualand coast.

During strip mining operations the topsoil is pushed to one side by bulldozer, and stock piled. The substrata is then excavated mechanically, removed by tip truck, and processed to extract the heavy metals. The tailings (waste material) are returned by tip truck, to the area from which they were mined, and levelled by bulldozer. The stock-piled topsoil is then returned and spread out by bulldozer over the levelled tailings. Indigenous plants are dug by hand, with a spade, from either the surrounding areas of natural vegetation or from the piles of topsoil (self-sown plants) and transplanted by hand into the spread topsoil. The planted areas are protected from wind erosion by erecting fine mesh nylon netting as windbreaks, 0.8 m high and 5 m apart. The nets are subsequently removed once the vegetation has successfully become re-established and may be re-used at the next rehabilitation site. This technology has been first experimentally and then routinely applied by the mining companies on the West Coast of South Africa. This form of strip mine rehabilitation has been in operation since 1990, and costs on average US$212/ha, with all costs borne by the mining company. The primary purpose is to restore the mined area to something approaching its former condition allowing it to again be used for extensive grazing. In the process wind erosion is reduced, by restoring a protective vegetative cover. It also contributes to increasing biodiversity with particular attention being directed at the planting of locally endemic and indigenous species.

<u>Establishment activities:</u>
Mining activities (not part of technology):
1. Removal and stock piling of topsoil.
2. Excavation, removal and processing of substrata to extract heavy minerals.
3. Return and levelling of the mine tailings.
4. Return and spreading of topsoil Technology activities.
5. Collection/digging up of indigenous plants.
6. Transplanting into returned topsoil.
7. Erection of fine mesh nylon net windbreaks.

Activities 1-4 are a continuous process associated with the speed of mining activities and involve the use of heavy earth moving machinery (bulldozers, front-end loaders, tipper trucks). Activities 5-6 take place immediately prior to the onset of the rainy season and involve hand labour for collection and transplanting and tractor and trailer for transporting collected plants. Activity 7 can take place at any time of the year involving hand labour for erection of the nets and tractor and trailer for transport.

<u>Maintenance / recurrent activities per year:</u>
Maintenance activities restricted to:
1. Ensuring the nylon nets remain upright.
2. Supplementary watering during the winter months, when rainfall inadequate, to support plant growth.

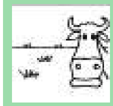
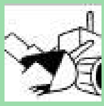
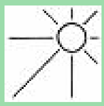


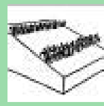
Location: Western Cape
Technology area: 0 km²
Conservation measure(s): vegetative measure, structural measure
Land use type: Grazing land: extensive grazing. Other land: mines and extractive industry
Origin: rehabilitation / reclamation of denuded land
Climate: arid
WOCAT database reference: QT RSA47
Related approach: Assistance by mining company
Compiled by: Mahood Kirsten, University of Stellenbosch, South Africa
Date: 06/12/2001, updated 28/04/2004 by Rinda van der Merwe

Classification

Land use problems: Overgrazing. In land users's view: Aridness and climate change. Erratic rainfall/climate. Frequent drought.

Land use **Climate** **Degradation** **Conservation measure(s)**



Stage of intervention

Prevention
Mitigation/reduction
Rehabilitation

Origin

Land user's initiative:
Experiments/research: recent (<10 years)
Externally introduced:
Other's (specify):

Level of technical knowledge

Low:
Medium: field staff/agricultural advisor, land user
High:

Main causes of land degradation: Mining

Main technical functions: ·

- reduction in wind speed

Secondary technical functions: ·

- increase in organic matter
- improvement of ground cover
- increase in soil fertility
- increase of infiltration

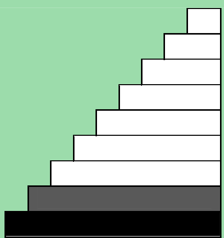
Environment

Natural Environment

Average annual rainfall (mm)

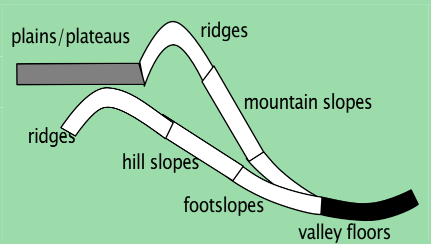
>4000
3000-4000
2000-3000
1500-2000
1000-1500
750-1000
500-750
250-500
<250

Altitude (m a.s.l.)

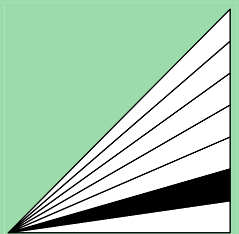


>4000
3000-4000
2500-3000
2000-2500
1500-2000
1000-1500
500-1000
100-500
<100

Landform



Slope (%)



Soil depth (cm)

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

Growing season(s): 120 days (June to August)

Soil texture: Coarse (sandy): most common

Soil fertility: Very low: most common

Topsoil organic matter: Low (<1%): most common

Soil drainage/infiltration: Good: most common

Soil water storage capacity: Low

Human environment

Grazing land per household (ha)

<0.5
0.5-1
1-2
2-5
5-15
15-50
50-100
100-500
500-1000
1000-10000
>10000

Land ownership: State: most common; individual (titled): common

Importance of off-farm income: < 10% of all income. Most of income from mining

Access to service and infrastructure: Leased: most common

Market orientation: Grazing land: mainly commercial

Implementation activities, inputs and costs

Establishment activities

1. Agronomic measures
   - topsoil pushed into stockpile
   - subsoil removed and processed
   - stockpiled topsoil spread over processed subsoil
   - plants transplanted onto spread topsoil
2. Vegetative measures
   - collection of plants from natural vegetation
   - collection of plants from topsoil stockpiles
   - transport plants to rehabilitation area
   - plant all plants
3. Structural measures
   - insert droppers into net pockets
   - spread nets over topsoil areas
   - erect nets and hammer in droppers

Establishment inputs and costs per ha

Inputs	Costs (US$ or local currency)	% met by land user
Labour (__person days) 6ha/days	75	100%
Equipment		
- machine hours (0.5/ha)	67	100%
Materials		
- nylon netting	70	100%
Agricultural		
- seedlings (2000 No)	0	100%
TOTAL	**212**	**100%**

Maintenance/recurrent activities

1. Structural measure
   - ensure nets remain upright

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$ or local currency)	% met by land user
Labour (3 person days)	37	%
Equipment		
-		%
Materials		
-		%
Agricultural		
-		%
TOTAL	**37**	**%**

Assessment

Impacts of the Technology

Production and socio-economic benefits

- +++ Fodder production/quality increase
- ++ Land rehabilitation

Production and socio-economic disadvantages

- -- Cost of rehabilitation

Socio-cultural benefits

- +++ Improved conservation / erosion knowledge

Socio-cultural disadvantages

Ecological benefits

- +++ Restoration of bio-productive function
- +++ Reduced wind velocity
- ++ Biodiversity enhancement
- ++ Improved soil cover

Ecological disadvantages

- -- Incomplete biodiversity restoration on site

Off-site benefits

- +++ Reduced wind transported sediments

Off-site disadvantages

Contribution to human well-being/livelihoods

Benefits/costs according to land user

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

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Low establishment costs, very low maintenance costs. → Use of micro-catchments to trap rainwater and improve soil moisture conditions for plants	Rehabilitation at cost for the mining company. → Ensure mining company meets the costs through enforcing legislation
Costs borne by the mining company - no costs transferred to those who subsequently use the land for grazing	Increased rehabilitation costs for mining companies
Land productivity restored. → Regular monitoring of success of soil and vegetation conditions	
Biodiversity increased → Seedling as well as transplanting	
Wind erosion minimised	
Good public image for mining company	
Land productivity is restored in eyes of the farmer	

left: and right: Sheet erosion

Extension Officer Approached by Commercial Farmer

Eastern Cape Province, South Africa

Farmer approached extension officer (acquire free service) for technical advice and subsidy.

Aim / objectives: The farmer was faced with serious sheet erosion on his farm. The farmer had good results where there had been treatment of this problem on a small scale. Having grown up with parents who were keen soil conservationists it was his desire to do something about this serious problem. The farmer then approached the local extension officer for technical advice and a subsidy. Work of this volume is a long-term project and needs support in the form of subsidies as no farmer can afford these expenses, due to the low returns of livestock farming today and the lack of capital. As far back as 1960, ripping of sheet erosion was being done successfully without a subsidy. This was on a small scale, bit by bit each year as finances dictated.

Location: Eastern Cape Province
Approach area: 1 km^2
Type of Approach: other (specify)
Focus: on conservation only
WOCAT database reference: QA RSA21
Related technology (ies): Ripping of sheet erosion
Compiled by: John William Phillips, Carrickmoor farm, South Africa
Date: 06/03/1999

Problem, objectives and constraints

Problems

Sheet erosion degrading natural veld and grazing potential. Funding is required to implement treatment

Aims/Objectives

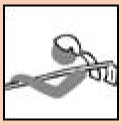
To get funding in the form of subsidies to initiate treatment in the form of ripping and revegetation by seeding. We had seen from past experiences that shallow and inadequate ripping was a waste of money. Equipment would have to be bought or hired, however.

Constraints addressed

Major	Constraint	Treatment
Financial	Capital and unable to pay interest rates asked by banks	

Participation and decision making

Stakeholders / target groups



land user/
individual

Approach costs met by:

Government	50%
Other	50%
TOTAL	100%

Decisions on choice of the Technology (ies): by land users* alone (self-initiative / bottom-up)
Approach designed by: land users

Land user involvement

Phase	Involvement	Activities
Initiation/motivation	Self mobilisation	Own idea
Planning	Interactive	Rapid/participatory rural appraisal; Farmer approached Department of Agriculture
Implementation	Self mobilisation	Responsibility for major steps; Farmer approached Department of Agriculture
Monitoring/evaluation	Interactive	Mainly: measurements/observations; partly: reporting; Farmer keep records on economics, extension officer wrote reports
Research	Interactive	On-farm; Farmer informed extension officer about changes, results of measurements kept by extension officer

Differences between participation of men and women: No
Involvement of disadvantaged groups: No

Technical support

Training / awareness raising:
Training focused on Farmer who asked for support from the Department. The technology was a co-development of farmer and extension officer.
Advisory service:
The extension system is quite adequate to ensure continuation of activities. Various extention staff have been visiting the place. Results and reports are available by the Department and there were also some scientists of the University of Potchefstroom (now North West) who produced a database on SWC.
Research:
Yes. Topics covered include technology experiences on how deep to rip and what and when to sow.

External material support / subsidies

Labour:
- Equipment (machinery, tools, etc) - machinery. Partly financed
- Agricultural (seeds, fertilizers, etc) - seeds, seedlings, labour. Partly financed

Credit: Credit was available at interest rates (9% per year) lower than the market rates. Subsidy
The credit receiver was a Land ownerp.

Monitoring and evaluation

Changes as result of monitoring and evaluation: Yes, great; New ideas (extension) for developing technology further.

Impacts of the Approach

Training, advisory service and research:

- Training effectiveness

  Land users* - good
  SLM specialists - good
  Agricultural advisor / trainers - good
  School children / students - good
  Planners - fair

Concluding statements

Sustainability of activities: Yes the land users can sustain the approach activities.

Strengths and → how to sustain/improve (	Weaknesses and → how to overcome
Owner supported financially by government Continue with subsidies	
Department open for new ideas	
Extension officer very enthusiastic: Good partnership	

left: Alien invasive plant species

right: Clearing of trees and the application of herbicide to prevent re-growth

Inter-Departmental Approach

All 9 Provinces, South Africa

Eradication of invasive alien plants to enhance water sustainability by increasing runoff into dams and rivers.

Aim / objectives: Programme started in October 1995, employing previously disadvantaged unemployed people to clear invading trees in catchments and along rivers. This has been going on for approximately 4 years. The leading department is the Department of Water Affairs and Forestry but they have been in partnerships with a number of other departments, e.g. Land Affairs, Agriculture, South African National Parks, Welfare etc. Labour intensive methods are used to clear trees and apply herbicides to prevent regrowth. Where in sensitive areas, rehabilitation techniques are employed, e.g. sowing grass seeds and re-establishing indigenous plants. There are also some wetland rehabilitation projects across the country where engineering techniques are used to rehabilitate wetlands. The inter-departmental approach is unique in the country, but very important as objectives span all departments. The work is done on farmland, community land, private company land and governmental land. New laws will force landowners to clear large stands of alien trees in future and this programme offers landowners a way of clearing their land before the law is enforced. The approach is to use labour intensive clearing techniques to provide jobs and also tackle an ecological problem. In so doing, the programme tackles socio-economic issues and environmental issues. The major objective is to create sustainable water supplies in a drought prone country; hence - Working for Water' (providing work to unemployed and increasing water availability).

Location: : All 9 Provinces
Approach area: 0 km^2
Type of Approach: project/programme based
Focus: mainly on conservation with other activities
WOCAT database reference: QA RSA34
Compiled by: Jacqui Coetzee, Working for Water Program, South Africa
Date: 18/10/1999

Problem, objectives and constraints

Problems

Aggressively invading alien plants; wetland rehabilitation; biodiversity impacts; social development & empowerment.

Aims/Objectives

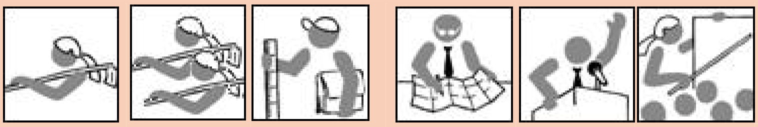
Facilitate economic empowerment.

Constraints addressed

Major	Constraint	Treatment
Other	Perceptions: People perceive a tree as good - do not distinguish between alien & indigenous	Massive public awareness campaign
Legal / land use and / water rights	Law was not enforced and also not defendable in court	Water law & Agricultural resources Act is under review to be more comprehensive.
Institutional	Responsibility to clear plants falls between 2 departments - Environment & Agriculture	On back of water benefit, Department of Water Affairs began clearing
Financial	Expensive to clear large tracts of land	SA is drought prone, sold the idea on potential water benefits.

Participation and decision making

Stakeholders / target groups



land user/ individual; land users/ groups; SLM specialists/ agricultural advisors; planners; politicians/ decision makers; teachers/ school children/ students

Approach costs met by:

Government	90%
International non-government	10%
TOTAL	100%

Decisions on choice of the Technology (ies): by politicians / leaders
Decisions on method of implementing the Technology (ies): mainly by SLM specialists with consultation of land users
Approach designed by: national specialists
Implementing bodies: government, national non-government, local community / land users, other

Land user involvement

Phase	Involvement	Activities
Initiation/motiviation	Passive	Rapid/participatory rural appraisal; Land owners informed of project and project manager determines if possible to work on land
Planning	Interactive	Rapid/participatory rural appraisal; Alien vegetation mapped 1: 50 000, social dynamics determined, availability of funding plays a major role
Implementation	Payment/external support	Mainly: casual labour; partly: responsibility for minor steps; Community supplies labour to clear trees; can be responsible to provide transport etc.
Monitoring/evaluation	Passive	Local people (farmers, communities) provide valuable feedback on progress; evaluation process mostly external
Research	Passive	

Differences between participation of men and women: Yes, little 50-60% of our work force is women. Very physically demanding work therefore not many women partially due to fact that forestry industry is mostly male dominated.
Involvement of disadvantaged groups: Communities supply the labour to do clearing through consultation, become aware of impacts of alien plants.

Technical support

Training / awareness raising:
Training was on-the-job, courses
Training focused on Alien plant awareness, water conservation awareness, all workers are given an introduction course on programme principles
Research:
Yes, moderate research. Mostly on station and on-farm research.
Biological control research & implementation in certain areas; impact of programme on local communities; cost/benefit of clearing alien plants

External material support / subsidies

Contribution per area (state/private sector):
Labour: Paid in cash. Wages & salaries for workers
Inputs: - Equipment (machinery, tools, etc) - machinery (Chainsaws), hand tools (Slasher). Fully financed
- Agricultural (seeds, fertilizers, etc) - biocides. Fully financed

- Infrastructure (roads, schools, etc) - community infrastructure (Support local creshes). Partly financed

Credit: Credit was not available
Support to local institutions: Yes, little support

Monitoring and evaluation

Changes as result of monitoring and evaluation: There were many changes in the approach. External M&E identified many problems in implementation of approach and inefficient operations standards were developed and are being applied. More stress on productivity. More detailed and planned social awareness projects were implemented rather than *ad hoc* approaches.

Impacts of the Approach

Improved sustainable land management: Yes, great; Water management more sustainable, improved biodiversity and decreased erosion
Adoption by other land users / projects: Yes, few; South Africa National Parks - using alien clearing on their parks to enhance social situation & empowerment
Training, advisory service and research:

- Research contributing to the approach's effectiveness - Moderately

Biological control research is the only sustainable way of controlling the alien plants. Hydrological research/monitoring provides proof of effectiveness

Land/water use rights:
Hinder - moderately in the implementation of the approach. Difficult to explain to landowner why we want to chop trees on their property, does not have to let us on.
The approach did reduce the land/water use rights problem (low). We need a law to enable us to clear trees, the law is still in development and not enforceable as yet. Rely on registrations with landowners.
Long-term impact of subsidies: Positive long-term impact - Moderately
Individuals are empowered through contracting systems to run and manage small business. In this way they can apply it to many other measurements of their lives. Possibly also seen their expertise outside of the programme

Concluding statements

Main motivation of land users to implement SLM:
Sustainability of activities: Yes the land users can sustain the approach activities.

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Sustainable water supply in drought prone areas Bring alien plant invasions to a sustainable/maintenance level to allow landowners minimal input to control them	Lack of planning Sustainable and assured funding will allow for better planning and mapping
Increased biodiversity in invaded areas Bring alien plant invasions to a sustainable/maintenance level to allow landowners minimal input to control them	Lack of adequate alien vegetation maps Sustainable and assured funding will allow for better planning and mapping
Empowerment at local communities WfW is just a kick start for the communities, once they have receive training they are empowered to seek jobs elsewhere	Lack of national weeds policy Need to mobilise relevant departments to start work
Vehicle for many other departments to reach a large number of people (e.g. for HIV/AIDS awareness, rape/abuse) WfW is just a kick start for the communities, once they have receive training they are empowered to seek jobs elsewhere	Lack of follow-up because of inadequate planning and mapping
Sustainable water supply in drought prone areas Bring alien plant invasions to a sustainable/maintenance level to allow landowners minimal input to control them	Stop or start the nature of funding - contract workers who never know if they have a job from one year to the next: Sustainable funding
Increased biodiversity in invaded areas Bring alien plant invasions to a sustainable/maintenance level to allow landowners minimal input to control them	

MANURING/COMPOSTING/NUTRIENT MANAGEMENT

Mixed-crop-livestock farming systems are characteristic of small and large-scale agriculture in South Africa. It is general knowledge that animal manure is a vital resource and not only supplies macro and micro nutrients to plants, but also replenishes soil organic matter. The nutrient content of manures varies depending on the type, age and animal diet. In general poultry manure is superior in quality compared with cattle or sheep manure. An important fact to take into account when calculating manure applications is that not all the N, P and K is available to the crop in the first year. In the case of small-scale farmers the manure is sourced from kraals and is mostly applied to home gardens, thereby contributing to higher soil fertility (higher in P, K, Ca and Mg) and lower soil acidity than in fields further away from the homesteads (Beukes *et al*., 2008; Mandiringana *et al*., 2005). Large (commercial) scale farmers are increasingly replacing their inorganic fertilizer applications with either a blend of inorganic and organic (manures) or a full organic complement. Numerous reports during the past two decades in South Africa portray success stories of organic fertilizers being used for various crops such as grain sorghum, maize, potatoes, vineyards and wheat. However, apart from the advantages of manure, or organic fertilizers, drawbacks still exist such as availability, low and variable nutrient content, bulkiness and method of application.

Green manuring is by no means a new technology and has been practiced by both the ancient Chinese and early Romans to benefit soil fertility. The cultivation of a leguminous or non-leguminous crop prior to the main crop serves to increase the fertility of the soil, or to fertilize the main crop. The decomposition of the green manure by fungi and bacteria is a rapid process, especially in sub-humid and humid regions, releasing N, P and other nutrients. It should be emphasized that the plant material being worked into the soil should still be green as dead material has a higher C:N ratio, leading to an extraction of N from the soil (so-called “N negative period”). Dead material contributes more to the formation of humus than green material, but green material is more important for the supply of nutrients (especially N) to the follow-up crop.

The use of cover crops as green manures as an agricultural practice should be promoted, especially against the background of decreasing soil fertility and land degradation. Ample reports exist that supply statistics on the latter phenomena in Central America, Asia and Africa, especially sub-Saharan Africa. The high price of inorganic fertilizer makes green manuring an attractive alternative. The use of cover crops has the additional advantage of weed suppression, thereby contributing to herbicide cost savings. Linked to conservation agricultural practices, especially reduced tillage, labour-saving attributes are also evident. A variety of strategies are available for integrating green manures into existing farming systems. Before planting of the main crop the green manure biomass can be managed in various ways ranging from full incorporation into the soil to no incorporation (when combined with the conservation agriculture practice of reduced or zero tillage). Challenges to the adoption and continued use of green manure/cover crops are also evident.

The availability of arable land is quickly decreasing, making it difficult to insert cover crops into cropping systems. A particular limitation to the adoption of green manure/cover crops by smallholder farmers is low prices of agricultural produce and lack of cover crop seed.

The composting of house-hold and garden refuse and the use of the compost is predominantly limited to home-garden scale in South Africa. However, against the background of increasing amounts of municipal wastes and increasing costs to dispose of these wastes, the composting of house-hold refuse should be promoted. Not only is the municipal waste stream reduced, but home owners have at their disposal a cheap and environmentally friendly organic fertilizer source that is free from weed seeds and pathogens. Compost is also produced and used by high cash crop farming enterprises (such as vegetable production in plastic tunnels) where compost trenches, *inter alia*, are used. Composting methods are readily available. Like the decomposition of any other organic material, the C:N ratio plays an important role in the rate of decomposition and consequent release of nutrients. A C:N ratio of less than 25:1 would result in rapid mineralization (release) of N, while a ratio of >30:1 would cause immobilization of N in the compost heap. As the mineralization of organic N has a net acidifying effect, addition of agricultural lime is recommended.

The composting of urban waste for use in urban and peri-urban agriculture has become increasingly important due to excessive waste generation, decreasing dumping site availability, as well as the increasing demand for food production in peri-urban areas. Depending on its nature there is considerable variation in the nutrient content of municipal wastes. Sewage sludge, as a specific type of municipal waste, may contain high concentrations of heavy metals or organic chemicals. However, for normal municipal refuse, like other organic materials, the most valuable gain to the soil is not so much the addition of nutrients but rather the beneficial effects through increased biological activity, improved soil physical properties, as well as the inhibitory effects on weed growth and soil-borne diseases. Although the technologies to compost urban wastes are available, there seem to be gaps in knowledge, *inter alia*, on the value, application rates and consistency of quality (Harris *et al*., 2001).

It has been proven that earthworms can alter organic wastes speedily and efficiently. The process is referred to as vermicomposting and can be defined as the controlled degradation, or composting, of organic wastes, primarily through earthworm consumption. It is an appropriate cost effective and efficient recycling technique for the disposal of non-toxic solid and liquid organic wastes. Vermicompost refers to organic manure produced by earthworms. It is a mixture of worm castings (faecal excretions), organic material including humus, live earthworms, their cocoons and other organisms. In South Africa the whole vermiculture industry has been commercialised: The scale of operation varies from so-called “worm farms” to kits for producing vermicompost on a small scale in a backyard. Composting earthworms (for e.g. the exotic red wiggler, *Eisenia fetida*) can be ordered on the internet. The liquid (“vermitea”) and solid (vermicompost) fertilizers are regarded as excellent organic fertilizers, and their use should lead to considerable savings on inorganic fertilizers, as well as improved health of plants, soil and the environment. At least two South African universities (University of the Northwest; University of the Free State) are conducting research and technology development projects on the promotion and implementation of vermicomposting.

Fertile, productive soils are vital components of stable societies to ensure that the plants needed for food, fibre, animal feed and forage, medicines, industrial products, and for an aesthetically pleasing environment can be grown. Irrespective of the scale, whether in a home garden or at a provincial, national or global scale, two underlying fundamental principles of sound nutrient management need to be emphasized. Firstly is the recognition that optimum soil nutrient status alone will not ensure soil productivity. Other factors, such as soil water content, temperature, porosity, compaction, acidity and salinity, and biotic stresses (disease, insects, weeds) can reduce the productivity of even the most fertile soils. Secondly is the realization that modern soil fertility practices need to emphasize environmental protection, as well as agricultural productivity.

Sound soil nutrient management is becoming more important as a spiraling world population, diminishing arable land and land degradation are putting unprecedented pressures on agriculture to produce more food and fibre per unit of land. Advances in plant genetics and breeding and other agricultural technologies (e.g. irrigation) are aimed at increasing crop yields but often with greater depletion of soil nutrient supplies. Depending on the crop and the land use, different soil nutrient management strategies should be used for maximum economic and environmental efficiency. Fertilizer guidelines for most agricultural crops under dry land and irrigation have been established over the last few decades in South Africa. Fertilizer requirements for various nutrients are in general based on a soil test value and the potential removal by the crop. Of course, other soil chemical and physical factors and the farming system also need to be considered. Different strategies are also required for (1) soils at land reclamation sites that are highly disturbed and may possess extremely unfavourable chemical and physical characteristics, including very low soil fertility; (2) soil conservation interventions that do not require maximum yield and where the goal should be to rather obtain low to moderate soil nutrient status and not agronomically optimum nutrient values; and (3) conservation agriculture practices where N demands are higher due to increased mineralization-immobilization processes near the soil surface, as well as the stratification of P and K near the soil surface due to the annual return of P and K through the crop residues. Sound soil nutrient management should also take cognizance of nutrient interactions in soil and plant nutrition, as well as nutrient balances and ratios within plants that are required for normal plant growth (Sims, 2000).

In an extensive review of the nutrient status of South African soils, Beukes *et al*. (2008) found that at large (commercial) scale sound soil nutrient management is maintained, particularly for high value horticultural crops. However, at the small (communal) scale serious deficiencies in, particularly soil P and K, occur, primarily due to the unaffordability of inorganic fertilizers. In order to ensure sustainability, this bottleneck will need to be addressed.

ROTATIONAL SYSTEM/ SHIFTING CULTIVATION/ FALLOW/ SLASH AND BURN/ MULTIPLE CROPPING

Two essential components of conservation agriculture or no-tillage are a variation (usually by planting cover crops and commercial crop rotation) in soil organic matter type and permanent soil cover (by crop residues, usually complemented by cover crops). Mixed species cropping/multi-cropping/intercropping/crop rotation are synonymous in that they imply the growing of two or more plant species in the same field in the same year and at least, in part, at the same time. For the purpose of this document, the term multiple cropping systems is used, covering all the individual approaches. Multiple cropping systems permit the intensification of the farm system, which results in increased overall productivity and biodiversity; the recycling of organic material; water management; soil erosion protection; and pest and disease suppression.

These systems ensure the effectiveness of natural processes conducive to the recycling of nutrients; the maximization of biological N fixation; and the minimization of nutrient losses. Multiple cropping systems are conducive to improving soil health and quality and to breaking the pest and disease cycle. These systems require little if any inorganic fertilizer; they mitigate weeds, disease, insects and other pest problems and therefore the frequent use synthetic control products. These systems reduce soil erosion as there is no or little incidence of bare soil areas for extended periods of time. As synthetic nutrients and control products are minimized, the risk of the contamination of water sources and C release (as CO_2) is nullified or at least minimized.

In South Africa the standard of CA / no-tillage technology and the knowledge of farmers about CA can be rated as good and in many instances as outstanding. However, in South Africa no-till is often practised without crop rotation, with little soil cover and without the use of cover crops, and adaptive research and development is needed to show the benefits of organic matter variation and high percentage soil cover. The missing elements are cover crops and often diversified rotations, creating an opportunity for improving the quality of the no-tillage system in order to achieve long term sustainability by adding these components. Often availability of adequate and economic crops in a region is a reason for monoculture or low diversity. But farmers will have to understand that the long term sustainability of the system can not be ensured with rotations with only two crops, such as maize and soybeans, when each crop is seeded every second year at the same place. This has already proven to be the case in the USA. One option to “fool” pests is the so called stacked rotations. In this case soybean is planted two years in a row and then maize two years in a row, that means that each crop is seeded every third year in the same field. But it is better to have at least 3 crops in the rotation. In this case each crop would only be repeated every fifth year in the same field, when stacked rotations are used.

Even though agroforestry practices in South Africa are primarily primitive and traditional, they have contributed to the country's annual timber volume. However, there is still a lack of understanding of the scientific principles on which the system is based and as a result, its economic potential has never been explored to the full. An understanding of the impact that different private, communal and state management systems have on both the utilisation and conservation of forest resources, and the welfare of local communities, is essential to sustainable development. Knowledge of the present and potential impacts that agroforestry is having and can have on future forestry development in South Africa, will be a fundamental component in ensuring that optimal land utilisation will be obtained and furthermore, ensuring that this will be done on a sustainable basis. Agroforestry practices can aid in achieving the desired goal of sustainability, which in turn, can be described as the aim of ensuring that resources are maintained in the long run (http://www.timbersa.com/woodSA/ article.asp? articleID=184&month=5&year=2003).

AGROFORESTRY

Agroforestry is defined by the International Council for Research in Agroforestry (ICRAF) as “a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are used on the same land management unit as agricultural crops and/or animals, either in some form of spatial arrangement or temporal sequence. In agroforestry systems, there are both ecological and economical interactions between the different components". It is also seen by ICRAF as a dynamic, ecologically based, natural resources management system that, through the integration of trees on farms and in agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels (http://www.timberwatch.org.za/archives/ 2000807 stateofforrestry.htm).

Agroforestry falls under the umbrella of social forestry, which refers to forestry applied to satisfy local economic, social and environmental needs, and involves community participation in the design and implementation of projects (http://www.timbersa.com/WoodSA/article.asp?articleID=184&month=5&year= 2003). In South Africa, however, agroforestry has been little practised compared to many other parts of the world. This is partly due to nurseries, from which to supply the seedlings for this mix of crops, tend to be part of the operations of the corporate forestry sector, larger-scale commercial nursery firms, or are in State hands (in the previous homeland forestry institutions). Tree seedlings are seldom raised at the village level and sold in local markets, as is the case in countries such as Kenya.

There have been several phases in and forms of social forestry in South Africa, but, overall, social forestry has had little consequence in the country. The following factors have contributed to this fact:

- past land and agricultural policies hampered the development of social forestry projects;
- there were no proper arrangements for ownership of woodlot projects by local people, or ownership arrangements were inappropriate;
- support and extension services to the emergent social forestry farmers were weak;
- many State-imposed rural development schemes tended to focus on a single, large project such as irrigation schemes, instead of implementing projects within the framework of integrated rural development;
- training institutions were slow to adopt modern approaches to rural development, including such methods as participatory resource assessment and planning; trainees qualified without the benefits of these new paradigms; this weak education, together with ineffective institutions, severely undermined the efficacy of extension services (http://www.timberwatch .org.za/archives/2000807stateofforrestry.htm).

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AFFORESTATION AND FOREST PROTECTION

Globally speaking, forests play an extremely important role in the carbon balance, contributing to carbon sequestration and soil protection if properly and sustainably managed.

Currently, however, deforestation causes up to an estimated fifth of greenhouse gas emissions. The prominence of forests in the climate change debate is recognised in the attention given to Land use, Land-Use Change and Forestry (LULUCF) in negotiations around the Kyoto Protocol and the United Nations Framework Convention on Climate Change (UNFCCC). Reducing the rate of deforestation, or forest protection, is an effective way of reducing greenhouse gas emissions. Added to this are the advantages in environmental and developmental objectives such as increasing biodiversity and protecting soils and water from degradation.

At present there are no incentives in climate law for developing countries, where more than 90% of global deforestation takes place, to protect their forests. On the contrary, international trade, including demand from rich nations for cattle and beef, timber and plant oils, creates short-term financial incentives for forest destruction.

Aspects that require attention in relation to forests are afforestation, reforestation, reducing deforestation by various means (including subsidies and incentives) and general forest management.

In South Africa, 10,7% of the country is covered by natural forests, woodland and plantations. The largest natural forests, which cover some 0,52 million ha or only 0,4%, are in the Eastern Cape, KwaZulu Natal, the Western Cape and Mpumalanga.

Woodland, which comprises some 7,6% of the country, is mainly in Limpopo, the Northern Cape and North West.

Most forest plantations are in Mpumalanga, KwaZulu Natal, Limpopo and the Eastern Cape. Of planted species, Eucalyptus covers about 0,6% of the country, mainly in KwaZulu Natal and Mpumalanga, with Pine, at 0,4%, largely in Mpumalanga, KwaZulu Natal and the Eastern and Western Cape.

Areas that would be the most vulnerable are those where felled trees make up a significant percentage, mainly KwaZulu Natal, Mpumalanga and the Western Cape. The extent is in the order of 0,24 million ha. These are dynamic statistics, however, and management between felling and re-establishment is vital. Of greater importance, however, are areas where degraded forest and woodland occur. These make up some 1,3% of the country, or 1,6 million ha, and occur mainly in Limpopo and Mpumalanga.

Although there are currently no case studies on forest related issues in the data base, the importance of the subject warrants focussing on these in the future.

WATER QUALITY IMPROVEMENTS

The term water quality refers to the physical, chemical and biological characteristics of water and is most frequently used with reference to a set of standards against which compliance can be assessed. The most common standards used to assess water quality relate to drinking water, safety of human contact and for the health of ecosystems (http://en.wikipedia.org /wiki/Water_quality). As water is an excellent solvent and transport medium for particulates, it easily becomes contaminated by both natural processes (e.g. erosion and the dissolution of salts geologically present in soils) and man-induced processes and wastes. Contaminants of water can therefore include physical soil and clay particles, organic detritus, microorganisms, chemical constituents and radioactive substances (Hohls *et al*., 2002).

Water quality in South Africa is steadily decreasing and will continue to decrease as more pressure is put on the scarce water supplies (O'Keefe *et al*., 1992). Vast amounts of mine impacted mine water are produced annually in South Africa and irrigation with this water provides a novel approach to utilize and dispose of such mine water. Research has shown that this water can be used successfully for irrigation on various crops. Care should be taken, however, to ensure that long term irrigation with mine water does not impact negatively on groundwater quality and quantity (Vermeulen & Usher, 2009).

Water quality can also be improved in various other ways such as the use of sedimentation traps, filter or purification systems and infiltration ponds.

Sediment traps can be placed upstream in river or canal systems at specific points to create retention ponds and give sediment time to settle at the bottom of the pond. This sediment can then be excavated and used as topsoil (http://upetd.up.ac.za/thesis/available/etd-03132007-171421/unrestricted/04 chapter4.pdf).

Wetlands are natural purifiers of water and support a most diverse community of life forms. The principles of the natural function of wetlands can be used to construct wetlands in order to treat effluent from domestic, industrial and agricultural sources (http://www.lindros.co.za/Constructed%20Wetlands.htm).

SAND DUNE STABILIZATION

Sand dune stabilization is the fixing of surfaces, thereby preventing it from being blown and transported by wind e.g. sand dunes and light structured soils (e.g. as loess soils). The aim can be to reduce the material from being blown and / or to stop the shifting of dunes.

Sand dune stabilization projects were undertaken in various areas on the South African Coast, however cognizance should be taken when used/implemented as illustrated in the following examples:

- **De Mond, Cape South Coast:**

Near the Honey Nest River, where the combination of sand dune stabilization attempts and continuous prevention of the permanent siltation of the river mouth has caused significant changes to the environment. The sand dunes were stabilized by planting vegetation and by creating brushwood barriers to entrap the windblown sand, causing the formation of an artificial dune positioned parallel to the coastline – a significantly different environment to that of the 1766 coastline (www.meermin.org.za)

- **St Francis Bay Beach:**

A popular holiday and recreational destination for South African and international tourists, have been suffering from chronic erosion, significantly reducing the beach width and impacting on the amenities available. The stabilization of dune fields that fed sand to St Francis Bay has led to reduced sand supply to the area, resulting in severe undercutting of the beach. The loss of sediment supply from the wind blown sand has likely contributed to the beach erosion and also resulted in the great reduction in number of days per year of the surf break (www.stfrancisbay.org; www.asrltd.co.nz).

- **Bushman's River:**

The planting of alien invader species to stabilize the dunes to the west of the river mouth and the stabilization of the natural wind channel of the Dry Bones Valley have severe impacts on the accumulation of sediment in the Bushmans River surroundings. The natural movement of sand has been restricted and has resulted in the erosion of the Bushman's river bank threatening to undercut the road to the beach. Enormous sand dunes has formed behind the stabilized sand dune areas, reaching critical heights and migrating towards the car park and residential areas, thus presenting a potential threat to the houses in the area as the houses built in the dune area are under threat of under cutting and collapse (www.brm.org.za).

COASTAL BANK PROTECTION

Coastal bank protection can be defined as measures taken to protect land and infrastructure from water erosion and the impact of waves.

In South Africa the river banks are subject to regular floods, although only occurring once or twice a year the effects can be quite devastating. Factors contributing to riverbank erosion include 1) change in land use e.g. rapid urbanization contributing towards increased run-off patterns and 2) rainfall in interior parts South Africa: high volume, short duration precipitation with considerable dry spells between rainfall events. It is vitally important that engineers should take note of the total catchments in order to anticipate possible effects on the proposed protection on the overall stability of the channel/water course/river.

The application of water erosion control measures (e.g. the construction of concrete retaining blocks) should incorporate special detailing and design, taking into account hydraulic forces (a clear understanding of the factors affecting the stability of the existing bank and or the stability of protection) and environmental effects (irrespective of the materials and form of the construction the bank protection should form part of the natural environment) (www.cma.org.za).

River bank protection measures for erosion control were implemented at a multi-storey development on the Margate beachfront adjacent to the Inkongweni River on the KwaZulu South Coast, South Africa. The residents of the development were concerned that the erosion caused by the strong flow of the water in the river would result in the deterioration of the riverbank that would cause instability to the building foundations. The solution entailed the construction of a high, environmentally friendly, gabion structure to aid river bank protection and erosion control (www.africangabions.co.za). Erosion control measures were also implemented at the Cresta Centre, Randburg – where the continued erosion of a stream embankment posed a serious threat to buried municipal services. An earth retaining structure, making provision for maintaining existing vegetation, was constructed to protect municipal services and allow the stream to meander along the water course (www.cma.org.za).

PROTECTION AGAINST NATURAL HAZARDS

Floods, storms, earth quakes, stone fall, avalanches, land slides, mudflows.

Natural disasters such as floods, storms, earth quakes, stone fall, avalanches, land slides and mudflows are frightening and difficult to comprehend because there is no control over when and where they happen. However, what can be controlled is how well prepared communities and governments are to deal with the dangers that such natural disasters bring. People need to be educated on the risks in their local/specific areas and on what actions (what to do) should be taken when a disaster occurs. Donated food, clothing, medicine and experienced professionals are crucial in such circumstances, however it might take years to rebuild and ensure that future disasters can be managed in an appropriate manner. Underdeveloped infrastructure and widespread poverty can exacerbate the devastating effects of a natural disaster. Although natural disasters can't be avoided, it is possible to, with good preparation and well-organized assistance/help, survive and go back to normal life after such an event (http://issues.tigweb.org/disasters).

According to the article by Professor Alexander titled: " Floods, droughts, poverty and science", published online at www.scienceinafrica.co.za, it is stated that the increase in vulnerability to disasters in many developing countries of Africa can be attributed to the following repetitive sequence: Growing population - increasing utilization of natural resources – collapse of natural ecosystems – hunger and malnutrition – migration to the cities – unplanned occupation of high risk peri-urban areas – few employment opportunities and rising crime rate as a means of survival – breakdown of civil administration – political instability. State assistance (responsibility to implement disaster mitigation measures for vulnerable communities – to help people to help themselves) should be such that it increases the resilience of vulnerable communities without encouraging long-term dependence on the State. Natural disaster reduction/vulnerability reduction methods (e.g. Concept of a Comprehensive Disaster Managements System (CDMS)) can only be addressed as part of inter-disciplinary and inter-institutional studies based on scientific knowledge comprising a wide range of disciplines (http://www.scienceinafrica.co.za/2001/september/floods.htm).

A Comprehensive Disaster Management System consists of various phases (www.ufs.ac.za, www.uovs.ac.za):

1. Non-disaster phase:
    - Preparedness - Planning, Exercise, Education
    - Mitigation and Prevention - Risk Assessment, Risk Avoidance, Risk Reduction, Risk Management

2. Pre-disaster phase:
Early Warning, Alert and Notification, Prepare, Monitor, Evacuate

3. Disaster

4. Post-disaster phase:
   - Response phase – Emergency, Relief, Assessment
   - Recovery phase – Continuity, Rehabilitation, Reconstruction

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MANURING/COMPOSTING/NUTRIENT MANAGEMENT

ROTATIONAL SYSTEM/SHIFTING CULTIVATION/FALLOW/SLASH AND BURN /MULTIPLE CROPPING

AGROFORESTRY

AFFORESSTATION AND FOREST PROTECCTION

WATER QUALITY IMPROVEMENT

SAND DUNE STABILIZATION

COASTAL BANK PROTECTION

PROTECTION AGAINST NATURAL HAZARDS