



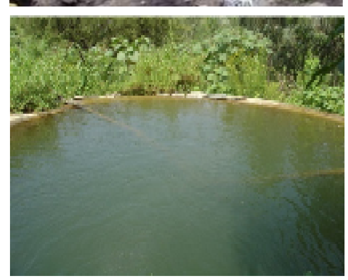
Sustainable Land Management Technologies and Approaches in Ethiopia









Ministry of Agriculture and Rural Development (2010)

Sustainable Land Management Technologies and Approaches in Ethiopia:

Edited by

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EthiOCAT Network Members
(Names indicated on each technology and approach)

The Federal Democratic Republic of Ethiopia
Ministry of Agriculture and Rural Development

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	ESAPP	

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Front cover photos: some among the screened practices defined and presented as indigenous and introduced technologies to be scaled up in the various agroecological and farming practices of Ethiopia

Contents

Forward

The Ministry of Agriculture and Rural Development (MOARD) has been involved in the implementation of land management activities since the 1970s through the various national programs and projects launched at different times in different parts of the country. In the mean time substantial financial and technical support has been provided by various development partners to assist this endeavor. Furthermore, a number of local and international NGOs have been involved in the execution of projects in land management during this period. More importantly, local communities have been practicing a range of traditional land management practices for centuries with the purpose of improving land productivity, increase availability of soil moisture and reducing soil nutrient losses. The indigenous knowledge that evolved in the various localities and communities from the land users' experiences has been well adopted as an integral part of the farming systems in the respective communities.

Despite all these, the area coverage and sustainability of land management practices have been limited and localized in project and program areas and only with the communities practicing them. Among factors that have constrained the scaling out of the technologies to other areas and communities has been the lack of proper documentation of the practices. This has in turn limited the availability of information that would help identify the best practices that could be scaled up and to know where and what approaches are to be pursued in the dissemination of the technologies. Taking this into account, the Ministry of Agriculture and Rural Development in collaboration with the relevant stakeholders and partners initiated the establishment of the Ethiopian Overview of Conservation Approaches and Technologies (EthiOCAT) Network, under the Natural Resources Sector with responsibilities of documenting the various approaches and technologies applied for land management in the various localities of Ethiopia.

In addition to this, the MOARD has recently developed the Ethiopian Strategic Investment Framework for Sustainable Land Management (ESIF_SLM) which provides guidance on harmonization and alignment of efforts, resources and expertise needed for scaling up sustainable land management practices in a systematic manner. The ESIF-SLM also offers strategies, directions and investment opportunities for SLM in Ethiopia for the coming 15 years. I sincerely hope that this work will be helpful in the implementation of the ESIF-SLM and is expected to be further enriched and improved as more experience is gained.

The MOARD further believes that this work which is a compilation and synthesis of selected technologies and approaches from those documented will be used in the scaling up of sustainable land management activities. It will be instrumental to realize Government policies and strategies that aim at adapting climate change, mitigating environmental degradation, improving food security and reducing poverty as indicated in the Plan for Accelerated and Sustained Development to End Poverty (PASDEP). It will also be used as a reference material and a menu of practices from which good practices will be selected to be scaled up in the various agro ecological zones in the country.

Preface

The document presents an overview of traditional and introduced Technologies and Approaches applied for managing land resources in Ethiopia. It is an outcome of the documentation undertakings carried out by the Ethiopian Overview of Conservation Approaches and Technologies (EthiOCAT) Network during the period 2001 – 2009. Land management specialists at various levels (national, regional, woreda), including development agents have participated in the collection of information using the WOCAT questionnaires. About 52 Technologies and 27 Approaches have been documented during this period and the data is found in the EthiOCAT database. Among these, 35 Technologies and 8 approaches have been screened as best practices and presented here to be used in the scaling up of land management interventions in the country.

Each technology is implemented pursuing one or more approaches and on the other hand an approach is used to implement more than one technology. Eight approaches have been selected as the most widely used and common ones and as a result not all technologies documented have the corresponding approach described. An Approach or two could be indicated as an Associated Approach in the Technology section and it is to be noted that wherever the Associated Approach is indicated but not presented it means that the associated approach has been described under one of the technologies already discussed. Approaches are presented following technologies and not all technologies are followed by approaches.

This work is the result of the activities accomplished by the EthiOCAT Network in Ethiopia, which is coordinated by the Ministry of Agriculture and Rural Development with the objective of developing a menu of appropriate information on technologies and approaches applied in various localities and communities in the country. It is envisaged that practitioners at various levels, policy / decision makers, researchers and students will benefit from this work. The Technologies and Approaches, which are presented in this overview book, however, are not exhaustive enough as the documentation was undertaken only in few woredas. As a result, further work needs to be carried out to document more and more indigenous as well as introduced technologies from other woredas and agro ecological zones not considered here.

Acknowledgement

Special thanks are owed to all contributors whose names appear as contributors including land users who provided the information. Many SLM specialists from the Federal Ministry, experts from the Regional Bureaus and subject matter specialists of Agriculture and Rural Development Offices have been actively involved in the collection of information, analysis and review work organized by EthiOCAT, MOARD during the past years. The Ministry of Agriculture and Rural Development deserves gratitude for housing EthiOCAT in particular and availing all the necessary facilities (office, equipment, vehicles, etc) including manpower to conduct the project.

EthiOCAT would like to extend especial thanks to the Eastern and Southern Africa Partnership Program (ESAAP), and the World Overview of Conservation Approaches and Technologies (WOCAT) of the Center for Development (CDE), the University of Bern for the financial and technical support provided. The lion's share of the finance for undertaking documentation, conducting review workshops and write up of this document were provided by ESAAP. WOCAT has been instrumental in providing technical support, training and facilitating workshops conducted for training SLM specialists and the review of the results.

Sincere thanks go to Hans Peter Liniger, Professor Hans Hurni, Professor Urs Wiesmann, Eva Ludi, Rima Mekdaschi Studer, Gudrun Schwilch and others from CDE who played the role as initiators, facilitators, supporters and contributors to the documentation of Technologies and Approaches. They have also provided backstopping services and have been involved in the review of the document.

EthiOCAT would like to express its heartfelt thanks to Dr. Albrecht Ehrensperger and Ato Berhanu Debele who: throughout the course of implementing the project were very supportive, provided smooth facilitation by channeling project finance in time and offered encouragement always.

Acronyms, abbreviations and definitions of some terms

BOARD	Bureau of Agriculture and Rural Development
CDE	Center for Development and Environment of the University of Bern
ESAPP	Eastern and Southern Africa Partnership Program
EthiOCAT	Ethiopian Overview of Conservation Approaches and Technologies
MOARD	Ministry of Agriculture and Rural Development
SLM	Sustainable Land Management
SNNPR	Southern Nations and Nationalities and Peoples Region
WFP	World Food Program
WOCAT	World Overview of Conservation Approaches and Technologies

Agro-ecological Zones of Ethiopia

A1	Hot to warm arid lowland plains
A2	Tepid to cool arid mid highlands
SA1	Hot to warm semiarid lowlands
SA2	Tepid to cool semi-arid mid highlands
SM1	Hot to warm sub moist lowlands
SM2	Tepid to cool sub moist mid highlands
SM3	Cold to very cold sub-moist sub-afroalpine to afroalpine
M1	Hot to warm moist lowlands
M2	Tepid to cool moist mid highlands
M3	Col to very cold moist sub-afroalpine to afroalpine
SH1	Hot to warm sub-humid lowlands
SH2	Tepid to cool sub-humid mid highlands
SH3	Cold to very cold sub-humid sub-afroalpine to afroalpine
H1	Hot to warm humid lowlands
H2	Tepid to cool humid mid highlands
H3	Cold to very cold humid sub-afroalpine to afroalpine
Ph1	Hot to warm per-humid lowlands
Ph2	Tepid to cool per-humid mid highlands

Land degradation (degree, land form)

Land degradation (degree)	Land Use	Land form	Quantity
S= severe	C= cultivated	R = ridges	s = small
VS = very severe	G=grazing	P = plateau/ plain	l = large
L=light	F= forest	V= valley floors	m =medium
M== moderate	M = mixed	M=mountain slopes	
		H= hilly	

Definition of commonly used terms

Sustainable Land Management (SLM): SLM in the context of WOCAT is defined as the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions.

SLM Technology: consists of one or more conservation measures belonging to the following categories: agronomic (intercropping, contour cultivation, mulching), vegetative (tree planting, hedge barriers, grass strips), structural (graded banks or bunds, level bench terrace), management (land use change, area closure, rotational grazing).

SLM Approach defines the ways and means used to promote and implement a SLM Technology and to support it in achieving more sustainable soil and water use. A 'SLM Approach' - as defined by WOCAT - refers to a particular land conservation activity, be it an official project/program, an indigenous system, or changes in a farming system towards more sustainable soil and water use. A SLM Approach consists of the following elements: All participants (policy-makers, administrators, experts, technicians, land users, i.e. actors at all levels), inputs and means (financial, material, legislative, etc.), and know-how (technical, scientific, practical). An Approach may include different levels of intervention, from the individual farm, through the community level, the extension / advisory system, the regional or national administration, or the policy level, to the international framework.

Vertical interval (VI): is the elevation difference between two consecutive bunds, fanya juu, bunks and terraces. It is used to space physical and biological measures and is expressed in meters. It is a function of a ground distance and slope divided by 100.

Cost
Numbers given as year 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 represent year 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009 and 2010 respectively.

Approximate values of the qualitative expressions: for degree, extent, depth, height, quantity, etc

Qualitative expression	**Percent equivalent expression**	**Decimal (factor of 1)**
High / great	>75	>0.8
Medium/moderate	50-75	>0.5-0.75
Low/slight	<50	<0.5

Introduction

It is nearly four decades since modern technologies of land management have been introduced in Ethiopia, and over 400 years since traditional land management measures have been practiced in different parts of Ethiopia. The traditional as well as introduced practices, as a matter of fact have been concentrated in the lowlands and mid highlands of the country, which are characterized by low and erratic rainfalls, degraded lands and recurrent failure of crop production. Many best practices have evolved in these areas but there is no recorded evidence which explains about their usefulness and applicability in other areas. Moreover, scaling up of the practices has been largely constrained by lack of methods to evaluate and test them for wider scale applicability.

Studies show that despite the availability of many best practices in land management they are highly localized, and are not being expanded to other areas, while land degradation due to soil erosion, forest clearing and burning are advancing at an alarming level. A number of projects and programs have been implemented and financed by local and international NGOs, development partners and various Government Organizations, with varying levels of successes and failures but these have not been documented.

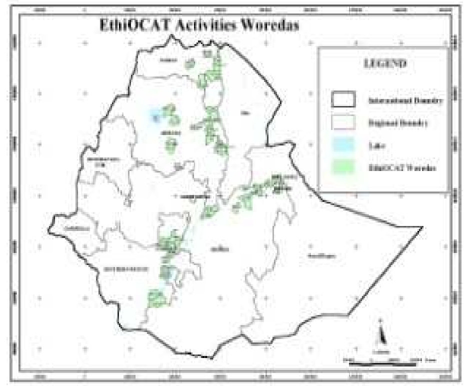
Considering this, the Ministry of Agriculture and Rural Development in collaboration with the World Overview of Conservation Approaches and Technologies (WOCAT), CDE of the University of Berne, initiated the Ethiopian Overview of Conservation Approaches and Technologies (EthiOCAT) network. EthiOCAT was established on a National Workshop conducted in Nazareth, in 2001. The Ministry of Agriculture was given the responsibility by the workshop participants to coordinate the activities of EthiOCAT.

EthiOCAT was established with a vision of supporting conservation planning and implementation by providing information on land management: needed by planners, extension workers, researchers, educationists and policy makers by establishing a database and producing reports, overview books and maps. The objectives of the Network are to: help realize sustainable soil and water management in making local experience available at other localities and provide data and information needed by various actors for planning and implementing sustainable land management practices.

Many organizations supported EthiOCAT's activities in providing financial, material and technical support. These included: The Eastern and Southern Africa Partnership Program (ESAAP), WOCAT and WFP. ESAPP has provided the biggest proportion of the project financing, WOCAT provided close technical support and backstopping and WFP provided computers to EthiOCAT coordination and permitted the use of the existing computer facilities in the regions. The Ministry of Agriculture and Rural Development provided all the other supports including office, office facilities, manpower engaged in the coordination, data collection and management including transport facilities.

EthiOCAT's activities started in training regional facilitators in June 2002 from Tigray, Amahara, Gambela, DiredDawa, Harari, Somali, Oromiya and SNNPR. Following this field practical training was given to 78 specialists and SLM technical staff who participated in the actual data gathering in the field from 2002-2007. The information collected by various contributors was continually updated and checked for quality and coherence.

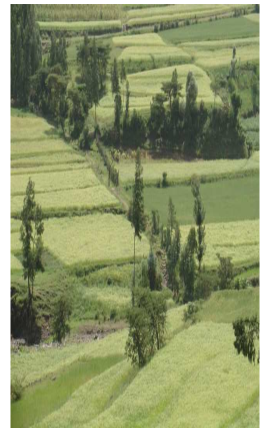
About 52 Technologies and 27 approaches have been documented and the information entered into the database. A number of review workshops have been conducted to review the work and enrich the information at different times in various regions. The National Workshop conducted in Nazareth in the year 2006 where SLM specialists from various organizations, regions, universities and research institutions participated screened about 35 Technologies and 8 approaches to be included in this Overview Book.



I. Indigenous physical land management practices

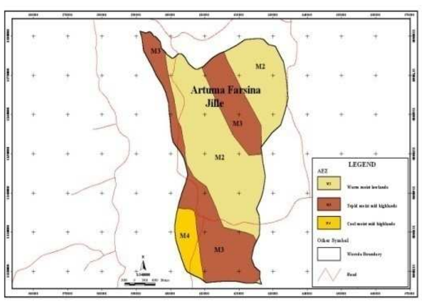
Stone terraces for planting high value crops in Dewa Chefa (Photo Teshome 2004)

Crop cultivation on protected gullies and slopes



1.1 Stone terraces and checkdams (DewaChefa, Amhara)

Common name of SLM Technology: Stone terraces
Local name: Kiter
Associated approach: Labor share and labor assistance
Contributing SLM specialist: Teshome Demissie Tolla, Oromia Zone Agricultural and Rural Development Department, Amhara Regional State / Oromiya Zone
Woreda: Dewa Chefa



Agroecology of Dewa Chefa woreda

Location of Dewa Chefa woreda

Definition

It is majorly a structural measure constructed by stone across a gully or dissected farmlands to control erosion, trap runoff and sediment to create favorable conditions for crop cultivation.

Description

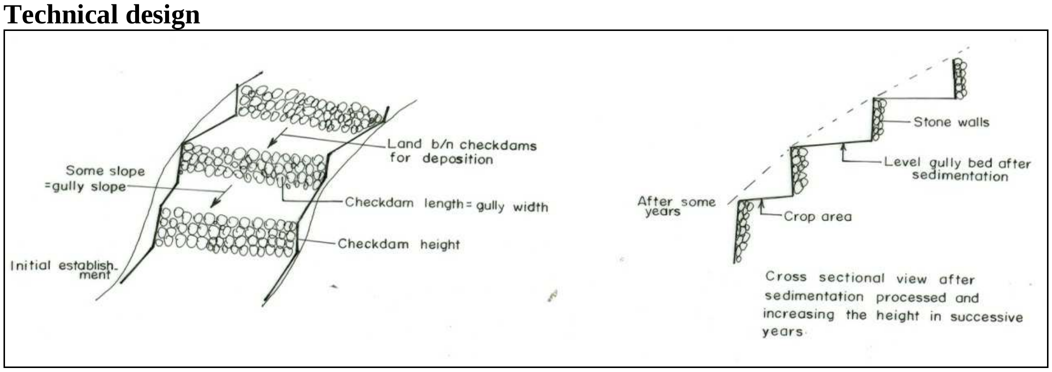
The technology has been practiced for more than a century in the Dewa Cheffa woreda. The area is seriously affected by gully erosion and the technology is widely practiced by farmers. Unlike other checkdams its construction starts from the bottom of the gully and proceeds upslope with varying dimensions. The height of the checkdam depends on the depth of the gully and it is increased from year to year. On the average, the top width is 1 m and the height is 1.80m. The length of the checkdam is the width of the gully and it ranges from 2-15 m. The technology is applied to: develop big gullies and for the treatment of small gully like depressions, change of slope to enhance land productivity, improve crop production and to conserve soil and water. The construction of stone checkdams starts with small gullies and proceeds by increasing additional height every year until the intended height is reached. The increase in height is also made during maintenance. The major objective of the technology is to stop gully expansion, trap sediment and retain water running down the gully. In the course of increasing the height, the area for sediment deposition becomes wider.

The technology is suitable to areas with low rainfalls under rugged steep topographic conditions. It can be applied in semiarid and arid agroecological zones. It consists of structural, vegetative, agronomic and management measures. The technology allows meeting the objectives of moisture harvesting, rehabilitation and improving productivity of rehabilitated gully. It is mostly practiced in the eastern escarpments of the woreda which experience low and erratic rains.

Types of degradation mainly addressed by the technology include: Water erosion (loss of topsoil by water, gully erosion and chemical deterioration), fertility decline and reduced organic matter. The technology combats land degradation by reducing slope angle, reducing slope length, increasing infiltration, maintaining water stored in soil and sediment harvesting. Applying methods of soil improvement such as planting fast growing trees, green manure, trees and shrubs, helps in further improving productivity of the gully.

Land users are organized by groups of self help to undertake the technology. The use of mulch and small water storing structures helps in maintaining good standards of the measures and improve land productivity. Land users have nurseries to produce appropriate seedlings to be planted on gullies. Some of the seedlings used in the gully plugging include: papaya, mango and avocado. Enclosure and fencing, planting in time and early planting methods improve productivity of the gully treated.

Technical design



Land degradation

Types of land degradation on the land surrounding the SLM area

Land use	Type of degradation	% area affected	Land form
Mixed land	Water erosion	75	P, R, H, V
Forestland		50	R, H
Grazing land		75	H, R
Cropland		80	P, R, H, V

Source: Field observation

The SLM area is situated in a rugged hilly terrain with a chain of ridges dividing it from north to south. The western part of the ridge has a relatively better rainfall and the eastern part has a very low rainfall.

Purpose and classification
Land use problems in the area without SLM are: increase in human and animal population, overgrazing and expansion of cultivated lands to areas, which are not suitable to cultivation. Owing to rapid gully expansion and because of the absence of preventive and control measures, there is considerable loss of soil from grazing and cultivated lands. Considerable area is getting out of production in the SLM Technology area where the technology has not been implemented.

Characterization and purpose
The technology is not intended to provide off-site benefits but it provides significant contribution for reducing sediment movement to downhill cultivated lands. The technology provides significant off-site benefits especially during the long rainy seasons where often cultivated and grazing lands at the valley bottoms are flooded. The sediment load from the eastern escarpments where the technology is applied has substantially reduced to the rivers flowing on the valley bottoms

***A pond constructed just below a hill treated with land management measures (photo 2009*)**

The SLM Technology is indigenous and is used for generations. The technology is developed by land users themselves. The aim of the technology is to increase soil water holding capacity, trap sediment, and increase crop and livestock production. Today the traditional SLM is used more. The technology is expanding to neighboring woredas and more land users are experiencing it. It has shown promising results in crop production because the technology lets more water to be stored in the soil. The appearance of the applied technology has gradually changed over time from stone embankments which are vertical, but now inclined and strengthened by vegetation at the down slope side.

Crop residue management and planting nitrogen fixing trees and shrubs is carried out on the gully sidewalls. Constraints include labor for constructing stone check dams, maintenance and upgrading. Proper SLM measures for soil improvement include: use fast growing trees and shrubs, manure application and green manure and these are also recommended to curb land problems. Land users are organized by groups of self-help. Mulch and small water storing structures are applied in between the structures to make them effective in controlling erosion.

Specification of vegetative measures

Vegetative measures	**Material**	**Plants/ha**	**Vertical interval (m)**	**Spacing**	**Interval (m)**	**Width (m)**
Aligned and contour	Trees	1500	1-1.8	8-10	1-2	1 x 1
	Grass		1-1.8	8-10	1-2	
	Fruits	2000	1-1.8	8-10	1-2	1 x l

Constraints during establishment include high seedling transportation cost, poor handling while planting and transporting, livestock interferences, and moisture stress. Constraints during maintenance are: uncontrolled livestock movement hindering proper growth and survival of plants. Improvement measures for this include: establishing nurseries for production of seedlings in the nearby plantation sites, practicing area enclosures and fencing and planting in time or early planting.

Specification of structural measures

Dimensions of each structure (checkdam) (m)

Measures	Material	Vertical interval	Spacing	Depth	Width	Length	Height
Check dam	Stone	1	8	0.3	1	5	0.5-1, 1, 5

Construction and maintenance

I) Field activities for agronomic measures			
Activity	**Energy**	**Tools**	**Timing**
Clean crop residue	Manual labor	Sickle	Early January
Primary digging		Hoe	Feb-March
Harrowing		Hoe	March
Manure application		Shovel	March
Planting		Hoe	April
Weeding and cultivation		Hand	June-August
Harvest		Sickle	Nov. -December

Re-vegetation practices

Seedling production	Manual labor	Hoe / spade	Nov. - June
Planting			June and July
Replanting		Hoe	During rains
Pruning and thinning		Axe	Dry season

Gully protection

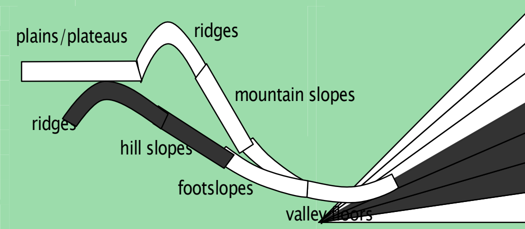
Excavation	Manual labor	Hoe	Dry season
Stone collection		Hand	Dry season
Construction			dry season
Stone collection			
Placing the stones where manual labor maintenance is required			Dry season
Replanting		Hoe	After plantation
Repairing breaks in fences		Axe	Before replanting

Check dams are regularly maintained, when breaks are observed and are continuously upgraded to increase the height until the desired check dam height is attained. The establishment is a gradual process and continues until the check dam height allows maximum possible width for cultivation. Constraints during establishment are lack of hand tools and labor. Constraints for maintenance are lack of labor. Regular maintenance and upgrading are required. Avoid building high checkdam initially and at one go.

Natural Environment

Average annual rainfall (mm)	Altitude (m a.s.l.)
>4000	>4000
3000-4000	3500-
2000-3000	3000-
1500-2000	2500-
1000-1500	2000-
750-1000	1500-
500-750	1000-
250-500	100-500
less than250	less than250

Landform **Slope (%)**



very steep (> 60)
steep (30-60)
hilly (16-30)
rolling (8-16)
moderate (5-8)
gentle (2-5)
flat (0-2)

Soil depth (cm)
0-20
20-50
50-80
80-120
less than120

Growing season:
Soil fertility: low, medium
Soil texture: medium (loam), coarse (sandy)
Surface stoniness: some loose stone, abundant loose stone, no loose stone
Topsoil organic matter: Low (less than1 %)
Soil drainage: good
Soil erodibility: high, medium and very high
Soil water storage capacity
Low

Human environment and land use
Typical household size of the land users is 5 persons. Population density is 100 persons/km^2. The annual population growth is 2.5%. The land size per household shows decreased trend because of population growth.

There is no marked difference between the better-off and poor in how they practice SLM. Off-farm income for the land users who apply the SLM technology is less than 10% of all income. Level of technical knowledge required for implementation of the technology is high for extension workers and is moderate for land users. The technology is highly relevant to smallholder farmers, who depend on conservation of runoff for crop production and for domestic uses under subsistence farming. Gullies and depressions plugged by stone check dams trap fertile soils coming from upslope. The trapped soil stores more water and supports healthy crop production.

Crop and livestock production
Number of heavy storms of water per year is 15-20. They mainly occur in the beginning and mid of the growing season. Rainfall in the longer rainy season is sufficient but not well distributed and in the short rainy season it is insufficient and not reliable. The number of growing seasons per year is 2.

Growing period	Length in days	Month
Longest	180	May – Nov
2nd longest	90	Feb- April

Land cultivation is performed by manual labor mostly and in some cases by animal traction. Type of cultivation is continuous cropping, rain fed and mixed farming. Planting perennial crops mixed with annual crops is a common practice and intercropping of cereals with pulses and trees is also known in the area.

The current trend in herd types is more small stock. Large stocks require more land area for grazing and land holdings are decreasing. The number of livestock units per household is 4 small stock and 3 large stock. The current trend in livestock numbers shows slight reduction due to decline in feed and fodder. Livestock production is decreasing primarily because of decreasing grazing lands. The main reason is that the number of livestock is the most important factor for herd owners than the quality. The land users like to own more number of livestock. More extension work will be needed to promote the awareness of livestock owners so that they give emphases to the quality of their herd.

The natural forest and woodlands are decreasing mainly due to expansion of cultivation and also to high demand for fuel and construction wood. However, owing to plantations on gullies, hillside closures and woodlots there is a positive trend of increasing wood availability as more trees are being planted.

Establishment and recurrent costs (Birr)

Category	**Input**	**Establishment**			**Recurrent**		
		Quantity	**Cost**	**% borne by land users**	**Quantity**	**Cost**	**% borne by land users**
Materials	Stone (m^3)	3315		100	331		100
Equipment	Tools	20	120	95	5	30	100
Labor	Person days	6630	4625	90	663	624	100
Total			4750	95		654	100
			470 US$			65 US$	

Labor, slope and depth of the gully, width of the gully and availability of construction material are factors affecting cost of establishment. The establishment cost considers the cost incurred during the 15 years of construction, maintenance and upgrading.

The major objective is to stop expansion of gully in width and depth and to trap sediment and retain water running down the gully. In the course of increasing the height, the area for sediment deposition gets wider and this allows for more area to come under plantation. Uncontrolled livestock movement hinders proper growth and survival of seedlings planted.

Cost recovery

I: Crops cultivated: (20% Coffee, 30% Chat and 50% Sorghum)/ on a hectare

Year	Costs (Birr)								Benefit (Birr)			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	1188		27	14	10	10	12	1261	105	59	164	-1097
2			27	14	8	10	12	71	120	59	179	+108
3		297	27	14	8	10	12	368	821	59	880	+512
4	950		27	14	8	10	12	1021	821	60	881	-140
5			27	12	8	10	12	69	826	60	886	+817
6		19	27	12	10	11	13	92	826	60	886	+794
7	950		27	12	18	11	13	1031	826	60	886	-145
8			27	10	10	11	13	71	831	60	891	+820
9	713		27	10	10	11	13	784	831	60	891	+107
10			27	10	10	12	13	72	836	60	896	+824
Total	3802	319	273	126	105	112	132	4848	6852	607	7451	-1370
Total US$	380	31						484	685	60	745	-

Note: 1= establishment, 2= upgrading, 3=recurrent costs, 4=land preparation, 5 = manure application, 6= seed/seedling, 7= herbicides, 8= total cost, 9= crop yield, 10= crop residue, 11= total benefit and 12= net profit

The cost benefit analysis for sorghum with cereals showed negative profit in the first three years of investment but for sorghum in combination with coffee, papaya chat and fodder crops starting from the fourth year showed substantial increase in the amount and quality with the resulting increase in income of land users. For cropping patterns which consider field crops in combination with cash crops the return is the highest.

For the technology to provide a high positive return it takes at least 15 years as indicated in the table above. Farmers nevertheless are encouraged to invest on the technology because without it cultivating land for all kinds of crops becomes impossible.

Benefits, advantages and disadvantages

Estimates of production

With or without SLM	Main plant type	Production (t/ha/yr)
Without SLM	No plantation	Very negligible (less than 2 q/ha/yr)
With SLM	Coffee	3-4 q/ha/yr

On-site and off-site benefits of the technology

Production and socioeconomic benefits	Socio cultural benefits
Crop yield increase	Community institution strengthening
Fodder production/quality increase	National institution strengthening
Wood production increase	Improved knowledge SLM/erosion
Farm income increase	
Off-site benefits	**Ecological disadvantages**
Soil cover improvement	Loss of land
Increase in soil moisture	Increased labor constraints
Reduced downstream flooding	Increased input constraints
Increased stream flow in dry season	Hindered farm operations
Soil loss reduction	
Biodiversity enhancement	

Economic analysis
Without SLM gross production value in US$ per hectare per year around the SLM Technology area is 100 US$. With SLM Technology, the gross production value of the land per hectare per year is 330 US$/ha/yr.

Compared to the situation without conservation estimated percentage gross production value increase in 10 years after implementing SLM is over 300%, considering the land occupied by conservation measures and in assuming current input and prices.

Adoption and adaptation
Farmers are trained on laying out check dams on a contour wherever gully width allows this. A change in spacing is made in order to make possible cultivation by oxen. Land users who have applied the SLM Technology have done it without any incentives from the beginning but food for work support was provided when there are production shortfalls at times of draught since 1970s. The number of land user families is 2500. It is practiced in 70 % of the SLM Technology area.

All land users who have implemented the technology, have done it voluntarily, without any other incentives other than technical guidance. Trend towards spontaneous adoption of the technology is high. Reclaiming gullies for agricultural land (crop and livestock production) is very useful. There is enough local skill and support to expand the SLM Technology. Farmers have all the skills to perform the activities.

Maintenance
Land users have adequately maintained and managed what has been done for many years

Strength and weakness

Strength	**Sustain/improve**
Reduce runoff velocity	Exercise frequent maintenance and stabilize the structures with vegetative measures
Reduce soil loss	Increase height of the checkdams
Moisture retention	Soil trapped provides more space for water to be stored. Reduce slope length by raising the gully bed
Land reclaimed	Fertility of soils to be increased by accumulated top soil from other areas

Supportive measures

Technologies	**Functions**
Trenches and microbasin	Reduce flood hazards
Hillside terraces	Catchment stabilization and rehabilitation
Cutoff drains	Remove excess water

Family managing this land need labor assistance from neighbors or relatives (Photo 2005)

Labor intensive SLM activities, which require labor assistance from other land users (Photo 2005)

1.2. Labor-share and labor assistance (Debo/Wenfel) approach

Common name of the Approach: labor-share (Debo/Wenfel)
Contributed by: Demissie Tola
Address: Dawa Cheffa Department of Agriculture and Rural Development
Technologies associated with the approach: Stone faced trench bund, Dewa-Chefa Check dam, Bench terrace

Definition

Debo is a labor assistance provided to a land user by his fellow land users. It is a socio-cultural tradition of co-operation where land users support each other by working in groups for activities which are labor demanding.

Description

Debo explains mutual voluntary labor assistance provided by land users to a land user who is a member in a community and who needs labor from neighbors or relatives to help him in getting timely farm activities done, which he or his family cannot perform alone. A land user who seeks Debo assistance prepares food and beverage to land users who assist him in providing their labor. It is a practice of getting activities done in time. Anyone in the community participates from the view point of a 'Nege-beine' (i.e. "Tomorrow could be my turn"). The land user / farmer sends a word around to the land users whom he thinks will assist him. Then a day is fixed for the work. Those who live around, friends and relatives come and assist him in constructing the SLM measures, in this case the checkdams and terraces.

Wonfel is a form of labor share among members of a group organized for sharing labor and each member gets equal opportunity for getting the farm activities done by the land users. The approach has been in existence since time immemorial.

Land degradation, shortage of land and shortage of labor are constraints faced for implementing the approach. The causes for this are: 1) Indirect; lack of labor, lack of capital, lack of knowledge, lack of enforcement of legislation and 2) Direct: agricultural causes, deforestation, over exploitation of vegetation and overgrazing, and natural causes.

Objectives and target

To organize land users in social groups so that they assist each other for getting timely and laborious activities done in time , which cannot be performed by a land user and the family labor alone. The specific objective is to manage cultivated land, moisture harvesting and increase the productivity of land.

Decision making

Decision on the choice of SLM measure is made by the land users themselves. No other technical people or decision makers are involved in the choice of the technology except providing technical assistance. Decisions on the methods of application of SLM technology is made by the land users (bottom-up). Technical people are involved in providing advice or technical support on the ways of implementing the technology. Decisions for implementing SLM technology at the household is made mainly by men. All groups in the community have right for decision making on their own land.

Framework for the approach

The community members in the area have established informal social groups that uphold and facilitate social life, mutual assistance and observance of a given traditional norms. There is regional regulation for land use and administration which has provisions of SLM, which states that land users would be required to protect the land they are holding from degradation, erosion etc. The proclamation enforces the rights for proper use and penalty for not properly managing the land. Land users will not have right to use the land if they fail to manage the land so that it continues to be productive. The Government encourages farmers to practice management measures on their land and provides technical and material support to land users willing to manage their land. For implementing SLM activities community members are organized in groups and they participate in all stages of planning, implementing, monitoring and evaluation.

Land users attitudes

The attitude of the majority of land users towards the approach is positive but few land users at the moment are reluctant to provide free labor to their friends, relatives or a villager who cannot hire labor. Nevertheless, quite a number of land users make best use of the approach. Women headed households and households who face labor constraints benefit most from the approach, when they request for support and are able to provide food and drinks. The better-off land users have financial means and capacity to access Debo more often and the average land users have opportunities to get organized in Wonfel. A land user or a group could initiate the establishment of a Wonfel and interested land users join to be members. Each land user will have his turn to be assisted by others for getting the farm activities done. In case of Debo the request comes from anyone who needs labor from others and could provide food and drinks.

Methods applied for involving land users at different phases

Phases	Methods of engaging	Action
Initiation	A land user requests and organizes a Debo. One or more land users could propose to get organized in Wonfel	A land user seeking labor support requests for support in case of Debo but in case of Wonfel schedule is prepared, which determines the date when a land user will get his turn.
Planning	The group for Wonfel An individual for Debo	
Implementation	Group for Wonfel Group for Debo	The group sets work schedules
Monitoring and evaluation	Measurements / observation / reporting	Each activity is measured by the group leader.

Training

Target groups	Training	Number of courses	Men trained	Women trained
Land users	Techniques of moisture conservation,	1	70%	30%
Extensionists /trainers	Techniques of implementing planning approaches	Several		
SLM specialists	SLM techniques and planning and various participatory planning approaches	Several		

Extension

Extension of the SLM technology is carried out through the regular extension system of the government. Extension agents are trained in general agriculture and natural resources management. The extension agents are mainly government staff but some NGOs and projects have extension workers as well.

Direct subsidies

There are no subsidies for the SLM approach. It is mostly through voluntary labor and material of the land users that most of the costs needed for the approach are covered. Hand tools and planting materials (seeds and seedlings) are partly provided by projects where projects operate. The approach has greatly encouraged the establishment and functioning of local institutions.

Credit

Credits are not available for SLM activities such as terraces, checkdam, bunds etc. However, there is some credit for activities such as water harvesting structures and other SLM activities.

Monitoring and Evaluation

Monitoring procedures

Aspect	Type	Frequency	Indicators
Bio -physical	Observation	Ad hoc	Change in slope, soil depth, soil moisture
Technical	Measurements	Regular	Standards, quality, area coverage, contour
Economic / production	Observation	Ad hoc	Income of land users, land productivity
Area treated		Regular	Hectare of land treated, land cover, land use change
Number of land users involved			Number of participating land users in the work

Reporting procedures

Type	Addressed to	Specific procedures
Kebele reports	SLM specialists	Achievement reports come from land users
Woreda reports	Woreda office	Kebele reports are aggregated
Regular meetings	Decision makers /Politicians	Wereda activity achievements
Regular meetings	SLM specialists	Analysis and review of the report /monthly, quarterly and yearly/
Regular reports	Office heads	Monthly, quarterly and yearly analysis

Impact

The approach has helped land users to improve soil and water management activities.
Changes including improvements are observed in laying out the contour lines, planting soil fertility improving plants, planting multipurpose trees and shrubs and improving land productivity. The approach has led to the changes in the management of croplands greatly. Planting economically useful fruit trees and crops is increasing. Livestock numbers particularly of large stocks decreased because additional grazing is being cultivated. The approach has helped land users to improve grazing lands moderately. Forest and woodlands are also addressed by this approach and a lot of plantation has been undertaken.

Problems: Natural woodlands, shrubs and forests are exploited; encroachment to state forest areas is increasing because of expansion in cultivated lands, which is triggered by rapid increase in population.

Implementation progress

The implementation progress has continued to increase. Similarly, land users understood very well the advantage of working in groups for sharing labor. Moreover, the approach has helped in strengthening and encouraging the formation of local institutions such as associations and various social groups

Other approaches used by various projects implemented in the area affected the approach. In the same woreda and in neighboring woredas there are projects such as the Safety Net Program and Food for Work projects, which provide food and cash payment to implement SLM activities. This resulted in developing negative impressions on land users in the SLM technology area, which are organized in labor assistance and are not given any kind of incentives.

Land ownership and use rights

The policy in the past for land ownership and use affected the approach to some extent. However, the recently issued Land use and Land Administration Policy and Legislation helped to solve the problem to a certain degree. The approach has little to influence the land tenure policy of the government. The land certification regulation is expected to motivate land users' feelings of being relatively secured of their user rights, which did not exist before.

Conclusion

Land users continued to implement the approach without external support.

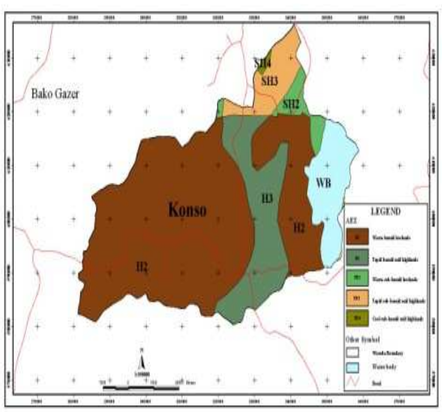
Strength and weaknesses

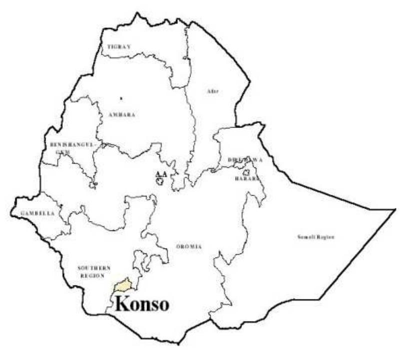
Strength	**How to sustain**
Sustainable	Encouragements and support
Group work helps to strengthen friendship and socialization	Training to be strengthened

Bench terrace developed after years of stone wall construction, maintenance and cultivation practices: (Photo 2007)

2. Konso Bench terrace (Konso)

Common Name of SLM Technology: Terrace
Local name: Kawata (Konso)
Associated approach: Voluntary labor assistance and labor-share (Debo/Wenfel)
Contributing SLM specialist: Friew Desta, Bureau of Agriculture, Southern Nation, Nationalities and Peoples Region (SNNPR), Awassa, Ethiopia
Date: 10/10/2002. Updated: 2007
Area information
Basin/Watershed: The lake basin
Woreda: Konso Special Woreda
Total SLM Technology area: 1500 sqkm





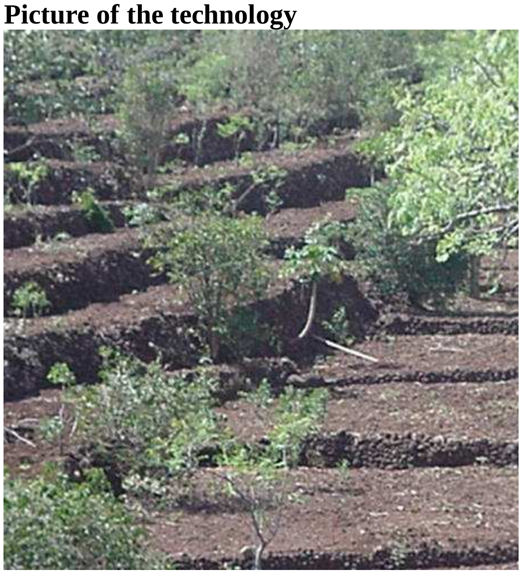
Agroecological map of Konso ***Location of Konso***

Definition

A stone embankment placed along the contour with land leveling in between two terrace walls to control soil erosion and increase rainwater retention.

Description
It is a traditional SLM practice whose wall is constructed from stones and supported at the down slope side by trees and legumes such as pigeon pea, coffee, moringa, etc. It is constructed by social organization (Debo) or labour wage (Parga). The purpose of the structure is to break the slope length and reduce flow concentration to control soil erosion and enhance moisture conservation. The first step during establishment is to dig foundation up to 30 cm and place the stones on the trench to form the foundation of the stonewalls. The height of the terrace wall is in the range of 1.5-2 m high above the ground, and in some cases even more. The Technology area is characterized by steep slopes, high percentage of surface stoniness, low rainfall, shallow and shallow to moderately deep soils.

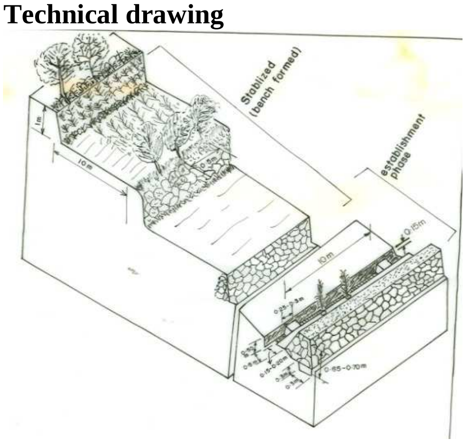
Picture of the technology

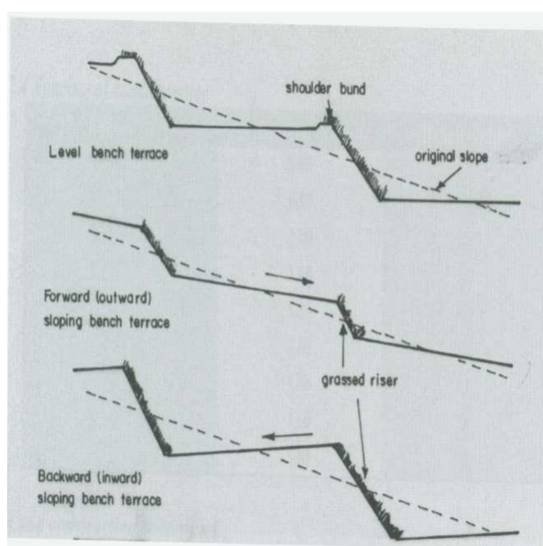


Bench terraces and inter terrace rainwater management measures in Konso (Photo 2006)

Stone terraces on a process of being converted to bench terraces (Photo 2004)

Technical drawing





Erosion due to water is controlled in the cultivated terraced lands but erosion is serious on cultivated lands that are not terraced or where terraces are not adequately maintained.

Land degradation

Problems: Shortage of rainfall and the erratic nature are the main constraints to agricultural and natural resources development and management. Lack of labor, food shortages and very little access to oxen plough, land shortage, moisture stress, soil fertility decline, shallow soil depth, high cost of farm inputs and pests are the constraints that limit agricultural productivity. Konso cropping system is largely multiple cropping and it is basically practiced for averting risk of crop failure. Without this technology crop failure is most likely and in case of shortage of rainfall one of the crops has the chance to survive and provide production. Leguminous crops are intentionally grown for soil fertility improvement along with other practices such as terrace maintenance. Introducing effective use of rains received, increased use of manure and compost, water harvesting structures and the use of energy efficient methods of land cultivation could solve the problems stated.

Types of land degradation on the land surrounding the SLM area

Land use	**Type of degradation**	**Degree**	**%**	**Landform (s)**
Cultivated land	Water erosion	S	80	HFR
Cultivated land	Chemical deterioration		80	HFR

Source: Woreda Agricultural Office

Technical function

Main	**Secondary**
Control of dispersed runoff	Reduction of slope angle
Increase and maintain water stored in soil	Sediment harvesting
	Increase of infiltration
	Improvement of soil structure

Status

The technology is indigenous and it has been practiced since long time (over 500 years according to elders in the area). The Konso Bench is practiced with the objective of reducing soil erosion and retain soil moisture. Today, the indigenous SLM is continued and maintained. The appearance of the applied technology is gradually changing over time from stonewalls to bench terraces laid out on contour lines.

Construction and maintenance

Activity	**Energy**	**Equipment**	**Timing**	**Frequency**
Field activities for agronomic measures				
Land preparation, sawing / planting, weeding / cultivation and manure application	Manual labor	Hoe	Dry season and beginning of rainy season	1-3 a year
Construction activities for structural measures				
Survey / lay out, collecting stones, digging foundation, land leveling and piling stones	Manual labor	Water level, poles, scoop hoe, spade	Dry season	Once a year

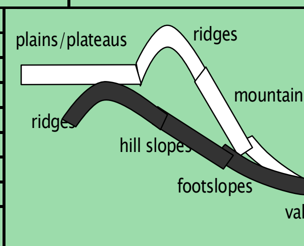
Maintenance activities for structural measures				
Stabilizing by putting additional stones, planting multiple crops, repairing breached terrace parts and replanting of vegetative material	Manual labor	Crowbar, hammer Hoe, spade	December-February and April - \June	1- 2 year

Soil moisture is the main constraint to crop and livestock production and is followed by lack of labor and access to oxen plough. Introducing water harvesting measures and the use of oxen for land preparation would solve the constraints prevailing in respect to crop production.

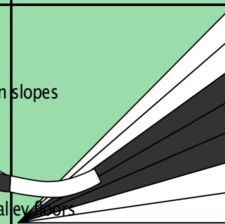
Natural Environment

Average annual rainfall (mm)	Altitude (m a.s.l.)
>4000	>4000
3000-4000	3500-
2000-3000	3000-
1500-2000	2500-
1000-1500	2000-
750-1000	1500-
500-750	1000-
250-500	100-500
less than250	less than250

Landform



Slope (%)



(>60)
steep (30-60)
hilly (16-30)
rolling (8-16)
moderate (5-8)
gentle (2-5)
flat (0-2)

Soil depth (cm)

0-20
20-50
50-80
80-120
less than120

Growing season:
Soil fertility: low -very low
Soil texture: Medium (loam) -Coarse (sandy)
Surface stoniness: abundant loose stone- some loose stone
Topsoil organic matter: low (less than1%)
Soil drainage: Good
Soil erodibility: High - Medium
Soil water storage capacity: low - medium

Human environment and land use

Typical household size of the land users is 7 persons. Population density is 50-100 persons/km^2 and the annual population growth is 2-3 %. Land ownership and land use rights did not affect SLM because the Konso bench has been practiced since long (over 500 years). Similarly, subdivision of land did not affect the implementation of the SLM Technology.
There is a moderate difference between the better-off and poor in how they practice SLM. The average and relative rich can implement SLM by hiring labor, but the poor do it by themselves if they are able otherwise the land is not treated. Off-farm income for the land users who apply the SLM technology is less than 10% of all income.

Level of technical knowledge required for implementation of the technology is moderate for field staff / extension workers and as well as for land users. Percent land users that cannot read and write is 80%. The technology is traditional and hence the inability to read and right has no effect on it.

Cropping system and major crops

Land cultivation is performed by manual labor using the hoe. Major cash crop is coffee. Major food crop is sorghum followed by maize. Other crops grown include: sunflower, pigeon peas, beans and millet. Water supply is rain fed and the type of cultivation is continuous cropping. Intercropping is greatly practiced. Crops that are intercropped include: Pigeon pea, Sorghum, Sunflower, Maize, Millet, Coffee, Cassava, Rahmanus (Gesho) etc. Sequence of crops: Sorghum/maize-Oil crops /pulses – sorghum/Teff (Maize - pulses. Konso is known for its local beverage called Chaka which is made from Sorghum and maize. Chaka is the staple local drink prepared by almost all households regularly and often used by the Konso community.

Benefits, advantages and disadvantages

With or without SLM	Main plant	Production (t/ha)
Without	Sorghum	0.4
With		0.6

Information mainly based on estimates and some previous reports

Finances

Cost details	Input (unit)	Quantity	US$	% borne by land user
Materials	Stone (m3)	200	300	100
Equipment	Tools (no)	35	70	10
Labor	Person-days	1650	1790	100

Economic analysis

Gross production value in US dollars per hectare per year without SLM around the SLM Technology area is less than 100. With SLM Technology, the gross production value of the land per hectare per year is greater than 200 US$ / ha / yr.

Adoption and adaptation

Land users who have implemented the technology, have done it wholly voluntarily, without any incentives other than technical guidance are 90% of land users that have applied the SLM Technology and this accounts for 95% of the technology area.

Supportive measures: Tide ridges are made up of stone and earth for moisture harvesting.

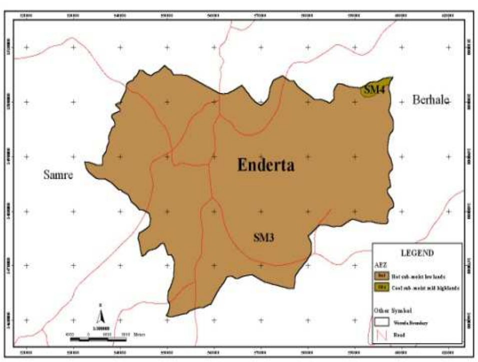
II. Introduced physical land management measures

Stone bunds constructed on cultivated lands (Photo 2002)

Water stored in ponds protected by stone bunds (Photo 2002)

3.2. Contour stone bunds (Enderta,Tigray)

Common Name of SLM Technology: Stone bunds of Tigray
Local or other name(s): Emni Zala (Tigrigna)
Associated Approach: Mass Mobilization
Contributing SLM specialist: G/Hawaria Wolde Gabriel, Bureau of Agriculture and Natural Resources, Tigray
Area information
Total SLM Technology area is 330.15 sq km.



Agroecology of Enderta Woreda

Location of Enderta

Definition

An alignment of stone barriers along the contour line and a soil embankment on the upper side and planted with grass and or fruit trees.

Description

It is a barrier to runoff formed across the slope established by stone walls and a soil embankment on the upper part. The soil embankment is for planting grass and useful trees. The purpose is to reduce soil erosion, conserve moisture, decrease slope length, and to decrease downstream siltation. It is integrated with biological SLM measures and maintenance is made regularly wherever necessary. The technology enhances the growth of natural grasses and improves microclimate. The SLM technology is suitable to all climatic conditions and could be applied wherever there is enough stone for construction.

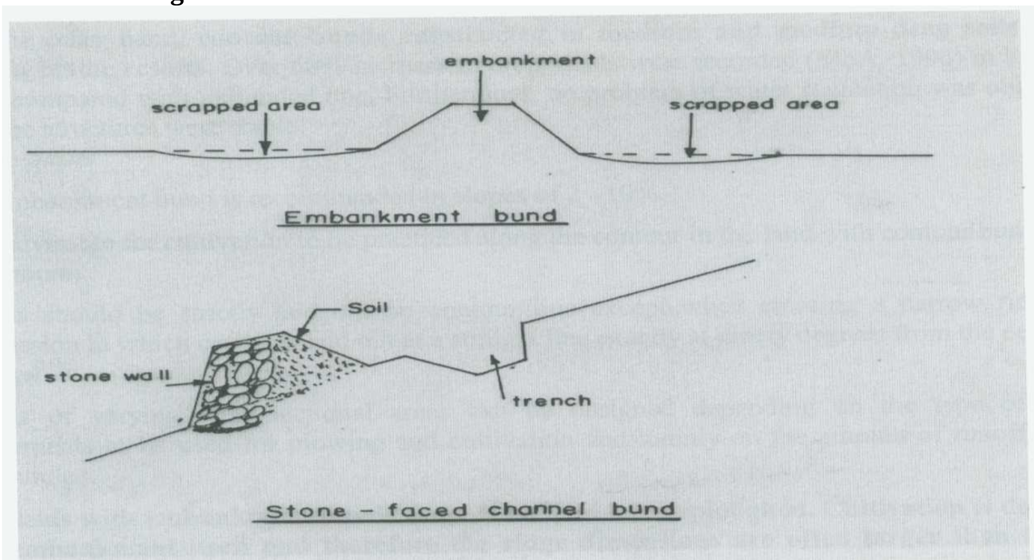
The technology is best described as program implemented. The SLM Technology is mainly new, including some indigenous practices. The technology was introduced from other countries such as India. Similar, indigenous SLM Technologies have been used before the current SLM Technology was introduced. These were simply stone lines embanked along a line not on a contour.

The aim of the technology is to reduce soil erosion, form farm boundary, and support tree plantation and crop planting. Today, the indigenous SLM is discontinued and replaced by the introduced measures. Stone bunds are of vital importance in reducing erosion and improving moisture in the soil. The current SLM technology was designed by National Specialists and the Regional Specialists made an improvement on this. The appearance of the applied technology has moderately changed overtime. Stone bunds silt up soon and converted to bench terrace in 5-6 years time, provided they are well maintained and upgraded on yearly basis.

Stone bunds on cultivated lands (Photo WOCAT Documentation, 2000)

Outward sloping bench terrace formed from soil bunds (Photo 2007)

Technical design



Land degradation

Technical function and impact

Main	**Secondary**
Trap dispersed runoff	Sediment harvesting
Water harvesting	Increase infiltration
Erosion control	Reduction of slope

Purpose and classification

The major land use problems in the area without SLM include soil erosion, overgrazing and soil compaction, deforestation, decline of fertility and productivity, aridity, low soil moisture, and free grazing. The problems from land user's point of view: shortage of drinking water, shortage of fodder and fuel wood, drought.

Characterization and purpose

The technology combats land degradation by means of controlling dispersed runoff, reduction of slope length, increase of infiltration, trap sediment, maintain water stored in soil and water harvesting. It is also intended to provide off-site benefits. It reduces runoff and decreases sedimentation, increase spring development, and enhances vegetation growth. Important constraints include: free grazing, farming practices that are not performed following the contour and lack of integration with biological measures.

Specification of vegetative measures

Type and alignment of vegetative measures (m)

Strips/blocks	Material	Plants/ha	Vertical interval	Ground spacing	Strip width
Vegetative material	Trees / shrubs	100	0.8 -1.5	15-20	4 -8

Establishment and maintenance activities

Activity	Energy	Equipment	Timing	Frequency
Field activities for agronomic measures				
Contour cultivation	Manual labor/ Animal traction	Hand tools	January-June	3-4 times
Establishment activities for vegetative measures				
Area closure (leave for natural regeneration)	Manual labor		June-October	Once
Construction activities for structural measures				
Survey and layout	Manual labor	Surveying materials	December	1-2 times
Stone collection		Hammer	January	Once
Stone collection	Pack animals	Crowbar	January	Once
Foundation excavation	Manual labor	Hand tools	Jan.-March	Once
Construction	Manual labor		Jan. -March	
Maintenance activities for structural measures				
Repairing broken parts of bund	Manual labor	Hand tools	December	Once

Acacia and other indigenous plants grow on the bunds naturally and major constraints during construction and maintenance include: livestock interference, rodents, dry soil and transporting stone. Possible improvements shall consider: protecting bunds from grazing and practice cut and carry for stall feeding, introduce controlled grazing system, integrate biological measures to control rodents and create awareness to the land users so that they carry out the maintenance by themselves.

Specification of structural measures

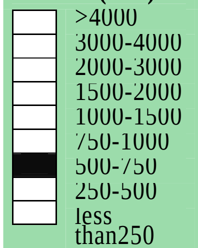
Type and layout of structures

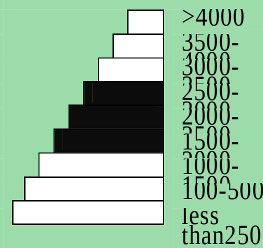
Structure	Material	Length (km/ha)	Space between two structures (m)	Vertical interval (VI) (m)	Width (m)
Embankment	Earth	1-2	5-10	0.8-1.5	0.75-1.25
Channel	Earth	1-2	0.20 of the same line 5-10 on alternating lines	0.8-1.5	0.30-0.65

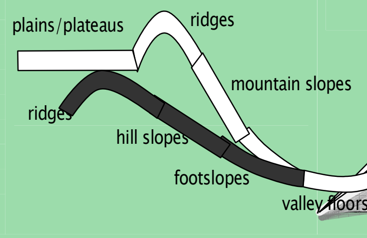
For water harvesting, the ratio between the area where water is applied and the total area in which water is collected is 1:1 - 2:1. Vegetative measures are used for stabilization of structures but the survival rate has been quite low owing to open grazing and moisture stress.

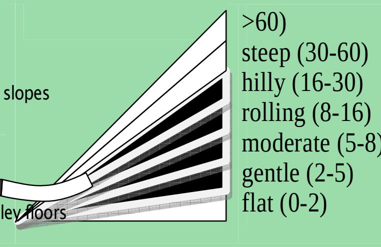
Natural Environment

Average annual rainfall (mm)	**Altitude (m a.s.l.)**	**Landform**	**Slope (%)**

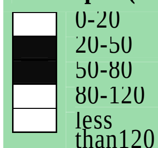








Soil depth (cm)



Growing season:
Soil fertility: medium, low
Soil texture: medium (loam), fine (clay)
Coarse (sandy)
Surface stoniness: some loose stone, no loose stone
Topsoil organic matter: medium (1-3%), low (less than1%)
Soil drainage: medium, poor, good
Soil erodibility: medium, low, high

Number of heavy storms of water per year is less than 10. Heavy storms occur mostly in the beginning and middle of the growing season. The rainfall in the growing season is sufficient for cereal crops but not well distributed. The number of growing season per year is 1.

The trend in land size per household is showing a decreasing trend because of population increase. Land ownership and land use rights slightly affected SLM. Similarly, subdivision of land has affected the implementation of the SLM Technology to a given degree. Some farmers are reluctant to maintain damaged terraces because they feel insecure of land holdings.

Crop and Livestock management

Crop harvest in the area with the technology is very good. Terraces increased soil moisture retention and improved crop stand with improved. Wheat grown in the terraced field is seen in the picture right. The watershed is properly treated and as a result the crop stand is better compared to crop fields not terraced and the watershed uphill is not properly treated.

Types of animals

Large stock	**Cow, ox, donkey, camel**
Small stock	Sheep, goat
Wild animals/game	Hyena, fox, rabbit

The current trend in herd types is more large stock because of the growing need for draught power and milk production. The number of livestock units per household is 3-4 small stock and 1-2 large stock. The current trend in livestock numbers shows slight reduction, the reason being lack of fodder and diminishing grazing lands. Land cultivation is performed by animal traction mainly and by manual labor in some cases.

Costs

Category	Input	Quantity	Cost (US$)	% borne by land users
Equipment	Animal traction number	15	83.00	
Labor for construction	Person days	126	110.00	*83*
Maintenance	Person days	12.85	11.25	*83*
Total			*204.25*	

The most important factors affecting costs are: availability of construction materials in the area and excavation of foundation. Costs are calculated for the length of structure (about 600m soil bund is constructed per hectare). Daily wage cost of hired labor to implement SLM is 0.875 US $ per person per day.

Benefits, advantages and disadvantages

With or without SLM	**Crop**	**Production (q/ha/yr)**
Without SLM	Wheat	0.8
	Teff	0.5
	Barley	1
With SLM	Wheat	1
	Teff	0.7
	Barley	1.3

The technology is improved to achieve more benefits through: awareness creation of the community, improving the quality of measures, participating the community from planning phase to implementation and by controlling free grazing. The technology helped in reducing sediment and runoff flow from up hills and this has posed difficulties on the bottom cultivated lands that depend more on runoff coming to them.

Economic analysis

Without SLM, the gross production value in US dollars per hectare per year around the SLM Technology area is 125 / ha / yr.

Compared to the situation without conservation the percentage gross production value increase 10 years after implementing SLM is over 200% considering also the land occupied by conservation measures and in assuming current input and prices.

Adoption and adaptation

Changes that have been made to the technology came as a result of realizing the benefits from stone bunds. Land users prefer to construct big stone walls so that these withstand external pressure of grazing animals and other farm activities. About 83% of the land users, who have implemented the technology, have received incentives for undertaking the activities. They were about 2075 of land user families and account to 90% of the technology area. Percent land users who have implemented the technology, without any incentives, other than technical guidance are 17. There is no trend towards growing spontaneous adoption of the technology. Land users are seen to seek some incentives for activities they undertake in land management.

There is enough local skill and support to expand the SLM Technology. There are production cadres in the community who are trained in SLM activities and act as link between DAs and the community. They are responsible for providing awareness among land users and do most of the technical and social mobilization matters in the community.

Maintenance
Land users maintain or manage what has been implemented but labor is the main constraint. Land users maintain the structures, which are built on their land but not those built on communal lands. They need to be compensated for activities on communal lands. Most projects support the communities by compensating them for the labor they expend on communal lands.

Supporting measures
Stone bunds are effective when implemented along with supplementary activities such as hillside plantation, gully rehabilitation with vegetative and as well as structural measures as could be seen for the pictures below

Gabion checkdams applied in integration with elephant grass for rehabilitating gully

Strength and weakness

Strength	Sustain / improve
Erosion control, moisture harvesting	Maintenance, stabilize with biological SLM measures
Crop and fodder production increased	Increase plantation of high quality fodder and high producing crops
Increased livestock production	Integrate fertility enhancement measures such as manure, compost and green manure application
Enhanced ground water recharge	Apply efficient runoff retaining structures

Weaknesses / disadvantages	Overcome
Labor intensive	Incentives needed
Shortage of construction materials and hand tools	Provision of hand tools
Shortage of skilled labor	Skill enhancement by training
Reduced cultivated land	Widen the spacing between bunds
Harbor rodents	Integrate with biological SLM measures and take rodent control measures


Community particicpation in mass mobilization approach, Tigray (Photo 2007)

3.2. Mass Mobilization

Common name of the Approach: Mass Mobilization (community mobilization)
Contributed by: Wolde Gabriel G/Hawaria
Address: Tigray Buraeu of Agriculture, Mekele
Technologies associated with the approach: Stone faced trench bund, Stone bund
Area information
Region: Tigray.; localities: Laelay Adet, Tahtay Adet, Naedir

Definition

Mass Mobilization is an approach pursued to implement SLM technologies by organizing land users to undertake SLM activities without incentives being involved.

Description

It involves the process of mobilizing and organizing land users in the community (men, women, and youth) who are able-bodied to participate in SLM activities. Land users participating in mass mobilization are required to form SLM groups. Plan for SLM is made at the woreda level and then distributed to kebeles and or sometimes each kebele proposes plan, which is later approved by the woreda. Each member contributes free labor of 20 days every year to undertake land management technologies (past) and this contribution is increased to account for 40 days a year since 2009.

The specific objective is to make land users participate in the management of land by implementing improved technologies. SLM measures control runoff and enhance rainfall water percolation. The approach involves organizing land users in SLM groups. Recently two groups are formed known as development team and a sub group called a work team. A development team group comprises 20-30 members while the work team group is 10-15 members. Women and men participate equally in the work groups and in leading the team. Activities undertaken by mass mobilization are mostly (80%) carried out on cultivated lands. Every day the group evaluates its activities. They also participate on the discussions of the plan.

There is a leader for each group and a production cadre for the groups at Kushet level (the lower administrative unit) who supervises activities of the groups. The groups also work on activities other than SLM. Problems addressed include: soil erosion, deforestation, declining productivity of land, low fertility of soil, low level of participation of the community in SLM activities.

All land users in the community are expected to participate in the implementation of the technologies through the mass mobilization approach. The approach area is defined by administrative and as well as watershed boundaries. The Kebele and woreda administrators, woreda specialists and development agents coordinate the implementation and planning of the approach.

Constraints hindering proper implementation of the SLM technology

Main	Specific	How to avoid
Financial	Shortage of hand tools	Provide hand tools
Cultural and religious	Many holidays are celebrated, and land users do not work on those days	Awareness creation
Technical	Widely spaced bunds do not control inter bund erosion	Training to be provided and also promote awareness

Objectives and target

Aware, organize and initiate land users to participate in SLM activities that aim at controlling soil erosion, which causes land degradation and encouraging land users to contribute free labor for implementing the SLM technologies introduced.

The specific objectives are: I) promote the awareness of land users on land degradation problem and II) show the importance of SLM measures which protect cultivated lands from erosion, retain soil moisture and improve fertility of soils.

Decision-making

Mainly SLM specialists in consultation with land users make decisions on the choice of SLM measures. Some community members are found not willing to contribute free labor for SLM activities in the past but currently many land users are convinced of the benefits of mass mobilization. Mainly SLM specialists in consultation with the community leaders make decisions on the methods and approaches for the implementation of the SLM Technology. Decisions for implementing SLM technology at the household level is made by both men and women. The resource poor are involved in decision making at the community level. All community members participate equally in decision-making at the community level.

Framework for the approach

Traditional rules exist for protecting and managing natural resources. There are community bylaws that encourage and prompt community members to participate in SLM activities and protect the assets created. The community recognizes traditional rules and large members of the community abide by it. The regional government has recently issued Land Use and Administration Proclamation that bestow responsibilities and obligations on the community to manage their land. The proclamation enforces the rights for proper use and penalty for not practicing the legislation. A land user will not have right to use the land if he fails to apply conservation measures on the land or lets the land to degraded and loose its productivity.

There is a policy provision that encourages farmers to practice conservation on their land. The regional government provides technical and material support to land users willing to conserve their lands. For implementing SLM activities community members are organized in groups and they participate in all stages of planning, implementation, monitoring and evaluation.

The government initiated the approach and specialists designed it. The Regional Bureau of Agriculture coordinates the SLM program and the Woreda Office for Agriculture is responsible for implementing and mobilizing land users to participate in the implementation. Development agents, kebele chairman, leaders of women and youth associations, the head of economic sector in Tabia Administration and two knowledgeable land users are represented in land management committee that mobilizes and leads the community for mass mobilization.

Participation

Specific target groups: land users, SLM specialists / extension workers and politicians / decision makers. Land users mobilized by the approach include all wealth categories (better-off, average and the poor). The attitude of the majority of land users towards the approach is positive. Some attitudinal changes were observed on land users who did not have positive attitudes in the beginning but after having observed the results of the SLM technology, their attitudes has changed and have later developed positive image towards the approach. Land users are more interested in getting immediate benefit from the technology. Land users are keen to plans of short period and few of them think of long term plans, particularly in regards of maintaining the fertility of land and pass it on to their descendants.

Methods applied for involving land users at different phases

Phases	Methods of engagement	Action
Initiation	Public meetings	General assembly meeting called for awareness creation and informing about the development plan.
Planning	Training	Train SLM commission members. They plan the activities which is later endorsed by the general assembly
Implementation	Free labor	20 days/yr
Monitoring and evaluation	Measurements / observation / reporting	Each activity is measured by the team leader and the other committee members.

Financing

Responsible	Item	% contribution
Community / local	Labor and material	95
Government	Training and work tools support	5

Direct subsidies

Labor from the land users is the most important input of the investment. It is mostly voluntary although initiations are taken by policy makers and the technical people. Hand tools and planting materials (seeds and seedlings) are provided by the local government and donors. The approach has moderately supported the establishment and functioning of local institutions.

Monitoring and Evaluation Procedures

Indicators	Type	Frequency	Indicators
Bio -physical	Measurements	Ad hoc	Soil depth, change in land use and land cover,
Technical		Each month	Dimensions and quality
Economic / production		Ad hoc	Increase in production per unit area
Area treated		Every month	Extent of work done
Number of land users involved		Every month	No. of participating land users in the work
Management of approach	Observations	Yearly	Impact, changes

Reporting procedures

Type	Addressed to	Specific procedures
Ad-hoc / sporadic	Politicians	Annually on special occasions
Regular meetings	Land users	Every week
	SLM specialists	On weekly basis
Regular reports		Every month
Regular reports	Politicians	Yearly
Extension / training materials	SLM specialists	As need arises and new technology is introduced

Evaluation

Groups that contributed for the evaluation

Groups	Type of evaluation
Land users	Strength and weakness, impact of the approach
SLM specialists/extensionists	Specifications, land users attitudes
Politicians /decision-makers	Plan versus achievements

Impact

The approach helped to carry out SLM technologies in considerably large area in short time because almost all land users participated in contributing labor for the work. This promoted the individuals understanding about land degradation problems better and encouraged them to contribute voluntary labor to SLM activities. Land users obtained knowledge and motivation to carry out SLM activities on their plots and also maintained SLM measures applied on their land. Forest and woodlands are also addressed by this approach and a considerably large area of plantation is undertaken pursuing this approach.

Implementation progress

Over the last few years the implementation progress has increased. Similarly, land users attitudes and working spirit has changed positively and more land users are convinced of the advantages of the approaches. Moreover, the approach has helped in strengthening and encouraging the formation and functioning of local institutions such as kebele associations, community conservation groups and various social groups

Strengths and weaknesses

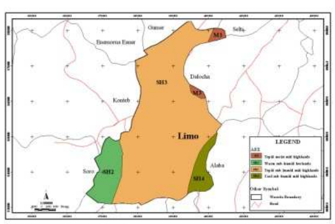
Strength	How to sustain
Working in group improves the management of large area of cultivated lands in short period	More training, awareness and study tour opportunities to be provided. Provision of hand tools.
Easy transfer of technology possible	
Weakness	How to avoid
Unwillingness from some land users to work in group.	Convincing land users.

Relay cutoff drains place along a pathway to convey runoff (Photo 1994)

Proper land management results in better crop performance (Photo 2004)

4.1. Graded soil bunds and relay cutoff drains (Hossana, SNNPR)

Common Name of SLM Technology: Relay cutoff drains
Local Name: Ditchra (Hadyisa)
Local or other name(s): Gidad. Yeafer Kab (Amharic)
Associated approach: Food for Work
Contributing SLM specialist: Daniel Danano Dale , Ministry of Natural Resources and Environment Protection.
P.O Box 62474, Addis Ababa.
Date: 27/06/1995: updated: 2007
Area information
Location: SNNPR: Lemo Woreda
Total SLM Technology area: $300km^2$



Agroecological map of Lemo woreda

Location of Lemo Woreda

Definition

Relay cutoff drains are structural measures constructed by digging a graded channel and embanking the soil to form a ridge. It is combined with graded soil bunds constructed on cultivated lands designed to safely discharge surplus rainwater from the field. They are particularly useful during the early planting season.

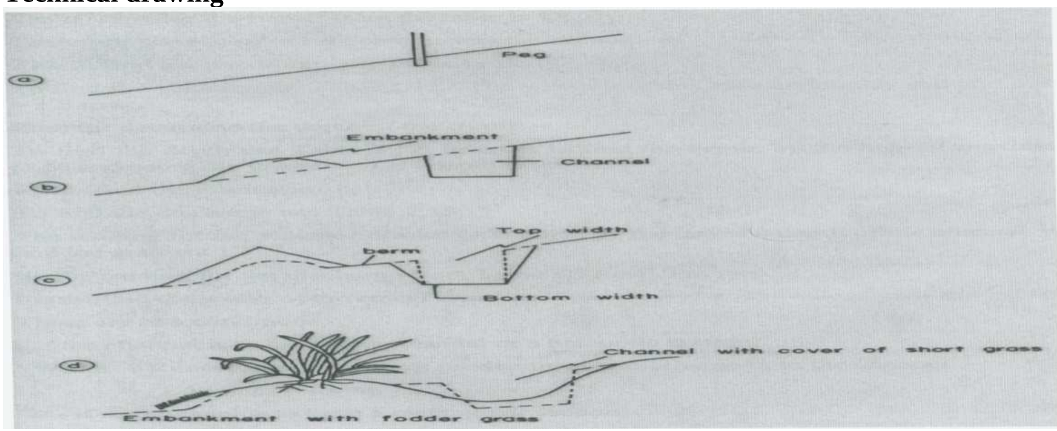
Description

Relay cutoff drains are applied in combination with graded soil bunds in the highlands with high rainfalls. They are placed on the top of graded terraces constructed on cultivated lands. They are suitable to highlands with high population densities and particularly in areas where cultivated plots are fragmented and land users have small plots that do not allow the placing of wider and longer drains. Relay cutoff drains are most effective and preferred by land users for conveying surplus runoff from one plot to the other by way of relaying the flow without crossing a path, a plot having perennial crops, a property of high value or any establishment that poses difficulties for placing drains across them as could be seen in the Photo of relay bunds above. When there is difficulty or it is impossible to run graded contour across a foot path or a plot with perennial crops or a homestead, then relay cutoff drains are applied by breaking the alignment short and start with a new alignment down slope. The upper relay cutoff drain is designed to carry less runoff and has smaller dimensions compared with the cutoffs placed successively next down slope, which are bigger in dimension to carry more runoff. The cross-section of the next relay cutoff is always kept bigger and bigger than the preceding cutoff since more volume of runoff is expected. Graded bunds carry water to the relay cutoffs and the relay cutoffs to natural or artificial waterways.

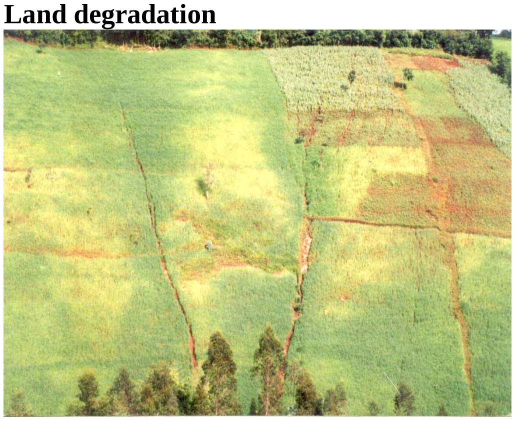
Cutoff drain placed on the upper part of a cultivated land to protect soil bunds and crop fields from excess runoff (Photo 1995)

Terrace developed from graded soil bunds (Photo 2005)

Technical drawing



Land degradation



Land degradation caused by cultivating steep slopes without SLM measures (Photo 1995)

Gully caused by farmland ditches made for draining crop fields (Photo 2004)

Technical functions

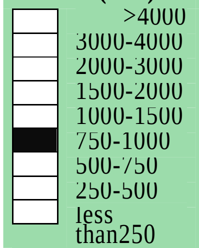
Main	***Secondary***
Reduction of slope length	*Marking field boundary*
Surplus water removal	*Control/ improve drainage in high rainfall areas*
Control erosion	*Support establishing of vegetative SLM measures*

Purpose and classification

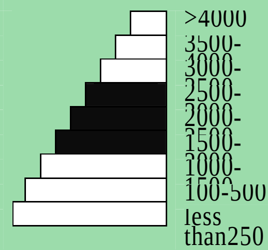
A major land use problem in the area is mainly the lack of awareness of land users on soil erosion problem. Soil erosion reduced agricultural production and as a result farmers have low incomes. The problems from the land user's point of view includes: land shortage, financial shortcomings, poverty, insufficient agricultural inputs, livestock and human diseases, shortage of clean water and lack of adequate public services. The technology combats land degradation by: reduction of slope length, removing excess water and improvement of drainage.

Natural Environment

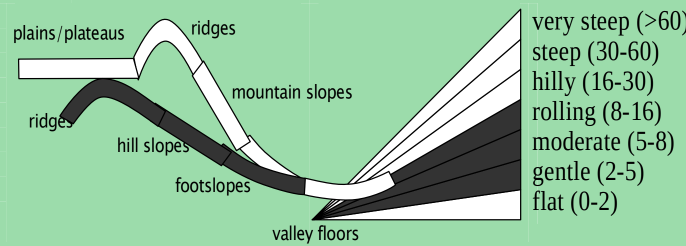
Average annual rainfall (mm)



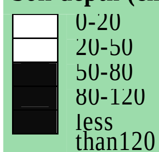
Altitude (m a.s.l.)



Landform **Slope (%)**



Soil depth (cm)



Growing season:
Soil fertility: low, medium, very low
Soil texture: sandy loam - medium (loam)
Topsoil organic matter: low (less than1%), medium (1-3%) and high (greater than3%)
Soil drainage: Good - Medium
Soil erodibility: medium- high
Soil water storage capacity: high, medium

Human environment and land use

Typical household size of the land users is 7 persons. The population density is over 500 persons/km^2 and the annual population growth is 2.9 %.

Construction and maintenance

Activity	Energy	Equipment	Timing	Frequency
Establishment activities for vegetative measures				
Raising seedlings Transplanting and planting	Manual	Shovel, spade, hoe, wheelbarrow, rake	Beginning of main rains	Once a year
Maintenance activities for vegetative measures				
Replanting Weeding and cultivation Harvest	Manual	Sickle, hoe	After the main rains	Once a year
Construction activities for structural measures				
Bund construction Relay cutoff drain construction	Manual	Spade, shovel, hoe	Dry season and before main rains	All round the year except during main rains

Difference between the better-off and poor in how they practice SLM is not much. The rich could pay the labor to undertake maintenance works. Off-farm income of the land users who apply the SLM technology is about 10-50% of all income. The SLM Technology is not hindered, when land users cannot read and write. Land cultivation is performed by animal traction and manual labor. Size of cultivated land per household is less than 0.50 ha.

Crop and livestock production
Seasonal intense rains, sloping cultivated plots, high human and livestock population characterize the southern highlands of Ethiopia. Land preparation is performed by oxen plough. Land is ploughed 4-5 times for crops such as wheat and teff, 3-4 times for barley and beans. Intense rains are received when crop fields are highly pulverized and a fine seedbed is prepared. This causes severe damage to the field unless protected by SLM measures. Crop fields immediately down slope the homesteads are less eroded because perennial crops at homesteads trap rainwater and let little runoff to the field down the slope.

Crop rotation is commonly practiced. The rotation involves pulses-cereals – pulses and cereals on yearly basis. Some land users plant the same crop every year relying on chemical fertilizers but the production has continued to decline from year to year. Land users that rotate crops are seen to have relatively better production compared with those planting the same crop every year.

There is a change in the trends of herd type. Herd size is getting smaller per household but increasing in number with increase in the number of land user households who own livestock. The number of livestock units per household is 2 for small stock and 2-3 for large stock. The current trend in livestock numbers per household is decreasing greatly due to decrease in grazing land as the expansion of cultivated land is increasing at a larger pace owing to in-migration (ex-soldiers and retirees) and population increase.

Economic analysis
Estimating cost recovery period of investment for soil bund technologies. The crop is Wheat. The cost is calculated taking into account 1 Pd = 6 Birr and 1 US$ is 8.6 Birr

Cost -benefit (US$)

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1	156	-	5.5	97.90	12.96	272.26	628	355.74	-
2		15.6	5.5	97.90	12.96	131.96	670	538.04	26.3
3		7.8	5.5	97.90	12.96	124.16	712	587.84	216.5
4		-	5.5	97.90	12.96	116.36	795	678.64	315.1
5		-	5.5	97.90	12.96	116.36	879	762.64	406.9
6		-	5.5	97.90	12.96	116.36	963	846.64	490.9
7		-	5.5	97.90	12.96	116.36	1047	930.64	574.9
Total	156	23.4	41.5	689.3	95.72	999.82	5701	4708.2	2030.6

Note: 1= establishment cost; 2= recurrent cost; 3= land and seed bed preparation; 4= seed and fertilizer; 5 = Weeding and harvest; 6= total cost; 7= benefit; 8= cost – benefit 9= benefit obtained from SLM

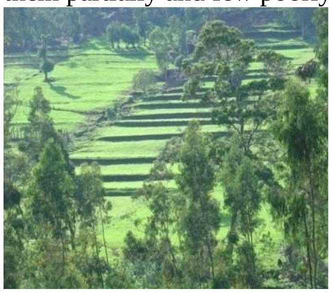
Adoption and adaptation
Land users who have implemented the technology are 10% and they did it wholly voluntarily or without any incentives other than technical guidance. There is a growing trend towards spontaneous adoption of the technology. In some cases the growth in adoption rate is highest particularly on steep slopes.

Supportive measures
Waterways: Physical structures made by excavating earth to convey excess water being disposed from filed bunds and relay cutoff drains.

Uphill plantation: Catchment treatment with suitable tree species aimed at decreasing and/or controlling runoff into the bunded area.

Bund planting: either grass or trees planted on earthen bunds. The process involves planting of grass for stabilizing the structure. Stabilizing natural waterways: waterways that are not stabilized are susceptible to erosion and they trigger the formation of deep gullies shown in one of the picture above..

Maintenance
There are farmers who have maintained the structures adequately, some land users maintain them partially and few poorly maintain. Pictures taken in 2009 below show this.



Land users participating in Food for work based SLM technology implementation, Gonder (Photo 2007)

Gully control measures undertaken through food for work (Photo 2007)

4.2. Food for Work

Common name of the Approach: Food for Work
Contributed by: Daniel Danano
Address: Ministry of Agriculture, Addis Ababa
Area information: Ana Limu, Hossana, Region: SNNPR
Major technologies promoted by the approach: soil bund, stone bund, area closures and hillside terracing

Definition

Food for work is an incentive given to land users for the activities they perform by participating in land management activities.

Description

Food grain and edible oil at a rate of 3 kgs/day of grain and 200 gm of oil per day (previously) only 3 kgs/ pd/day (present) is paid for an activity undertaken by a person. Land users who are selected to participate in the approach should be able bodied to undertake activities in land management and are paid the amount indicated for a given amount of work done according to the norm. A person is required to perform 10 meters a day of soil bund to be paid the rate described above. Other activities have different norms. There are some land users who could do more than this and are entitled to be paid more according to the norm.

FFW's role in soil conservation work: 1. it has motivated the involvement of many farmers 2. Help alleviate food shortages 3. Enabled create assets 4. Strengthened the functioning of Kebele Administration. The approach was implemented through a project initiated in 1990 in the woreda. Problems addressed by the approach included: soil erosion, sever gully and land degradation, loss of cultivated lands, absence of legislations, shortage of fuel and construction material and grazing land shortages. The direct causes for the problems were identified to be overgrazing, vegetation clearing, steep slopes cultivation and poor agricultural practices. Main constraints hindering proper implementation of technologies included lack of community collaboration, lack of sense of ownership and shortage of trained extension workers.

Objectives and targets

Rehabilitation of degraded land and planting trees on denuded slopes and hills: Protecting farmland from soil erosion and improving grazing lands and pasture for improved livestock feed production.

The Specific targets are to improve crop and livestock productivity, reduce fuel and construction wood shortages, control farmland soil erosion, improve grazing conditions and increase livestock production, alleviate water shortages by developing springs and pond construction and provide access roads. Benefits obtained included: rehabilitated degraded lands; improved crop and livestock production.

Decision making

Decisions on the selection of the technology were made purely by specialists and technicians, prior to 1990. After 1990 decisions were made mainly by the beneficiary communities in collaboration with the technical staff. Decisions on the methods of implementation are made by the technical staff in consultation with land users. The poor are involved in the decision making strongly and mainly the men are holders of land. However, men and women do the decision making together. Men work more on terrace construction and women in the collection of stones in case of stone bunds. Women participate more in planting trees, nursery management and in soil bund construction.

Traditional rules for managing and protecting natural resources exist for: 1. Protection of community developed forests 2. Protecting closed areas. 3. Controlling the cutting of trees from natural forests. If a man is found cutting trees from closed areas, he is penalized or he is excluded from sharing the benefits. The positive results: Erosion minimized, forests developed, agricultural yield increased. Negative results: Dependency on food incentives. Cooperation with local institution is on an ad hoc basis. The Development Committee is responsible for initiating cooperation among local institutions.

Participation

Target groups are mainly groups of land users and individual land users. The approach included other groups (groups of users organized by the project). Mostly the poor participate in the implementation of the project activities and some average land users also participate. Land users work by groups whose members could be equally men and women. Women dominate land management activities of plantations and nursery activities. Prior to the introduction of participatory approaches for planning and implementing SLM technologies, women participation was limited to not more than 10-25% in general. However, since the early 1990's onwards the participation of women gradually increased and at the moment (late 2000s) women became the major actors in land management activities in many parts of the country.

There is a moderate difference in wealth among land users in the community. Wealth ranking is by the size of land, fertility of land and the number of livestock owned by the land user. Land users' attitude in the beginning of the project was negative. A remarkable change in the attitude was observed after implementation and the results obtained thereafter. Land users after having seen the benefits of SLM measures started to maintain them. Land users' involvement in planning was passive before1990s and it became active since the mid of 1990's. Implementation and monitoring/evaluation followed the same trend.

Training is adequate for technical staff but inadequate for farmers. Training is not given to all farmers. Nevertheless knowledge of land users to carry out the SLM technology is not adequate. Form of training provided to land users was: demonstration areas, public meetings, and farm visits.

Extension
Type of extension is the conventional Government Extension System. Extension is carried out through government's existing extension system and projects work in collaboration with the extension.

Indicator	Type	Frequency	Remarks
Bio-physical	Observations	Regular	Physical achievements
Socio-cultural	Observations	Regular	Farmers' participation and acceptance
Economic/production	Observations	Regular	Results obtained

Reporting procedures

Type	Addressed / reported to
Regular meetings	Land user, SLM specialist
Regular reports	SLM specialists

Report is submitted every month. There are quarterly, biannual and annual reports

Evaluation
The Project is evaluated by the local government once in a year. Donors evaluate once in 3 or 5 years. Changes are observed as result of land users getting involved in the: 1. Planning of activities 2. Implementation 3. Selection of techniques 4. Identifying problems 5. Involving women to participate 6. Decision making process 7. Use of assets created.

Impact
Improvements are adopted by land users. Traditional soil fertility management was potentially used in the farming systems. The approach also led to proper management of grazing lands. Farmers were encouraged to own more livestock than they used to have, because of availability in improved fodder and grazing condition. The approach also led to changes in the management of forest and woodlands. Due to area closures and hillsides plantations, the quality of forest and woodland improved and the area planted increased. This was further enhanced due to site guards employed to guard the plantations and measures taken in integration. The approach helped in the change of management to crop fields by applying crop rotation and planting nitrogen fixing plants on contour bunds.

The approach has further strengthened local institutions. It has helped create communally owned assets. These have in turn helped in strengthening social interactions among the beneficiaries. An attempt was made to introduce compost making. But only few farmers practiced it. The commonly used method of fertility improvement is by applying manure at the backyards and chemical fertilizers on crop fields.

Adoption, training and extension
Training of farmers promoted the awareness of farmers on soil erosion problem and the means for controlling it. Farmers trained were in better awareness level compared to none trained and they also maintained the SLM measures on their land. Although the approach did not impact in influencing the attitudes of land users on land tenure it helped improve the productivity of land in a sustainable way. Participatory planning and implementing approach is in full swing and perhaps this could further enhance sustainability of SLM. The land tenure policy prior to 2000 was criticized by many (land users, investors, development partners etc) but at the moment since the issuing of Land Use and Administration Policy land users feeling of ownership on the assets created has increased. Developing positive attitudes required long time and experience with the technology.

Conclusion
Changes proposed include: appropriate choice of technologies, using fast growing and easily establishing tree species, high value crops and encourage farmers to maintain assets created.

Stone bunds (Photo 2004 and 2007)

5.1. Stone bunds (North Shewa)

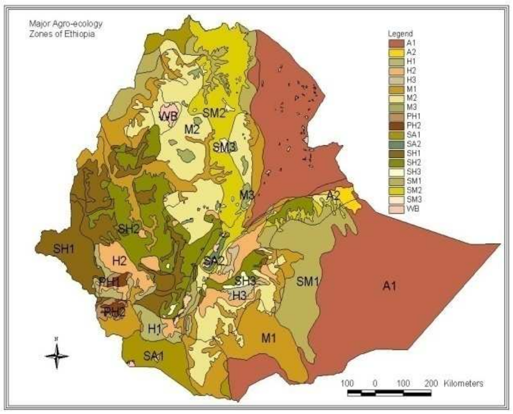
Name of Technology: Stone bunds of North Shewa
Local names: Erken (Amharic), cab (Amharic)
Associated Approaches: Self help, Social community infrastructures Approach
Contributing specialist/compiled by: Eva Ludi, (Researcher), Overseas Development Institute, 111 Westminster Bridge Road, London, United Kingdom
Email: e.ludi@odi.org.uk
Date: 1997, updated, 2007
Area information
Location: North Shewa, Awash and Abay Basin
Technology area: approximately 1’000 km^2

Definition
Stone bunds are constructed with stones, which are more or less aligned along the contour in combination with artificial waterways and traditional ditches to drain excess water, and form boundary banks.

Description
The technology is known for generations. Knowledge is transferred from one generation to the next. According to information obtained from land users, SLM started in 1906 EC (1913 GC) to be implemented at a wider scale in the area. The information is obtained from the Mesobit and Gedeba KA, which are about 500 ha. The SLM technology area is about 1,000 sq km.

The stone bunds have varying dimensions of height 0.5 – 0.6 during the initial construction and can be as high as and more than 2 m after successive maintenance and upgrading. The bottom width is 1 m to 1.5 m and top width of 0.2 m to 1 m. Stones are placed very carefully to form stable terraces, and in some cases, gesho (local hop, *Rhamnus prinoides*) is planted above the stone bunds, bisana (*Croton macrostachytus*) is planted below the stone bund and / or along field borders. Stone bunds vary in height depending on the slope. They are constructed along the contour combined with artificial waterways and traditional ditches for drainage. The height of the stonewall increases with increasing slope gradient. Bunds are maintained regularly and if necessary bunds are raised in height while upgrading or maintaining them. Farmers continue to build bunds on new plots. Stone bunds are suitable to all agro climatic conditions: but more conveniently where stones are available. The construction and maintenance of stone bunds in this area is encouraged by the government apparently owing to the fact that the land distribution of 1996/97 was not carried out in Mesobit and Gedeba, unlike in many other highland areas of Ethiopia.

The technology is best described as local. There is no historical record telling from where the technology has originated. Today, the SLM technology is used more because many farmers are adopting it. On newly cultivated fields, stone bunds are constructed every time. In some rare instances, new bunds were constructed on old plots assisted by Food-for-Work and supported by mass mobilization. Stone bunds are suitable to all agroclimatic conditions but more conveniently where stones are available. Care needs to be taken in areas with high rainfall to carefully drain excess water to prevent water logging. Stone bunds alone are economically not viable; they need to be combined with vegetative and agronomic measures (contour planting, applying mineral fertilizers).



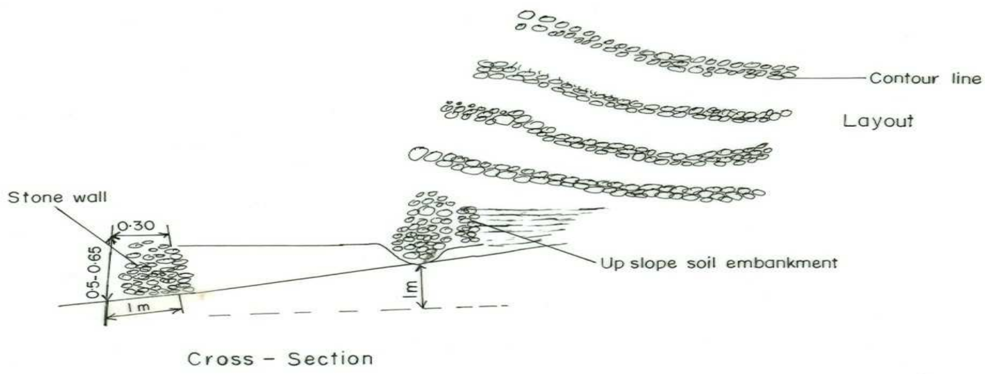
Terraces developed from stone bunds. Stone bunds are suitable to all agro ecological zones. The choice of the technology depends on the availability of stone for bunding

Design of the technology

Development agents (DAs) tried to introduce the idea of constructing stone bunds strictly along the contour. However, farmers preferred to make the layout without using leveling instruments. The appearance of the applied technology thus did not change over time. The construction is quite different from the conventional bunds.

Stone bunds forming outward sloping terraces (Photo 2007)

Technical drawing



Technical function / impact

Main	Secondary
Control runoff (impede, retard)	Reduction of slope angle
Erosion control	Control of concentrated runoff (drain/divert)
	Increase/maintain water stored in soil
	Sediment harvesting
	Increase of infiltration

Land use problems

Continuous cultivation and overgrazing due to high population pressure; declining soil fertility, which is addressed with increasing use of inputs and cultivating very steep slopes for cropping. Pests, continuous cropping which often results in soil fertility decline and overgrazing are the main constraints for sustaining agricultural productivity in the technology area.

Vegetative: Gesho (Rhamnus prinoides) and/or Bisana (Croton macrostachus) aligned
Agronomic (supportive): contour planting, manure and fertilizer application
Management (optional): fencing grazing area

Land degradation

Soil fertility decline is rarely mentioned as a reason for declining crop yield. Reasons for crop yield decline given were mostly change of climate, e.g., untimely rainfall (rain during ripening/harvesting period, no rain during germination period), excess rainfall, and shortage of rainfall. These are evidences given by the land users are indicators for climatic changes. Land users realize that they have been observing significant climatic changes taking place in their life time. Other reason given by farmers for declining crop yield is: land has lost productivity potentials.

Natural Environment

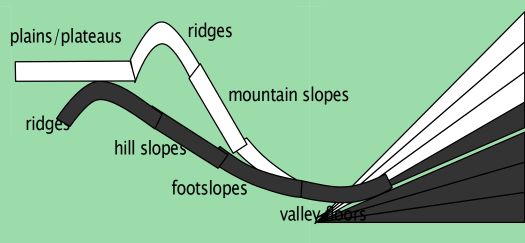
Average annual rainfall (mm)

- >4000
- 3000-4000
- 2000-3000
- 1500-2000
- 1000-1500
- 750-1000
- 500-750
- 250-500
- less than250

Altitude (m a.s.l.)

- >4000
- 3500-
- 3000-
- 2500-
- 2000-
- 1500-
- 1000-
- 100-500
- less than250

Landform



Slope (%)

- very steep (60)
- steep (30-60)
- hilly (16-30)
- rolling (8-16)
- moderate (5-8)
- gentle (2-5)
- flat (0-2)

Soil depth (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- less than120

Growing season:

Soil fertility: low-medium

Soil texture: sandy – loam soils

Surface stoniness: some stoniness to stony

Topsoil organic matter: very low

Soil drainage: medium to high

Soil erodibility: high

Growing season are 2 per year. Rainfall in growing seasons usually is sufficient with periods of excess in the main season and insufficient and not well distributed in the second season.

Implementation activities, inputs and costs

Establishment activities for vegetative measures

Activity	**Source of Energy**	**Equipment**	**Timing**	**Frequency**
Planting vegetation and manure application	Manual labor	Digging stick, hoe, basket	Beginning and in the middle of rainy season	As frequent as the material is available
Maintenance/recurrent activities for vegetative measures				
Weeding, cutting branches of gesho /hops/	Manual labor	Sickles, axe	immediately after rains withdrawal	Annual and or every 2nd year

Establishment activities for structural measures				
Collecting stones and form embankment, measuring slope and digging	Manual labor	Crowbar, hammer, hoe, spade	Dry season until crop sawing	
Maintenance activities for structural measures				
Placing stones and repairing broken terraces	Manual labor	Crowbar, hammer, Hoe, spade	February-June Any time of the year	Once or two times a year and mainly before planting

Various types and qualities of bunds exist in the Technology area. These include: masonry, dry stonewalls, constructed by farmers', which are very stable. Bunds built through Food-for-Work (1985-88) are not stable, stones just piled up, easily destroyed by water and livestock.

Bunds constructed through mass mobilization approach have shown similar trends to bunds constructed by FFW payments. They have shown very poor sustainability. Land cultivation is performed by manual labor and animal traction. Fertilizer, herbicides and pesticides use has increased. Dung of cattle not used as fuel in the same amount as in the other highlands. Therefore, in the midlands more cattle dung is used as manure. Sometimes combination of manure with tree leaves similar to composting is practiced. There is increased trend in the use of improved seeds for cereals such as teff and wheat.

Gesho (herbaceous plant whose leaves and stem is used as hop to make local beverages) is planted on the down slope side of the bunds and is left undisturbed for 3 years. In the fourth year branches are cut down to the roots. This is done every two to three years. Usually rows of gesho are combined with structural measures (stone bunds) planted where the topography does not allow cereal crop cultivation.

Supportive measures

Supportive measures	**Function**
Cut-off drain	Prevents run-on
Ditches	Drain excess water
Crop rotation	Help soils to be more fertile
Manure application, green manure	Improve soil structure and soil organic matter

Typical household size of the land users is 6 persons. Size of 'land' per household is 0.5-1 ha. Population density is 100-150 persons/km^2 and the annual population growth including migration is of the order 2-3%. The trend in land ownership and land use right is that land size is decreasing per household because of increase in the number of land users. No trend towards privatization of land is envisaged since land is owned by the state. Land ownership and land use rights did not affect SLM activities. In the Mesobit and Gedeba area all farmers consider terracing as their duty, even with the risk of losing the land in land distribution. Subdivision of land affected the implementation of the SLM Technology a little bit and this is reflected in investing less time for plots far away. Nevertheless, most farmers have their plots in the nearby area.

There is difference between the better-off and poor in how they practice SLM. Rich farmers can organize work-group and prepare food and beverage for people participating in the work. Poor farmers rely on family labor alone. The same is true with female-headed households, which in general invest less in SLM. Technical knowledge required for implementation of the technology is moderate for field staff / extension worker and moderate for Land user. The use of the SLM Technology is not hindered by whether land users cannot read and write. 50% of land users cannot read and write. Most of the younger people (below 35) can at least read and write, although they did not attend formal education but participated in literacy campaigns.

Off-farm income: is less than 10% of all income. Some families rely heavily on off-farm income (petty trade, handicraft). For such families, off-farm income can be as high as 50%.

Economic analysis

Gross production value in US dollars per hectare per year around the SLM Technology area is 150 / ha / yr. Compared to the situation without conservation, estimated percentage gross production value increase 10 years after implementing SLM is 60% considering also the area occupied by conservation measures and in assuming the current input and prices.

Impacts of the technology

Benefits	**Production (in t/ ha/season)**	**Main plant**	**Run off as % of annual rainfall (t/ha/year)**
Without SLM	60	Teff	0.4
With SLM	10	Teff	0.7

Off-site impacts: The technology is not intended to provide significant off-site benefits. Off-site effects were not considered when the technology was applied.

Adoption, adaptation and replicability

Zero percent of land users that have applied the SLM Technology have done it with incentives. It means that the land users put all stone bunds without any sort of payment or incentive support from outside. All land users who have implemented the technology, have done it wholly voluntarily, without any incentives other than technical guidance. 100 % of land users that have applied the SLM Technology have learned the experience from fellow land users locally. Young farmers are a bit more reluctant to continue building new bunds, however they maintain existing ones. Young land users are somehow reluctant to continue building new bunds, however, they maintain the existing bunds.

Traditional technology has changed little and the same stone bunds have been constructed for generations. The quality of the 'new' stone bunds placed by the help of FFW is of poor quality. There is enough local skill and support to expand the SLM Technology.

Maintenance

Land users have adequately maintained or managed what has been implemented. Some farmers neglect maintenance, percentage is very low (below 10%). Otherwise, maintenance of existing bunds has been carried out since the beginning.

Concluding statements

Important constraints during establishment are minor disturbances by goats. Possible improvements are better ground cover by encouraging growth of grass or other useful vegetation between plants (supportive agronomic measure). When branches are cut down, no vegetative cover remains and the soil becomes bare. Land users say that clearing the ground is necessary to control pests, which affect crop. A second reason for digging the soil is to increase water infiltration.

The number of farmers plowing small plots of grazing lands to cropland is increasing. As a result there is a growing trend in feed shortage. Fencing grazing area is advised during rainy seasons to allow grass to grow properly (optional management measure).

Building schools as an incentive for commuinties participating in land mangement activities (Photo 2005)

5.2. Social Infrastructure for Land Management

Common name of the Approach: Social Community Infrastructure
Contributed by: Hans Hurni, Centre for Development and Environment, University of Bern, Switzerland
Area information
Region: Gojam, Anjeni, 1985 and Shewa, Merhabete 1992
Major technologies promoted by the approach: soil bund, water harvesting and hillside terracing.

Definition
Negotiation with the communities in the watershed on social incentives is to be offered by external agency for inputs from the community such as labor and material used as an investment for carrying out land management activities.

Description
The overall purpose of the approach is to achieve sustainable land management without direct incentives such as food-for-work, cash payment, etc. The community will be entitled to select a social investment in their area which addresses most pressing needs, e.g. clinic, school, road, etc. The specific objective is to convince land users of the advantage of sustainable land management that is achieved without payments.

It was implemented through the Soil Conservation Research Program - Anjeni Pilot Conservation Area project initiated in 1985. Problems addressed by the project include: Accelerated soil erosion, declining crop production, overland runoff damaging crops and causing gullies, poor social infrastructure. There are direct and indirect causes of the problem. The indirect causes include: Lack of capital, lack of knowledge and lack of legislation /enforcement and the direct cause were deforestation, overgrazing and agricultural practices. Main constraints hindering proper implementation of the approach are social (lack of community collaboration), legal (lack of land ownership) and institutional (lack of trained extensionists).

Objectives and targets
To demonstrate technologies supporting the sustainable use of natural resources for improved livelihoods of the land users in the area. In Anjeni this was achieved by the help of a specific incentive at social level. The specific targets were to conserve one catchment as a pilot area. Benefits realized included: Stabilized production, social infrastructure developed such as clinic or school for community.

Decision making
A decision on the selection of the technology is made mainly by the land users in consultation with the SLM specialists. Development of technology was based on existing indigenous technologies which were implemented in complementarities. A 10 ha demonstration area was established for one year, and an agreement was reached later to implement it on 100 ha, if social infrastructure support was given. A decision on the methods of implementing is made by SLM specialists alone as a directive (top-down). Decisions at the household level are made mainly by men. Resource poor men are involved in the decision making strongly. Traditional rules exist particularly for protecting the cutting of trees in and around church areas. Traditional rules exist and are strong with coercive measures and punishment (fines), followed for not abiding by the rules especially for forest and other resources around churches.

Aim of the approach followed by the project: Contribution to sustainable use of natural resources through research. Positive results obtained were: basic information on land use dynamics, erosion processes, conservation technologies and approaches country wide and the negative results observed included little flexibility to adjust adverse frame conditions for SLM in Ethiopia. Participation of land users was limited but eventually increased.

Participation
Target groups: technicians, SLM specialists, planners, politicians and decision makers and teachers were involved. The approach included other groups of users organized by the project. Land users work by groups and members are mainly men and some women participated.

Land users' attitudes
At the beginning of the project land users' attitudes towards the approach was neither positive nor negative. Change in the attitude during implementation was observed later. After several years of cooperation, farmers began to trust the extension system more and more.

Financing
International: CDE/SCRP contributed 25%, the National Government through the Ministry of Agriculture contributed 5% and the community contributed 70%.

Training
Knowledge of land users to carry out the SLM technology was totally inadequate in the beginning. Although problem is perceived, consequences are not clearly seen, and solutions at appropriate level are totally unknown or seen inapplicable. Form of training provided to land users: on-the-job, demonstration areas and public meetings.

Extension
Type of extension is the Government Extension System. The key elements considered were holding of meetings and layout of SLM techniques. Extension is carried out through the government's existing extension system and projects own extension structure and agents. Target groups for extension awareness and visits were primarily school children (students). Demonstration visits to nearby watersheds and preparation of a school book on experience on SLM in the area was prepared in Amharic (the local and official language).

Monitoring approaches and reports

Aspect	Type	Frequency	Remarks
Technical	Observations	Every month	Changes and adaptations of SLM
Socio-cultural		Every year	Changes and adaptations of SLM
Economic/production	Measurements	Every year	Harvest yields

Reporting procedures

Type	Addressed / reported to
Research reports	SLM specialists
Audio-visual presentations	Politicians
Regular meetings	
ad-hoc / sporadic	
Audio-visual presentations	

Technology was adapted according to farmers' needs, namely adjustments of narrow terraces by removing some, including drainage furrows over terraces and not along them.

Impact

Traditional soil fertility management was already exhaustively used in the farming systems. The approach helped in the management of croplands. Some amounts of fertilizer were considered economical by farmers. The approach also led to proper management of grazing lands. Area closure was applied in parts of the watersheds and afforestation undertaken. The approach also led to changes in the management of forest and woodlands. Cut and carry of grass and dead wood collection were allowed from enclosures. The approach also led to changes in the management of other lands. Plowing had to be adapted because of narrower strips of cultivated land on terraces. Weeding was necessary more than before. Maintenance of drainage ditches was necessary. The approach has further strengthened local institutions. Extensionists improved their knowledge on graded structures. Food-for-work approach was clearly seen as more expensive and less adaptive approach.

Conclusion

Layout and design should be discussed with land users before construction and their suggestions considered.

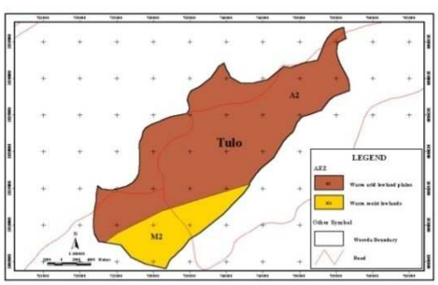
Strength	Improve
Negotiations	Train extensionists
Social incentives	Better cooperation between different ministries on their activities as a package

III. Indigenous vegetative, agronomic and physical (combined) practices


Ridges and furrows of sweet potato, Harerghie Highlands (Photo 2005)

6.1 Ridges and furrows of sweet potato (Harerghie)

Common Name of SLM Technology: Sweet Potato Ridges
Local or other name(s): Daga (Oromifa)
Associated Approach: Extension Regular
Contributing SLM specialist: Daniel Danano Dale, Ministry of Agriculture and Rural Development, Email: ethiocat@ethionet.et
Date: 12 / 20/ 2006   Updated: 05/12/2008
Area information
Total SLM Technology area: over 1000 Sqkm



Agroecological zones of Tulo Woreda

Location of Tulo Woreda

Definition

A technology involving light earth movement on a crop land by digging the earth to form a furrow where runoff is trapped to form an embankment by dug out soil to form a ridge where sweet potato is to be planted.

Description

Establishment: Sweet potato ridges are formed of soil dug out from the furrow. Farmers make the furrow and ridge by Dengora (Harerghie local hoe) and a Spade sometimes. In some cases oxen scoop is used to move the soil and form the ridge. Sweet potato is planted by cuttings. It is planted twice and the first plantation takes place during the short rains and the second during the end of the main rainy season. There are different methods employed in making ridges and furrows.

Objective

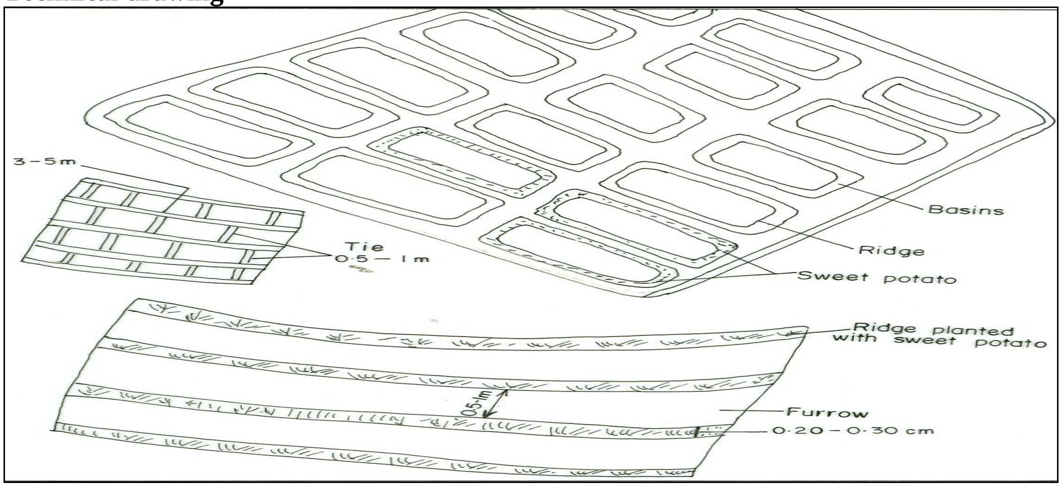
Is to store as much as possible the rain water received in the soil for potato production. To store more rain water, improvements are made on the structure to accommodate the amount of rainfall received, which varies from time to time. Mulches are applied in some cases in order to increase the effectiveness of the measures to control runoff movement and reduce evapotranspiration losses.

The furrows are meant to collect rainwater and the cuttings of sweet potato are planted on the ridge. The plant benefits from the soil water stored in the furrows. Sweet potato has primary and lateral roots which branch out to the sides and that go deep in search of soil nutrients and water. Forming the ridges and basin is quite laborious. The ridges are replaced new and in some cases the former ridges and furrows are maintained.

Picture of the technology

Methods of rainwater management by means of ridges and mini-basins in the Hararghie highlands (Photo 2005)

Technical drawing



Land degradation

Types of land degradation on the land surrounding the SLM area

Land use	Type of degradation	Degree (%)	Landforms
Mixed	Water erosion	60	PRH
Grazing land		100	
Cropland		80	

Observation and estimate

Purpose and classification

The major land use problems in the area without SLM are**:** soil moisture stress, erosion, high population density, shortage of rains, lack of finance for purchasing improved seeds and fertilizers.

Characterization and purpose

Land use type	% total area utilized by land users who applied the SLM Technology
Cropland: annual cropping	100

The technology combats land degradation by: increasing water stored in the soil, water collection, and control of dispersed runoff and reduction of slope length.

The technology is indigenous. It has originated locally from long-years of practice and improvements. The indigenous SLM technology has been used before the current SLM Technologies was introduced. Ridges formed by digging soil from a given area (2x2 – 5x5m meters) land area and the soil is embanked to form the ridge. The technology helps to trap rainwater, store and make it available to the plants. Today the indigenous SLM is used more. A number of farmers are experiencing the technology and it is expanding. Improvements are made on the way the structures are constructed in order to increase effectiveness.

Land is prepared during the dry season immediately after the main rains withdraw and early at the beginning of short rains (belg). Sweet potato takes about 5-6 months to mature in the field and there are some varieties which can mature in 3-4 months. It is planted twice a year. The SLM technology is designed by the land users themselves with some technical support from the extension services of the Ministry of Agriculture, research organizations and universities. Although the technology is locally originated, some introduced elements have been incorporated such as placing the ridges along the contour and placing tie ridges at a given interval. Soil and stone bunds are included to reinforce the ridges and are widely spaced.

The appearance of the applied technology has gradually changed over time. Some years ago ridges were not combined with bunds but now bunds and ridges are integrated to reinforce the ridges. Household garbage, manure and kitchen ash are applied to fertilize the land and increase production.

Specification of vegetative measures

Type and alignment of vegetative measures (m)

Vegetative measures	Material	Plants / ha	Vertical interval	Spacing	Interval	Width
Aligned contour	Chat	1500	0.2	2.5	2	2.5

Construction and maintenance

Activity	Equipment	Timing	Energy
Tillage	Dengora	Dry season	Manual labor
	Oxen		Animal traction
Harrowing			Manual labor
Contour ridging	Dengora, spade	On set of rains	
	Scoop		Animal traction
Planting	Spade	Rainy season	Manual labor
Cultivation			Manual labor
Seedbed preparation	Spade	Dry season	
	Oxen	Onset of rains	
Pitting	Hoe	Dry season	
Manure application	Manual	Onset of rains	
Planting	Hoe	Wet soils	
Cultivation	Spade, hoe	During rains	
Reconstructing basins	Dengora	Onset of rains	
Ridges and tie			
Excavation (furrow formation)	Scoop and hoe	Rainy season	
Embankment (ridge forming)	Hoe		
Planting sweet potato			
Repair of ridges and furrows	Dengora, hoe	Before planting	
Placing of fertile soil on the Ridges	Spade, hoe		
	Dengora		
Applying manure		After planting	

The vegetative measures considered here include dispersed trees left on cultivated lands, Chat hedgerows and grass planted on bunds, constructed on farm boundaries. Use of manual drawn scoop for making ridges would reduce work burden.

Specification of structural measures

Type and layout of vegetative measures (m)

Structure	Material	Vertical interval	Spacing	Ditch		Bank
				Depth	Width	Length
Retention basin	Earth	1.5-2	0.2-0.5	0.2-0.3	0.5-1	
Ridge	Earth	2-3	0.3-0.5			50-70

Before the ridges and furrows are formed the land is tilled, harrowed and a fine seedbed is prepared. The soil is dug to form the furrow and ridge. While forming the ridge the better-off farmers use oxen plough and scoop and the poor use manual labor and Dengora.

Important constraint during establishment is labor. In some cases the soil is compacted and it is hard to dig. If some showers are received the digging becomes easier. Number of erosive water storms is less than 10. The rainfall in growing season is usually insufficient and not well distributed. The Number of growing seasons per year is 1.

Human environment and land use
Typical household size of the land users is 6. Population density is greater than 350 persons/km^2 and the annual population growth is 3 %. Land size per household is showing a declining trend owning to population pressure. Land ownership and land use rights did not affect SLM. In East Hararghie farmers have a long time tradition of practicing soil and water management measures of which sweet potato ridge is one. Subdivision of land is widely practiced but it has not affected the implementation of the SLM Technology.

There is marked difference between rich and poor in how they practice the SLM Technology. Although, all land users practice it, the rich do it more because they hire labor and get all their land implemented with the technology. Land users who have a wider area of chat plantations are economically better off and hence hire daily laborers to get the ridges formed which are essential for water harvesting. Off-farm income for the land users is less than 10% of all income of households who apply the SLM technology. The level of technical knowledge required for implementation of the technology is moderate for field staff / extension workers and also moderate for land users.

Crop and livestock production
Land cultivation is performed by hoe. Sweet potato is mostly planted on level and gentle slopes and hence land preparation is performed largely by hoe and sometimes supported by oxen plough. The ridges block concentration of surface flow and the furrows provide space for rainwater storage. Sweet potato improves the soil structure by initiating microbial activities and also improves water storage capacity of soils.

Type of cropping systems and major crops grown. The cropping is rainfed and it is often mono-cropping. Intercropping is practiced and crops intercropped include sweet potato-legumes-sorghum. Cropping system or sequence of crops is sorghum-sweet potato-maize-pulses. Croplands are well managed by applying the technology and land productivity is improving. Farmers are well aware of the importance of soil and water management in agricultural activities. Croplands are mostly conserved with various conservation measures which include bunds, soil bunds, hillside terraces and area enclosures. Types of animals: Large stock; cattle, donkey, horses and the small stock: goat, sheep

Costs
Total labor expended to till the land, pulverize it, harrow and for making the ridges is given in the table below. The cost includes the monetary estimate of manure applied, tillage and purchasing of the sweet potato cuttings.

Agricultural activities	Input	Quantity	Costs US$	% Borne by the land user
Agricultural	Manure	70 (tons/ha)	50	100
Agricultural	Seedlings	15000	25	
Equipment	Plowing	120	35	
Labor	Pd	90	73	
Total			183	

Daily wage cost of hired labor to implement SLM is 0.81 US $ per person per day
Cost of establishment: Labor is the most constraining factor for the establishment. Duration of establishment phase is 1 year. Light textured soils are very simple for operation and least cost incurred. Loam soils are light with moderate cost of investment.

Benefits, advantages and disadvantages

Estimates of production, soil loss and runoff

With or without SLM	Plant	Production (t/ha)	Runoff as % of annual rainfall (t/ha/yr)
With	Sweet potato	4	50
Without		8	0

Soil loss and runoff are negligible on a field where sweet potato is planted on well managed ridges and furrow with additional reinforcement by soil or stone bund. Sweet potato is a very good cover crop, which considerably reduces rain impact and runoff.

On-site and off-site benefits of the technology

Production and socio-economic benefits		**Socio-cultural benefits**	
Crop yield increase	High	Community institution strengthening	High
Fodder production/quality increase		Improved knowledge on SLM and erosion	
Farm income increase			
Ecological benefits		**off-site benefits**	
Soil cover improvement	Medium	Reduced downstream flooding	High
Increase in soil moisture	High	Increased stream flow in dry season	
Efficiency of drainage		Reduced downstream siltation	
Increase in soil fertility			
Soil loss reduction			
Biodiversity enhancement	Negligible		
Production and socio-economic disadvantages		**Ecological disadvantages**	
Loss of land	Medium	Water logging	Negligible
Increased labor constraint	High		
Increased input constraints	Little		
Hindered farm operations	negligible		

Economic analysis

There is no data on the economic returns resulting from conservation measures. However, without SLM, the gross production value in US dollars per hectare per year around the SLM Technology area is estimated to be 257 / ha / yr. With SLM Technology, the gross production value of the land per hectare per year is 450 US$ / ha / yr. Compared to the situation without conservation the percentage gross production value increase 10 years after implementing SLM is 80% considering also the land occupied by conservation measures and in assuming current input and prices.

Adoption and adaptation

Many changes have been made to the technology since the technology has evolved. The technology evolved from the land users' needs of storing as much rainfall as possible. Different methods for laying out and constructing the ridges and basins have evolved through time and at the moment there are very efficient methods and techniques. There is a growing trend towards spontaneous adoption of the technology. More land users are practicing the technology. There is enough local skill and support to expand the SLM Technology

Maintenance

Land users have adequately maintained and managed what has been implemented

Land management specialists share experience on water harvesting structures and livestock extension in Adama, (Photo 2005)

6.2 Regular Extension Approach

Common name of the Approach: Extension
Contributed by: Assefa Aga
Address: East Hararghie, Buraeu of Agriculture, Harar
Technologies associated with the approach: Ridges and basins, soil bund, stone bunds, and stone faced soil bunds
Area information
Region; West Hararghie

Definition

It is an approach where by model farmers are selected based on their interest to practice a technology and demonstrate it to other follow land users in the area.

The overall purpose is to train land users who will practice SLM technology by following model farmers who serve as a bridge between land users and the Development Agents. In applying the SLM technology using the approach, communities are able to improve productivity of land and increase their income. The specific objective is to increase the productivity of land and sustain it.

Methods: Select model farmers, train them and demonstrate the techniques of implementing the technology. Model farmers implement and demonstrate the technology on their plots and other land users learn from them.

Stages of implementation: Select model farmers – create awareness, demonstrate the technology by doing and evaluate it. The approach has enabled land users to develop sense of ownership and avert dependency, however, lack of adequate technical staff for providing efficient technical support has been a limiting factor.

Lack of awareness, lack of improved farm implements, poverty, low productivity are problems encountered. The causes of the problem include: 1) Indirect; lack of capital, lack of knowledge and land subdivision and 2) Direct; agricultural causes, deforestation, over exploitation of vegetation and overgrazing.

Constraints hindering proper implementation of SLM technology

Main	Specific	How to avoid
Financial	Lack of money	Provision of hand tools, incentives
Institutional	Frequent restructuring of the SLM Department	Minimize the turnover of trained manpower
Sociocultural/ religious	Limited participation of women in the development activities	Awareness creation

Objectives and target

Is to enable land users to be self-sufficient in food and other incomes needed by a household through practicing land management measures, which help in improving productivity of land using their own resources, with technical assistance from the government. The specific target is to reduce dependency on external support such as food aid and cash payment for SLM activities. SLM activities enhance rehabilitation of degraded lands and increase land productivity, which increase income of land users and gradually enable them to be self sufficient in food as well as capital needed for implementing SLM activities.

Decision making

Decision on the choice of the SLM practice is made mainly by the land users in consultation with Development Agents. Decisions on the methods of application of SLM technology is made mainly by the land users with consultation of watershed technicians. Decisions for implementing SLM technology at the household is made by men. Technical advice and close follow up is provided by SLM specialists. The resource poor are moderately involved in decision making at the community level. Most often, men and young men groups of medium and better wealth status are involved in decision making.

Framework for the approach

The traditional rules established for protecting and managing natural resources are weak. There are traditional bylaws for protecting natural resources such as protecting community forest/trees but often neglected on account of the fact that the bylaws are observed voluntarily as there are no obligatory measures. Demand for more cultivated land coupled with weak bylaws led to wide spread miss-management of resource and this is the major challenge to sustainable land management. No laws or acts regarding SLM have so far been in place but land use policy has been issued recently. No enforcement has been in place owing to non-existence of laws and regulations on land management. However, the recently approved Land use and Land administration policy has provisions that encourage investments on SLM but is not yet operational.

The approach is based on the previous approach referred to as the Minimum Package of the EPID (Extension Program Implementing Department) of the Ministry of Agriculture in the early 1970s. The current extension approach has been designed by the Ministry of Agriculture of the Federal Republic of Ethiopia to support the realization of the National Policy for food self sufficiency. People involved in the implementation of the approach are the regular extension workers of the Ministry of Agriculture. Linkages with local institutions such as village and social committees are very strong.

Participation

The approach focuses on grouping land users. The approach encourages land users to work in groups and as well as individually. Men are the principal source of labor for SLM activities in many areas but recently the involvement of women is considerably increasing. All categories of land users are encouraged to be embraced by the approach but the average farmers are the major target groups because they require extension advice and provision of inputs if possible by effecting down payments. The better-off afford buying inputs themselves.

Land users attitudes

The attitude of the majority of land users towards the approach was negative in the beginning. Awareness creation through training and intensive extension support enabled farmers to develop positive attitudes towards extension afterwards. Land users are more interested in having short term benefits although the majority aspires for immediate benefits from the technology. Land users are keen to plans of short period and few of them think of long term plans such as maintaining the fertility of land and pass it on to the heirs.

Land users involvement

Methods applied for involving land users at different phases

Phases	**Methods of engagement**	**Action**
Initiation	Public meetings interviews/questionnaires	Most land users in the community attend public meetings when they are invited. Land users are also seen to provide information they are asked but sometimes suspect the type of questions being asked that particularly focus on incomes.
Planning	Training interviews/questionnaires	Selected farmers attended meetings called for planning. Questions targeting at planning of development activities are highly appreciated
Implementation	Responsibility for major steps casual labor	All land users are basically required to participate in the implementation of SLM but are unhappy to work on the plots of other land users.
Monitoring and evaluation	Measurements/observations, reporting interviews/questionnaires	Trained land users are involved in measuring achieved activities but almost all land users were found willing to respond to questions for evaluation.

Financing

Responsible	**Item**	**% contribution**
National government	Work tools, training	40
Community / local	Labor and material	60
Total		100

Indirect subsidies

The implementation of the technology requires moderate knowledge on the layout and construction of SLM measures and this is obtained from training. Knowledge of the land users to carry out the SLM technology on their own was inadequate at the initiation. The training mainly concentrated on the management and how best to maintain the technology so that sustainable development is attained. The approach provided land users training on the causes of soil erosion, layout and construction of SLM measures and methods of monitoring and evaluation.

Training conducted to varying target groups

Target groups	**Training**
Land users	Layout and excavation
SLM specialists	SLM techniques and planning
Extensionists	SLM techniques and planning

Direct subsidies

The labor from land users is the most important input of the investment. It is mostly voluntary although initiations are taken by policy makers and the technical people to mobilize the land users. Hand tools and planting materials (seeds and seedlings) are provided by the government and donors. The approach has moderately supported the establishment and operations of local institutions.

Monitoring and Evaluation Procedures

Aspect	**Type**	**Frequency**	**Indicators**
Bio -physical	Measurements	Ad hoc	Change in slope, soil fertility, moisture level of the soils
Technical		Every month	Amount of work done
Number. of land users involved		Yearly	Number of farmers involved in the approach
Management of approach		Yearly	Impact, changes

Reporting procedures

Type	**Addressed to**	**Specific procedures**
Regular reports	SLM specialists	Annually on special occasions
Regular reports	Politicians	Extension agent reports to the woreda SLM specialist and the SLM to the decision makers. (weekly and monthly)

Groups that contributed to the evaluation

Groups	**Type of evaluation**
SLM specialists/extensionists	Provide information on some technical aspects
Land users	Providing basic information such as production and income obtained

Changes due to monitoring and evaluation are many and the involvement of individual farmers in group has been increasing in recent years.

Impact

The approach initiated land users to practice multiple cropping and inter cropping practices, which improve the productivity of land and crop production. Land users are changing their attitudes towards the rearing and owning of livestock. There is a growing awareness and tendency to use stall feeding to reduce the number of livestock by focusing on quality and increased livestock productivity. The number of land users understanding the use of trees is increasing. More land users are requesting seedlings from woreda nurseries to plant them on their holdings. It was expected that the approach would bring considerable impact on the livelihoods of the farming communities but due to various biophysical and social constraints, the changes obtained are not very impressive.

In the beginning, farmers did not appreciate physical structures owning to the space they occupy and the resulting reduced production in the initial period and particularly the difficulties they pose on ease of farm operations with oxen. However, at present their attitude towards physical structures is getting better because land users have observed the effects of structures on water harvesting and soil deposition behind the bunds, which they have realized it supporting an increased production.

Implementation progress
Over 150 land users adopted the technology introduced in short time (5 years) and liked the approach used for obtaining the result. Over the last few years the implementation progress has increased. Moreover, the approach has helped to strengthen and encourage the formation of local groups and associations including social groups.

Training, extension and research
Considerable effort was made to aware land users about land degradation problems and the impact of conservation measures in solving the problem. Training and extension enhanced SLM activities but other incentives such as food grain and cash payments created dependency in some cases where these were introduced in the wrong way. Land users could not continue with the approach without external support because they saw that other land users in the nearby villages were being provided with food and cash incentives for participating in SLM activities. Cash and food incentives if properly used could encourage investment on land and in addition to this timely supply in sufficient quantities of agricultural inputs, training and visit will further improve land users participation on SLM.

Conclusion
Land ownership, which the government had vested on itself as the owner of land in the past, has considerably discouraged land users to invest on SLM. Nevertheless the land use right regulation, which is issued recently, is a positive step forward in playing active role to encourage land users to invest on land. The regulation has provisions providing for land certificates ensuring user rights for a longer period.

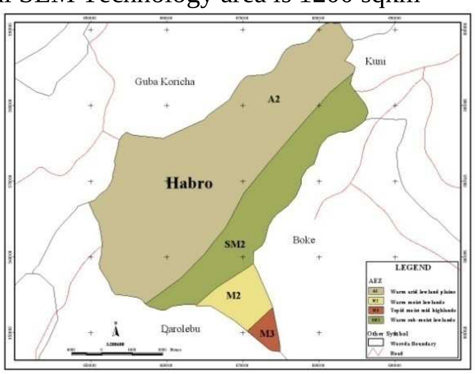
Strengths

Strength	**How to sustain**
Land users are acquainted with new and modern technology	Regular training and extension services.
Awareness raising on land degradation and the combating measures	Through regular training and extension services.
Farmers are able to solve their problems by organizing themselves in groups	Participation on problem identification and finding solutions.

Broad furrows and ridge bund farming in the Harrerghie highlands (Photo 2005)

7.1. Broad basin and ridge (Harerghie)

Common Name of SLM Technology: Ridge bund
Local or other name: Ketara (Oromigna)
Associated approach: Self Help
Contributed by: Teshome Nigussie Biruk, Natural Resources Development and Environmental Protection Authority, Habro. Oromiya
The Technology area
Total SLM Technology area is 1200 sqkm



Agroecology of Habro woreda *Location of Habro woreda*

Definition

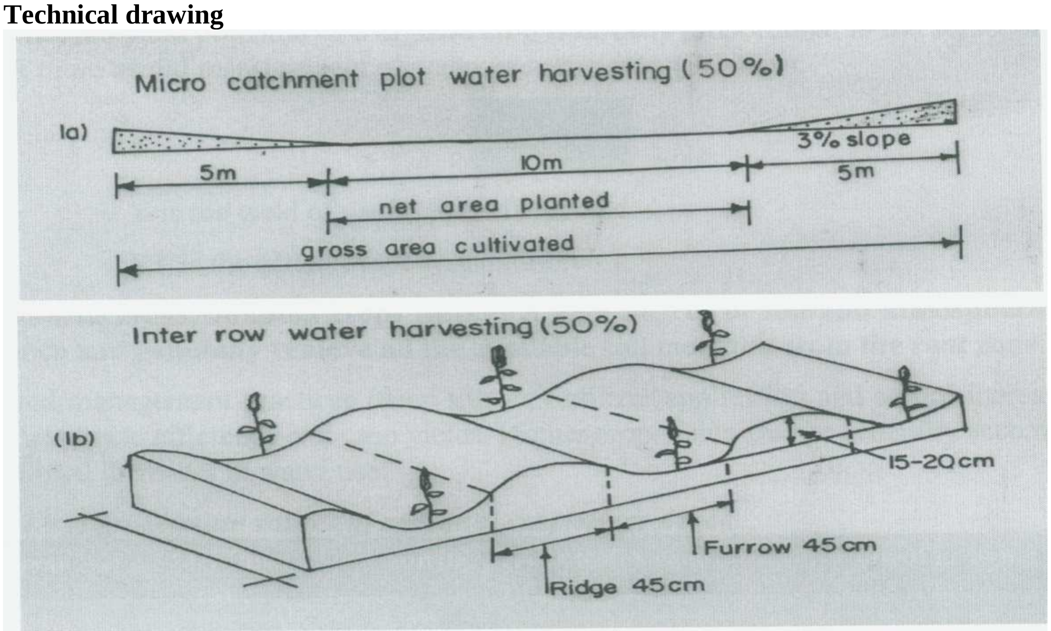
It is an embankment of earth formed by digging and scooping the soil to place it along the contour on croplands.

Description

Broad furrow and ridge is an earth embankment constructed nearly along the contour by the use of oxen drawn scoop or a local hand tool called Dengora. Ridge bunds provide maximum protection from runoff since all the rainwater is trapped in the basin formed while forming the ridge. The ridge embankment controls overflow of rainwater and the water is stored in the basin. The length of the ridge could be the length of a field a land user cultivates and often not more than 50 meters. The ridge has 10-25 cm top width but may have a bottom width of more than 2 meters. Soil is excavated from above to make the ridge at the down slope side. The technology is established mostly during the onset of rains but land preparation is done prior to that. The ridges are planted with suitable crops, pulses, and fodder spp. and fruit trees. The purpose of the technology is to maximize crop production by storing all rain water received if possible and increase soil moisture that is available to crops. It further aims at controlling runoff and soil loss below threshold level and by maintaining soil moisture.

Establishment: it involves massive movement of earth and it requires substantial labor for establishment. Relatively lower input is required for the maintenance but it has to be done frequently. The technology is suitable to light soils with high water intake capacity and workability.

Technical drawing



Purpose and classification

Land degradation

Major land use problems in the area without SLM are: Soil erosion, gully formation, losses of soil fertility. Soil erosion, water scarcity and decreasing of productivity are identified by the land users as major land use problems.

The technology consists of structural, vegetative and agronomic measures. The technology combats land degradation through control of dispersed runoff by retaining it, increase infiltration, reduce slope length. The technology is best described as indigenous since it has been in use for generations. The technology is locally originated. Today, the indigenous SLM is used more. The prevailing moisture stress problem and shortage off water forced land users to practice SLM measures because without these structures there is a reduction or a total loss of production.

Construction and maintenance

Field activities for structural measures

Activity	Energy	Equipment	Timing	Frequency
Forming basin	Manual labor	Hand tools	Onset of rain	Twice
Forming ridge			Before planting	Each cropping season
Harrowing and seedbed preparation			Onset of rainfall	Each cropping season

Field activities for agronomic measures

Activity	Energy	Equipment	Timing	Frequency
Breaking compacted soils	Manual labor	Hand tools	Onset of rain	3 times
Mixed cropping			Rain season	Each cropping season
Collection of animal dung			Onset of rainfall	Each cropping season

Specification of vegetative measures

Type and alignment of vegetative measures (m)

Nature of strips or blocks	Material used	Plants/ha	Vertical interval	Spacing	Interval	Width
Aligned /contour	Perennial crops	1400-2000	0.3-1	3x3	2	0.75
Scattered / dispersed	Trees/shrubs	1000	1			

Constraints during establishment: low survival rate of seedlings mainly due to shortage of rain. Improvement measures include: use of more efficient measures integrated with the ridges for increasing moisture harvested and selecting suitable plant species.

Specification of structural measures

Type and layout of structure (m)

Structure	Material	Length (km/ha)	Spacing	Depth	Width	Height
Ridge	Earth	3	3	0.5	2	0.35

Conserving rainwater in the soil and maintaining soil moisture for crop use is the principal objective of the technology. It requires substantial amount of labor, every season the structure is cultivated in order to control weeds.

Natural Environment

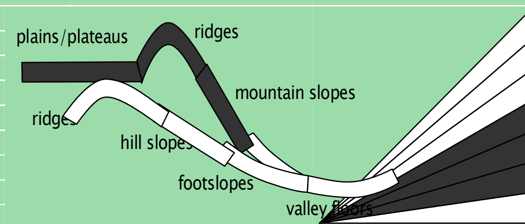
Average annual rainfall (mm)

- >4000
- 3000-4000
- 2000-3000
- 1500-2000
- 1000-1500
- 750-1000
- 500-750
- 250-500
- less than250

Altitude (m a.s.l.)

- >4000
- 3500-
- 3000-
- 2500-
- 2000-
- 1500-
- 1000-
- 100-
- less than250

Landform **Slope (%)**



very steep (>60)
steep (30-60)
hilly (16-30)
rolling (8-16)
moderate (5-8)
gentle (2-5)
flat (0-2)

Soil depth (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- less than120

Growing season:

Soil fertility:

Soil texture: medium (loam), coarse (sandy)

Surface stoniness: no loose stone

Topsoil organic matter: medium (1-3%)

Soil drainage: Good

Soil erodibility: medium, high

Number of erosive water storms per year is less than 10. Heavy storms occur in the middle of the growing season. Rainfall in growing seasons is usually insufficient and not well distributed. The number of growing seasons per year is 2. The rainfall duration and amount is too short for growing annual crops but the other natural conditions are favorable.

Human environment and land use

Typical household size of the land users is 5 persons, the population density is 100-200 persons/km^2 and the annual population growth is 2-3 %. The land size per household shows a decreasing trend and land belongs to the public. Land ownership and land use rights have affected SLM to a certain extent. Subdivision of land has similarly affected the implementation of the SLM Technology more seriously. Some farmers have been discouraged for fear of the might happen again subdivision of land.

There is a significant difference between the rich and poor in how they practice the SLM Technology. The rich have opportunities to hire labor to implement SLM on their land compared to the other groups of farmers (poor, average). Off-farm income is 30-50% of all income for the land users who apply the SLM technology. Land cultivation is performed by manual labor (90%) and animal traction (10%).

Costs

The most important factors affecting the costs are high labor requirement and soil workability. Costs are calculated for the length and width (volume of earth work). The cost depended on the specification of the structure (length, width and height) and it is assumed that 3 km of ridge bund is constructed on a hectare of cultivated land.

Cost

Category	Input	Establishment			Recurrent	
		Quantity	(US$)	% borne by land users	Quantity	(US$)
Agricultural	Pitting	1400	28	100		30
	Weeding	1	30		1	
	Planting	1400	14			80
	Compost / manure	10000	80		10000	16
	Fertilizer (kg)	50	16		50	
	Seedlings (No.)	1400				5
	Seeds (kg)	15	7.5		10	
Materials	Earth (cum)	808.5	80	100	80	
Equipment	Tools	2	12			
	Animal traction	30	56			
Total			323.5			131

Daily wage cost of hired labor to implement SLM is 1 US $ per person per day

Benefits, advantages and disadvantages

Level of crop production with or without the technology

With or without SLM	Crop	Production (q/ha/yr)	Runoff as % of annual rainfall
Without SLM	Catha edulis (Chat)	30	45
	Sweet potato	15	40
With SLM	Catha edulis	40	5
	Sweet potato	25	5

In areas where SLM is applied soil texture is improved, amount of runoff harvested increased and the productivity per unit area improved.

On-site and off-site benefits the technology

Production and socio-economic benefits		Socio-cultural benefits	
Crop yield increase	High	Community institution strengthening	Medium
Fodder production increase	Medium	Improved knowledge of SLM	
Farm income increase	High	Off-site benefits	
Ecological benefits		Reduced downstream flooding	High
Soil cover improvement	High	Increased stream flow in dry season	
Increase in soil moisture	Medium	Reduced downstream siltation	
Increase in soil fertility		Ecological disadvantages	
Soil loss reduction	High	Water logging	Negligible

The technology could be improved to achieve more benefits by increasing the size of ditch, height of bund and stabilizing the bank with suitable plant species

Economic analysis

Without SLM, gross production value per hectare per year around the SLM Technology area is 150 US$ / ha / yr. Compared to the situation without conservation the percentage gross production value increase 10 years after implementing SLM is 100% considering also the land occupied by conservation measures and assume current input and prices.

Adoption and adaptation

Changes have been made to the technology several times and through ages since the time the indigenous technology evolved. Modifications were done to get extra benefits. Land users who have implemented the technology, without incentives are 100% and this is practiced in all 100% of the area where the technology has been implemented.

Land users who have implemented the technology, did it wholly voluntarily, without any incentives and they account to 100 % of land users that have applied the SLM Technology. There is an increasing trend towards spontaneous adoption of the technology because land users have realized that increased production is only possible if they practice the technology.

Strength

Strengths / advantages	**To sustain / improve**
Controls erosion	Regular maintenance
Improves soil moisture	Maintain ditches
Reduces slope length / angle	Proper layout and construction
Increases infiltration	More inter-bund structures

SLM Technologies implemented on self help approach (photo 2005)

7.2. Self-help Approach

Common name of the Approach: Self Help
Contributed by: Ahmed Muhamed, Office of Agriculture, Hulet Eju Ennesse, Amhara
Technologies associated with the approach: Ridge and Basin, stone faced bench terrace, waterways and cutoff drains.

Definition
A household and the family members work on SLM measures to manage their land without external support.

Description
Self-help approach explains the responsibility taken by a land user household to undertake SLM activities on the land he is holding using his and the family labor, without incentives provided from external sources. It aims at enhancing household land users' responsibilities for managing their land so that they will be able to increase land productivity and improve the livelihoods. This approach is as old as communities and farming. Land users cultivating on steep slopes practiced SLM activities using this approach for many years. The approach area is defined by administrative and watershed units.

Problems: shortage of trained manpower to provide adequate technical advice, support the households at the time of planning and implementation. Causes of the problem are: 1) Indirect: lack of knowledge, lack of enforcement of legislation, land subdivision and 2) Direct: over-exploitation of vegetation, agricultural causes and overgrazing

Constraints hindering proper implementation of the SLM technology

Main	**Specific**	**How to avoid**
Institutional	Inadequate emphasis given to implementation compared to the plan	Attention should be given to action on the ground
Technical	Lack of skilled power to implement the approach	Enhance the skill of support staffs
Other	Lack of integration of SLM with other agricultural activities	Provision of improved inputs

Objectives and target
To enhance household responsibilities in the management of land, improve land productivity and efficiency of labor.

Mainly SLM specialists in consultation with land users make decision on the choice of SLM measures. The approach is initiated by land users themselves because they did not want to participate in mass mobilization approach, which according to them has resulted in poor quality of SLM activities. The community after evaluating the problem of mass mobilization decided that each land user should assume responsibilities to apply SLM activities on his / her land. SLM specialists and development agents provide technical support for land users in the planning and implementation of the SLM Technologies.

Most land users were not willing to contribute free labor for SLM activities through mass mobilization. Decisions for implementing SLM technology at the household level are made mainly by men.

Framework for the approach
Land users practice traditional ditches to drain excess water from crop fields and have traditional rules that govern the community members to abide by the community rules. Draining excess water needs agreement to be reached among land users whose plots are in the same drainage system. Land users form groups to construct waterways to safely dispose runoff from the ditches. No land user can dispose water on the plot of the other. Neighbors agree to construct ditches and waterways that carry runoff from all fields to natural drainage ways.

Traditional rules for protecting and managing natural resources around churches and graveyards exist. The churches normally have the traditions of maintaining and protecting trees around the church premises. The regional government has issued Land Use and Administration Proclamation, which encourages the community to manage their land wisely. The Proclamation enforces the right for proper use and penalty for ignorance in observing the legislation. The legislation enforces that land users do not have right to use the land if they do not protect the land from degradation.

There is a policy provision that encourages farmers to practice conservation on their land. The government provides technical and material support to land users willing to conserve their lands. The government supports the approach and the specialists follow up the implementation and provide the required technical support. The Regional Bureau of Agriculture coordinates the SLM program and the Woreda Office of Agriculture is responsible for implementing and encouraging land users to participate in the implementation.

The approach is preferred by land users not willing to take part in the campaign approach, which was applied in the entire country to implement soil and water conservation activities. The campaign approach enforced some three decades back failed to be appreciated by land users and the assets created through it have not been sustained. Then a new initiative known an mass mobilization approach came to existence which in nature was different from the campaign approach as this entails a consultative planning to a lesser extent with the land users. However, the quality of activities achieved remained to be low and there was no one to assume responsibilities to maintain and protect, the assets created. Self help approach encouraged land users to work on their own land without anyone persuading them.

Land users attitudes

The attitude of the of land users towards the approach is positive. Land users are more interested in getting immediate benefit from the technology they undertake.

Participation

The specific target groups identified in the process of initiation, facilitation, planning and implementation are: Land users (in all phases of development), SLM specialists / extension workers (initiation, facilitation and planning), politicians / decision makers (facilitation).

The approach focuses on: individual land users; groups of land users; land users implementing SLM activities individually and in groups.

Extent of Land users' involvement in all stages of the approach

Phases of involvement	Extent
Initiation	Moderate
Planning	Moderate
Implementation	High, individual households assisted by labor from their relatives, friends and neighbors.

Methods applied for involving land users at different phases

Phases	Methods of engagement	Action
Initiation	Public meetings	Land users undertake SLM activities on their own plots
Planning	Training	At any time in the year but most commonly in the dry seasons before the onset of rains
Implementation	Family labor	Engaged any time their involvement is needed
Monitoring and evaluation	Field visits	Development agents and group leaders make field visits to evaluate the activities.

Inputs needed to implement the approach

Responsible	Item	% contribution
Land user	Labor and material	100
Government	Training and technical support	100

Indirect subsidies

Knowledge of the land users to carry out the SLM technology on their own was inadequate at the initiation. The approach provided land users training on the causes of soil erosion, method of moisture harvesting, design, layout of SLM techniques, methods of monitoring and evaluation. Forms of training provided to land users included: awareness on public meetings, visits and learning by doing

Extension

Extension of SLM is carried out through the regular extension system of the government. The extension agents are generalists who are trained in general agriculture and natural resources development. The extension agents are mainly government staff. The government structure is appropriate to ensure the continuation of SLM activities.

Target groups for extension

Target groups	Activities
Land users	Planning, layout, construction and evaluation
Technicians/SLM specialists	Training, supervision, monitoring and evaluation
Politicians/decision makers	Awareness creation, evaluation

Direct subsidies

The labor from the land users is the most important input of the investment. Hand tools and planting materials (seeds and seedlings) are provided by the government and donors. The approach has moderately supported the establishment and operations of local institutions.

Monitoring and Evaluation Procedures

Aspect	Type	Frequency	Indicators
Bio -physical	Measurements	Regular	Amount of work done
Bio-physical	Observation		Number of farmers practicing SLM measures
Technical	Measurements		Quality of work
Technical	Observation		
Area treated	Measurements		Extent of work done
Number of land users involved	Records		Number of participating land users in the work
Area treated	Observation		

Reporting procedures

Type	Addressed to	Specific procedures
Meetings	Land users	Every forth night
Compiling field level achievements	SLM specialists	On monthly basis
Submit biannual reports	Politicians	Twice annually
Regular reports	SLM specialists	Every month

Evaluation

No external evaluation has been conducted. Internal evaluation is done every year.

Groups that contributed for the evaluation

Groups	Type of evaluation
Land users	Strength and weakness, impact of the approach
SLM specialists/extensionists	Specifications, land users attitudes
Politicians /decision-makers	Plan versus achievements

Impact

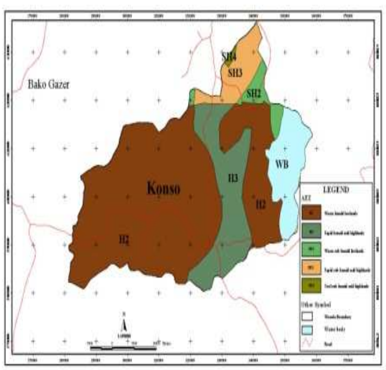
The approach helped to carry out SLM in considerably large area in short time because almost all land users practiced it. Land users are now increasingly engaged in the maintenance and adoption of the technology.

Trashlines on sloping and gentle lands in the Wozeka/ Dearshe valley floors (Photo 2002)

8. Trashlines (Derashe, SNNPR)

Common Name of SLM Technology: Trashlines
Local or other names: Mona (konso), Malduowa dorai (Gamo)
Associated approach: Voluntary labor assistance and labor-share (Debo/Wenfel)
Contributing SLM specialist: Friew Desta, Bureau of Agriculture and Rural Development of the Southern Nations, Nationalities and Peoples Region (SNNPR). Awassa,
Date: 10/10/2002 Updated: 10/5/2007
Area information
Woreda: Derashe
Total SLM Technology area 1300 sqkm



Agro-ecological map of konso *Location map of Konso*

Specification of the SLM Technology

Land use types: Cropland - annual and perennial mixed cropping
Main function: Water harvesting, fertility improvement, reducing evapo-transpiration, and erosion control. Secondary function is to increase/maintain water stored in soil. Climatic regime: semi-arid

Definition

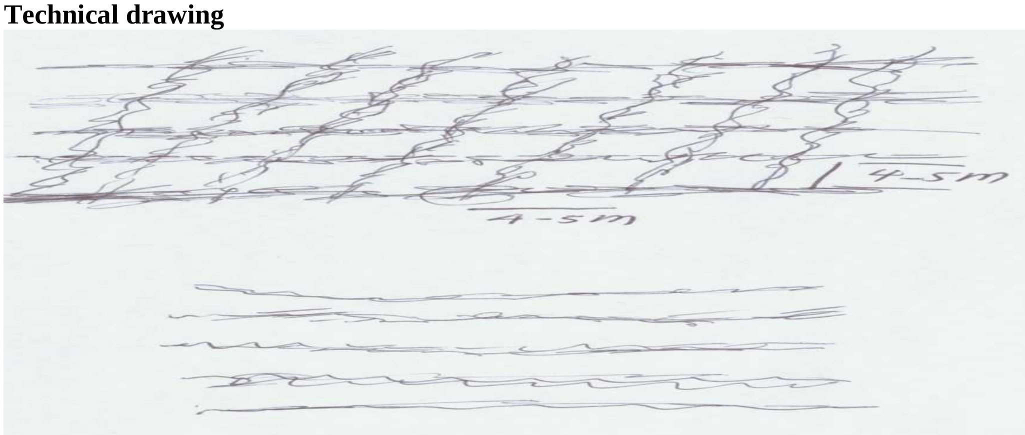
Trashlines are stalk and leaves of maize or sorghum uprooted after harvest and placed along the contour or on a line to form barriers for runoff and trap it in the soil.

Description

Trashlines are formed by sorghum, maize or teff straw pulled up after harvest and placed along and across the slope to form a rectangular basin. The main lines are constructed nearly along the contour. The trashlines are either placed on bunds and basins constructed before or are simply placed on the field without them. The technique is of multi uses and addresses the objectives for water harvesting, soil trapping, physical obstruction of runoff and soil and improves soil fertility. Trashlines perform best if placed on contour or nearly contour lines. The environment in relation to the technique is characterized by having low and erratic form of rainfall with high rates of evapo-transpiration.

Trashlines management for moisture conservation and erosion control, Derashe, SNNPR

Technical drawing



Sketch of Trashlines placed on cultivated lands immediately after harvest. Some are arranged in a rectangular form while others on a single line along the contour

Purpose and classification

The major land use problems in the area without SLM include: Farming on steep slopes, pests, human and livestock diseases and land shortage

Technical function

Main	Secondary
Water harvesting	Increase/maintain water stored in soil
Fertility improvement	Sediment harvesting
Soil erosion control	Increase of infiltration
	Improvement of soil structure

Land degradation

Types of land degradation on the land surrounding the SLM area

Land use(s)	Types of degradation	Degree	Land form(s)
Cultivated land	Water erosion	S	V
Cultivated and grazing	Chemical deterioration	M	M

Source of data: Observations on the site

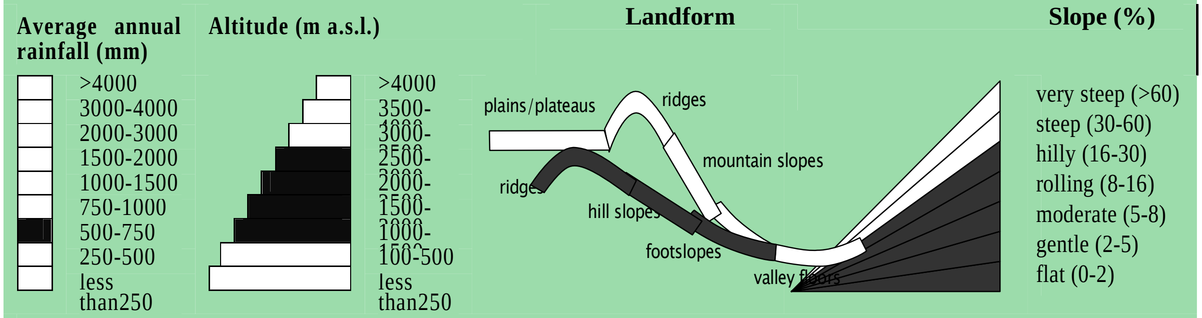
Trashlines are formed of sorghum, maize or teff straw arranged in different shapes (a rectangular, square or a trapezoidal basin) with the objective to retain rain water. Crop stalk / residues are heaped and aligned nearly on contour. The technology provides multi purposes such as water harvesting, soil trapping, and physical obstruction to runoff and soil fertility improvement.

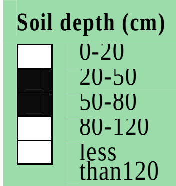
The technology is well adapted in Gidole and the surrounding woredas in general. Trashlines have evolved from long year practicing of the land users. Initially, trashlines were practiced alone but at present being integrated with structural measures such as bunds and tied ridging. Recently, teff straw trashlines are being increasingly used. There is a significant improvement in the way the technology is advancing.

Field activities for agronomic measures

Activity	Energy	Equipment	Timing	Frequency
Prepare crop residue or stalk to be trash lined	Manual labor	Sickle	Immediately after harvest	Twice a year
Collection of straw	Manual labor Donkey load	Hand	Immediately after harvest	Twice
Arrange the straw and stalk on a line	Manual labor		Dry season	

Natural Environment





Growing season:
Soil fertility: medium-Low
Soil texture: Medium (loam) – coarse sand
Surface stoniness: loose stone- some loose stone
Topsoil organic matter: low (less than1%)- medium (1-3%)
Soil drainage: medium - good
Soil erodibility: medium - high

Important information on the natural environment where the technology is applied: The number of heavy storms of water per year is 10 -15. These occur at the beginning and mid of the growing seasons. Rainfall in growing seasons is usually insufficient and not well distributed. Number of growing seasons per year is 2.

Human environment and land use
Size of land per household is less than 1 ha for 60% of land users and 1-2 ha for 40% of land users in general. Typical household size of the land users is 7 persons. Population density is 200-250 persons/km^2. Annual population growth is 2-3 %.

The trend in household land size shows a decreasing trend because of population growth. No indications appear to be seen towards privatization of land because land is owned by the state and the public. Nevertheless, land ownership did not affect SLM. Similarly, subdivision of land takes place but it did not affect the implementation of the SLM technology.

There is difference between rich and poor in how they practice SLM because poor farmers have limited access to participate in share-labor, which requires offering of food and drinks for people working. Poor farmers are unable to provide food and drinks and hence are unable to benefit from it.

Off-farm income is significant for the land users who apply the SLM technology and is about 50% of all income. Most farmers practice the technology and also are engaged in petty trades. The use of the SLM Technology is not hindered because land users cannot read and write. About 90% cannot read and write but still they practice the technology. Production is not subsidized for cropland and cropland mixed with another land use type. Land cultivation is performed largely by manual labor using the hoe.

Cropping is rain fed mostly and in the majority of the cases land users cultivating the valley floors practice flood or runoff farming by diverting runoff from hillsides and roads and directing it to the field. The type of cultivation is continuous cropping by rainwater and post-flooding. Intercropping is practiced widely. Crops intercropped include: Sorghum, maize, paper, cotton, and beans. The cropping system (e.g. sequence of crops. etc.) is of a pattern Sorghum - Maize – Beans.

Main canal for flood water irrigation on a maize field (Photo 2003)

Flood water diverted to a filed from a seasonal flood water course (Photo 2003)

Secondary canal directing flood water for a crop filed (Photo 2003)

Economic analysis

The gross production value in US dollars per hectare per year around the SLM Technology area is less than 100/ha/yr. Compared to the situation without conservation, estimated percentage gross production value increase in 3 years after implementing SLM taking into account any production losses due to the area rendered non-productive because of the presence of the SLM measures is over 100%.

Compared to the situation without conservation, estimated percentage gross production value decrease in 10 years after implementing SLM is 100 - 200%, by considering also the land occupied by conservation measures and in further assuming current input and prices.

Adoption and adaptation

Many changes have taken place in terms of improving the application of trashlines. These evolved through long time practice by the land users themselves. Initially trashlines were practiced alone but through time structural measures such as bunds and tied ridging are combined with trashlines and now these are being increasingly practiced. Recently, teff straw trashlines are also practiced. There is significant advance in the way the technique is improving. Land users who have implemented the technology with incentives are 0 % and cover 100% of the SLM technology area.

Percent land users who have implemented the technology and who have done it wholly voluntarily, without any incentives other than technical guidance is 100% of land users that have applied the SLM Technology in the 100 % of the area.

There is a very significant growing trend towards spontaneous adoption of the technology. Trashlines are localized to sorghum growing areas mostly at the moment but there are chances for expanding the technology to teff growing areas as well because there is emerging experience with teff trash lining. The technology is easily replicable. The SLM Technology is less durable but can be easily maintained and kept in good shape

Trashlines formed from teff stubble straw after harvest (Photo 2002)

Maintenance: land users have adequately maintained and managed what has been implemented. Maintenance is made regularly twice or once every year immediately after crop harvest and before land preparation.

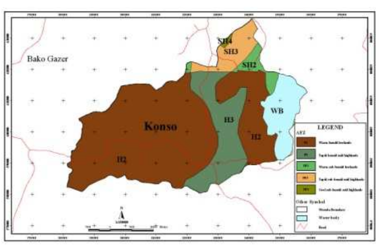
Supportive measures: 1**.** Soil bund: earth embankment across the slope and 2**.** Tie ridges: are water**-**harvesting measures built in rectangular shape

Multiple cropping in Konso (Photo 2002)

9. Multiple cropping (Konso)

Common Name of SLM Technology: Multiple Cropping
Local or other name(s): Ulupe unta pisa ayleta (Konso)
Associated approach: not documented
Name of Contributing SLM specialist: Taye Mamo, Office of Agriculture, Konso special Woreda, Karate
Region: SNNPR
Date: 11/10/2002 updated 20/10/2006

Total SLM Technology area is approximately:
4000 skm



Agroecology of Konso

Location of Konso

Definition

Multiple cropping is a practice of growing two or more crops on the same land in the growing period. It is a practice of growing different types of crops in the same field. The crops grown together are, however, harvested at different times.

Description
It is an agronomic land management practice, which involves the growing of different kinds of crops in the same field. The crops grown together are, however, harvested at different times. In Konso farmers are used to growing of 10-15 types of crops on the same field. The aim is to avoid risk of crop loss and reduce vulnerability to food shortage. Some crops are more resistant to or escape the adverse conditions of drought, pest and diseases. Annual crops are sown or planted in two seasons. Annual and perennial crops are planted and managed according to their seasonal calendar. Low fertility status, unpredictable and erratic rainfall, pest and diseases are some of the constraints limiting crop production.

Various crops planted in the same field in the same cop calendar (Photo 2003)

Physical and vegttataive measures applied in integration with multiple cropping (Photo 2003)

Technical functions

Main	**Secondary**
Fertility improvement	Improve soil structure
Control of raindrop splash	Control of dispersed runoff
Use of drought resistant crops	Increase in organic matter

Construction and maintenance

Field activities for agronomic measures				
Activity	**Energy**	**Equipment**	**Timing**	**Frequency**
Primary tillage	Manual labor	Local hoe	Dry season	Annual
Collection of mulch	Animal traction	Oxen plough	Partly wet	each crop
Mulch mixing with soil / incorporation	Manual labor	Sacks and hoe	All seasons	
Seedling planting		Hoe	Wet season	Twice
Weeding		Sickle	Middle of rainy season	Twice

Establishment activities for vegetative measures				
Land preparation	Manual labor / oxen	Hoe	Dry season	2-3 times
Seeding/ sawing / planting		Hoe	Wet season	2 seasons
Maintenance activities for vegetative measures				
Thinning	Manual labor	Hoe	Wet season	
Ratoon management		Sickle	Dry season	

Owing to the prevalence of recurrent drought in the area, farmers are obliged to practice multiple cropping even in areas with very soils suitable for single-cropping. To conserve moisture, farmers use stone-mulches on croplands.

Land degradation

Types of land degradation on the land surrounding the SLM area

Land uses	Type of degradation	%	Land form(s)
Cultivated and grazing lands	Water erosion	60	HP
Cultivated lands	Chemical deterioration	70	HP


Water erosion caused land degradation problem in the SLM technology area (Photo 2001)

Characterization and purpose

Land use types	Percent
Cropland: annual cropping	33
Cropland: tree / shrub cropping	7
Crazing land: intensive grazing	5
Grazing land: extensive grazing	8
Woodlands and bushes	27
Total	100

The technology combats land degradation through: control of raindrop splash, control of dispersed runoff (retain/trap), increase in organic matter, increase in soil fertility

Problems with land use are: Continuous cultivation of the same land, absence of crop rotation practice and the rapidly increasing population that aggravate soil degradation in the SLM Technology area.

Status

The current status of the technology is best described as traditional. It is used since generations. The technology has emerged from long time practice to averting risk that may occur owing to recurrent drought. It is a coping mechanism to adverse climatic conditions. It is an agronomic measure involving the growing of more than one crop on the same field in a season. Aim of the technology is to reduce risk of failure and is a coping strategy in case of drought or disease prevalence. Today the traditional/indigenous SLM is used more and is expanding. Owing to recurrent drought occurring in the area, farmers prefer multiple cropping to single cropping. The appearance of the applied technology has gradually changed over time. Currently land users are trying to use complementary crops such as cereals mixed with pulses as a component crop where land equivalent ratio can be justified. Stone mulching and manure application are an integral part of multiple cropping.

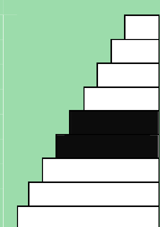
Constraints during establishment include lack of knowledge on the use of complimentary crops that are grown together e.g. Pulses with cereals and high competition for soil nutrients and moisture. Improvements could be done by introducing complementary crops for effective land equivalent ratio. It should be designed such that effective harvesting of rainwater and obstructing surface runoff is adequately addressed. Constraints during establishment are shortage of rain, shortage of seeds and labor. Constraints during maintenance include: Lack of labor, pests and diseases.

Natural Environment

Average annual rainfall (mm)

>4000
3000-4000
2000-3000
1500-2000
1000-1500
750-1000
500-750
250-500
less than250

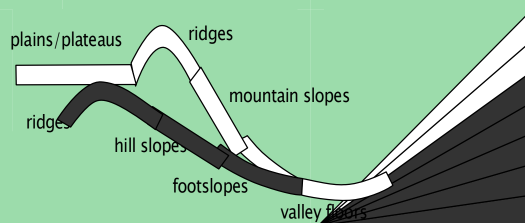
Altitude (m a.s.l.)



>4000
3500-
3000-
2500-
2000-
1500-
1000-
100-500
less than250

Landform

Slope (%)



very steep (>60)
steep (30-60)
hilly (16-30)
rolling (8-16)
moderate (5-8)
gentle (2-5)
flat (0-2)

Soil depth (cm)

0-20
20-50
50-80
80-120
less than120

Growing season: rainy months
Soil fertility: medium-Low
Soil texture: Medium (loam) – coarse sand
Surface stoniness: loose stone- some loose stone
Topsoil organic matter: low (less than1%)- medium (1-3%)
Soil drainage: medium - good
Soil erodibility: medium - high

Technology implementation

There is a moderate difference between rich and poor in how they practice SLM. Better-off farmers hire labor locally called Parga and also have enough grain to provide the labor with food and drinks. Off farm income contributes less than 10% of family income for the land users who apply the SLM technology.

The level of technical knowledge required for implementation of the technology is moderate for field staff / extension worker and moderate for the land user. 80% of the land users cannot read and write. The reason is low access to education and some cultural barriers which limit access to education. Females and the first born in the households are not allowed to go to school in some households. Production is not subsidized.

Land cultivation is performed by manual labor using the hoe. Size of cultivated land per household is very small (less than1 ha). Some farmers practice seasonal fallowing by planting nitrogen fixing perennials such as pigeon pea which improve the fertility of soils. Important human and land use conditions relevant for the technology are: farmers usually practice managing their holdings applying structural erosion control measures and water harvesting structures to improve soil moisture content and soil fertility.

Crops tolerating difficult conditions and that produce yield even in adverse climatic conditions such as low rains and pest manifestation are preferred for multiple cropping. The most important factors affecting the costs are labor, high temperature, topography, surface stoniness, and poor workability.

Benefits, advantages and disadvantages

Estimates of production, soil loss and runoff

SLM measures	Main plant	Production (t/ha)
Without SLM	Sorghum	0.6
With SLM	Sorghum	0.9

Reports indicate multiple cropping is as old as the practice of crop growing in the area.

Technology adaptation

Land users design the SLM Technology in such a way that it allows changes. Yet the production farmers get from the system is not improving because over 15 different types of crops are grown together, which makes it difficult to determine the productivity of each component crop.

Supportive measures

Bench terrace: It is traditional and mainly built of stones to reduce the steepness of slope of by placing series of level benches.

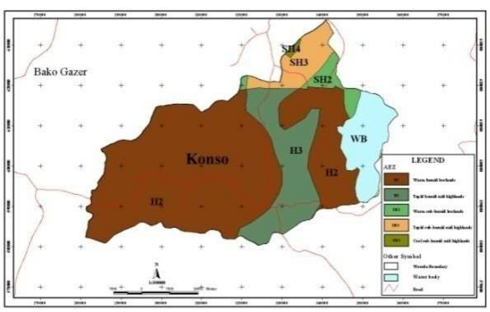
Tie ridge: is designed for harvesting rainwater and obstructing surface runoff.

Stone mulch: to conserve moisture, farmers use stone mulch on plots of land. Stone is collected while plowing until the crop planted germinates.

Crop residue management (mulching) (Photo 2002)

10. Crop residue and stone mulch management (Konso)

Common Name of SLM Technology: Crop residue and stone mulch
Local or other name(s): Mona (Konso),
Associated approach: Voluntary labor assistance and labor-share (Debo/Wenfel)
Contributed by: Friew Desta, 1999, Bureau of Agriculture, Southern region
Updated by Daniel Danano, 2007
Area information
Basin/Watershed: Lake Basins / Segen River Basin
Total SLM Technology area: 2000 sq km. Woreda area is 2400 km^2 and the mulches are practiced throughout the Woreda (cultural practice).



Agroecological map of Konso Special Woreda *Location map of Konso*

Definition

It is an agronomic land management practice established by using residue of cereal crops such as maize, sorghum, teff and crops together with stone mulching and physical measures.

Description

Crop residue mulch is applied seasonally and after every harvest by the land user using maize and/or sorghum or other crop residue for mulching. The crop residue biomass is not enough to provide adequate cover to the soil from erosion and improve soil productivity unless combined with other measures which retain runoff and provide effective soil erosion control. The technology provides multi uses such as water harvesting, reduction of evapo-transpiration, reduction of soil water losses, trapping soil that is moving downslope, soil fertility improvement, etc. It is applied on lands that have varying slope ranges (flat – sloping lands) and is very suitable to semi-arid areas.

The SLM Technology is indigenous / traditional and has been used for generations. The technology has originated locally. According to farmers it is an indigenous technology that has been practiced through generations.

Maize stalk mulch, Moringa trees used as soil fertility enhancing measures (Photo 2003)

Mulch is arranged as trashline and are applied in combination

Technical functions

Main	Secondary
Increase in soil fertility	Improvement of ground cover
Water harvesting	Increase in organic matter
Increase /maintain water stored in soil	Soil moisture increase
Increase of infiltration	
Control of erosion	

Land degradation

Indications of degradation on Cropland including mixed land

Sheet/rill erosion	**High**
Crop Yield decline	Moderate
Increased inputs to maintain yields	Low
More stones on a plot	Moderate

Problems in the area: Rainfall shortage, farmland shortage and crop/livestock diseases

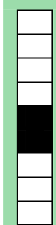
Characterization and purpose

The technology combats land degradation through

Increase of infiltration Increase/maintain water stored in soil Water harvesting Increase in soil fertility Increase in organic matter	Improvement of ground cover Reduction of slope angle Reduction of slope length Improvement of soil structure

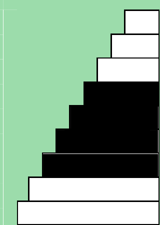
Natural Environment

Average annual rainfall (mm)



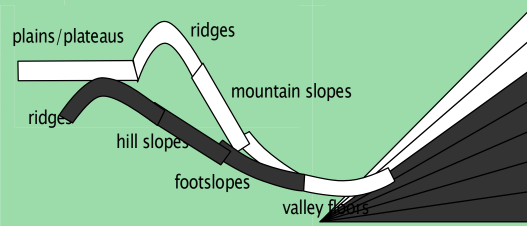
>4000
3000-4000
2000-3000
1500-2000
1000-1500
750-1000
500-750
250-500
less than250

Altitude (m a.s.l.)



>4000
3500-
3000-
2500-
2000-
1500-
1000-
100-500
less than250

Landform **Slope (%)**



very steep (>60)
steep (30-60)
hilly (16-30)
rolling (8-16)
moderate (5-8)
gentle (2-5)
flat (0-2)

Soil depth (cm)

Growing season:
Soil fertility: medium-high
Soil texture: Medium (loam) – coarse sand
Surface stoniness: low, medium, very low
Topsoil organic matter: medium (1-3%), high (>3%)
Soil drainage: v. good - good
Soil erodibility: low

Number of erosive storms per year is less than 10. Rains are often insufficient and erratic in growing seasons. There are two rainy seasons in the SLM technology area.

The number of growing seasons per year is 2.

Field activities for agronomic measures

Activity	Energy	Equipment	Timing	Frequency
Harvesting grain/crop	Manual labor	Sickle	Dry season	Biannual
Cutting straw				
Spreading of mulches			After harvest	

Construction activities for structural measures

Activity	Energy	Equipment	Timing
Stone mulch spreading	Manual labor	Spade / scoop/hoe	Dry season
Stone collection and sorting		Scoop/ spade	Before planting
Aligning and placing field and boundary banks		Spade / hoe	Dry season
Placing crop residue on the banks		Sickle	Dry season

Maintenance activities for structural measures

Activity	Energy	Equipment	Timing	Frequency
Replacing of and alignment of stone banks	Manual labor	Sickle, hoe	After harvest	Twice a year

Human environment and land use
Typical household size of the land users is 6 persons. Population density is about 150 persons/km^2. Annual population growth is 2-3%

Land use rights
Cropland is individual and grazing land is communal unorganized. There is no trend towards privatization of land. Land ownership and land use rights did not affect implementation of SLM. The trend in land size per household is decreasing. Limited off-farm activities and, few out migrations are coping strategies. Subdivision of land has not happened and has not affected the implementation of the SLM Technology. The use of straw for fodder and fuel wood increased. The Technology shows immediate impact.

There is no marked difference between rich and poor in the way they practice SLM. Off-farm income for the land users who apply the SLM technology is less than10% of all income. These include: crafts, daily labor. Level of technical knowledge required for implementation of the technology is moderate.

Benefits

With or without SLM rainfall	**Production (t/ha)**
Without SLM	0.5 (Cotton)
With SLM	1.3

Information mainly based on estimates

Economic analysis
Gross production value in US dollars (US$) per hectare per year around the SLM Technology area is less than 100 / ha / yr. Without SLM gross production value decrease in 10 years, assuming current inputs and prices. 50%. The gross production value of the land per hectare per year with SLM Technology is 150 /ha/yr.

Adoption and adaptation
Changes that were observed as result of practicing the technology over time included: The amount of biomass from crop residue being added on the bank has increased, the widths of the banks is getting narrower and the length getting shorter. Land users themselves do this.
A number of land users who have implemented the technology, have done it wholly voluntarily, without any incentives other than technical guidance and are about 100 % of land users that have applied the SLM Technology. They are more than 2500 land user families on 100 % of area under the technology.

There is enough local skill or local support to expand the SLM Technology within the community and even in other areas. The SLM Technology is set up in a way that it will be applied every season and can be easily maintained and kept in good shape.

Maintenance: Land users have adequately maintained or managed what has been implemented. Some estimates say it is has been practiced for over 400 years.

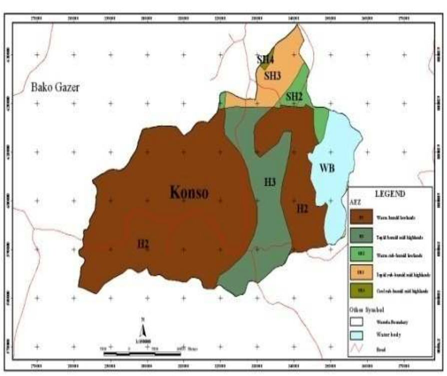
Ridge basin crop cultivation practices of Konso (Photo 2007)

11. Ridge Basin (Konso)

Name of Technology: Ridge Basin
Local or other name: Monna (Konso Language)
Associated Approaches: Voluntary labor assistance and labor-share (Debo/Wenfel)
Contributing SLM specialist: Firew Desta, Bureau of Agriculture, Southern Nation, Nationalities and Peoples Region, SNNPR
Date: 15/10/2002, updated 2007

Area information

Woreda Konso Special Woreda and Derashe



Agroecological map of Konso   *Location of Konso*

Definition
A rectangular / square / circular shaped soil embankment created by digging soil and forming a ridge and a basin for collecting rain water in it.

Description

It is a basin and ridge of various shapes and sizes made by a local implement called 'Bayra' (scoop shaped hoe) and maintained every three years during the dry season. The technology is applied on moderately deep and medium textured soils. It is intended to collect and store rainwater in the soil (in situ water harvesting) and is often applied in areas with low and erratic rainfalls. The width and length of the basins vary depending on the depth of soil, type of crop grown and availability of labor. More than one crop is planted in the basin. Water tolerant crops are planted in the basin while plants susceptible to water logging are planted on the ridges. Sweet potato, sorghum, beans, cotton and pigeon peas are planted on the ridge. In households where more labor force is available the households implement the technology with very little support from others. Farmers are organized in groups to construct ridge basins. It is a high labor demanding activity but very essential for increasing and maintaining crop and land productivity.

The technology has evolved from long years land users own practice in the area. The Konso people practiced it since long time and the technology originated from farmers' own understanding of coping up with unpredictable climatic regimes.

Aim of technology: It is basically and primarily aimed at harvesting rain water, store soil moisture and in the mean time control soil erosion. Today, the indigenous SLM is continued and maintained. The beginning of the technology is not known but could be traced back to generations and it continued until the present time with further improvements and expansion.

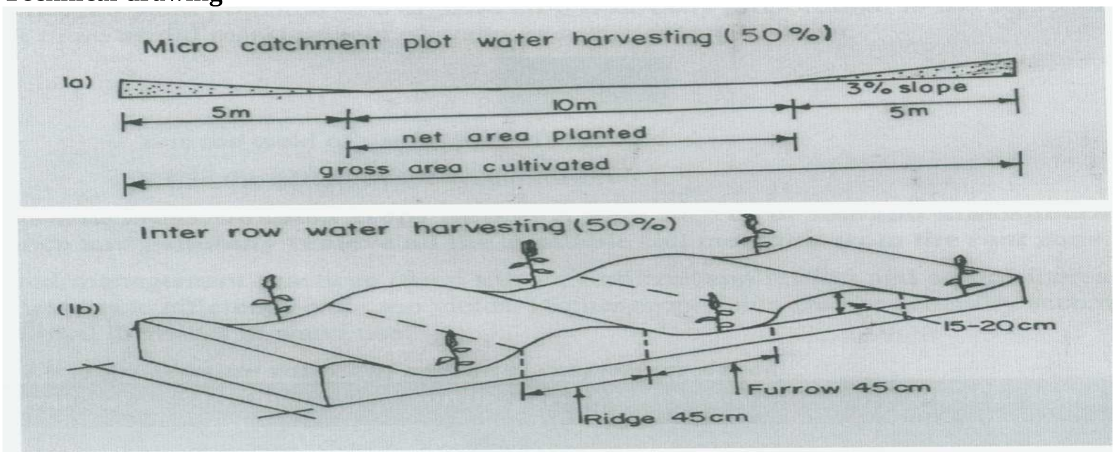
The appearance of the applied technology has greatly changed over time. It is assumed that the present practice of making larger basins and ridges came to exist from continuous improvements made on the small furrows and ridges used in the early times. Compost is applied in the basin to improve fertility. Household garbage is also collected and applied in the basin. Rainfall is erratic and unreliable and hence the basins trap all the rainwater and store it in the plant root zone

Manure applied in a basin for improving soil fertility (Konso) (photo 2007)

Specification of structural measures (m)

Type of basin	**Width**	**Length / diameter**	**Depth /height**
Circular		2-3	0.5-1
Square	2-4	2-4	0.5-1
Rectangular	3-5	3-10	0.5-1

Technical drawing



Land degradation
Land use problems include: land shortage, pests, high price of inputs, low and erratic rains are major problems. Land degradation problem mainly addressed by the technology are water degradation, acidification, soil moisture problem and soil erosion by water.

Technical function

Main	**Secondary**
Moisture harvesting	Increase/maintain water stored in soil
Fertility improving	Control of dispersed runoff (retain / trap)
Land preparation	

Natural environment

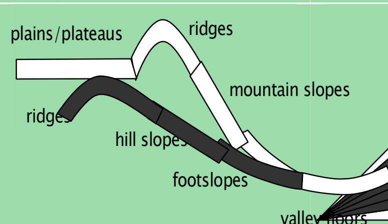
Average annual rainfall (mm)

- >4000
- 3000-4000
- 2000-3000
- 1500-2000
- 1000-1500
- 750-1000
- 500-750
- 250-500
- less than250

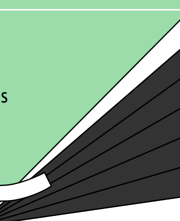
Altitude (m a.s.l.)

- >4000
- 3500-4000
- 3000-3500
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 100-500
- less than250

Landform



Slope (%)



- very steep (>60)
- steep (30-60)
- hilly (16-30)
- rolling (8-16)
- moderate (5-8)
- gentle (2-5)
- flat (0-2)

Soil depth (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- less than120

Growing season:
Soil fertility: low - medium
Soil texture: medium loam
Surface stoniness: little stones, some loose stones
Topsoil organic matter: low (less than1%), medium (1-3%)
Soil drainage: medium, good
Soil erodibility: high, medium

Soil depth is more than 25 cm, low surface stoniness, and medium soil texture. The gradient along the rows/strips is 0%. The number of erosive water storms is less than10 per year. In most cases ridge bunds are constructed on moderate, gentle and flat slopes where surface stoniness is low

Implementation activities, inputs and costs

Establishment activities for structural measures				
Activity	**Energy**	**Equipment**	**Timing**	**Frequency**
	Manual labor	Stick	Dry season	
Soil excavation		Baira (local tool)	Dry season	
Maintenance/recurrent activities for structural measures				
Soil excavation	Manual labor	Baira (local tool)	Dry season	Each cropping season

Field activities for agronomic measures		
Activity in sequence	**Energy**	**Equipment**
Land preparation	Manual labor	Hoe, seeds
Planting sorghum		
Planting cotton		
Planting pigeon peas		
Planting beans		

Establishment activities for vegetative measures			
Activity	**Energy**	**Equipment**	**Timing**
Land preparation	Manual labor	Hoe	Dry season
Planting			On set of rains
Weeding			Rainy season

The ridge and basin are frequently modified and upgraded during seedbed preparation, planting and weeding. Land cultivation is performed by manual labor using the hoe. Animal traction is hindered as a result of the ridge and basin structures not allowing the animals to freely move. Only hoe cultivation is possible when the technology is applied but the need for upgrading it to be use with the oxen is not to be ruled out. The type of cropping system is continuous cropping involving intercropping and the type of cultivation is rain fed. Crops grown include sorghum, maize, haricot bean, finger millet, sunflower, coffee, cassava, pigeon pea, etc. Mulching is a practice used along with the technology for controlling erosion and reducing evaporation losses.

Costs

The most important factors affecting the costs are labor, farm implements, soil workability and surface stoniness. Costs are calculated on per ha of land treated. The daily wage cost of hired labor to implement SLM is 0.65 US $ per person per day.

Establishment and maintenance cost (US$)

Agricultural	**Input**	**Quantity**	**Cost**
	Compost / manure (kg)	500	9
	Seeds (kg)	70	15
Equipment	Tools	5	12
Labor	Person days	444	261
Total			287

Human environment

Typical household size of the land users is 7 persons. Size of land per household is 0.5 ha. Population density is 150 persons/km^2. Annual population growth is 2.8 %. There is a marked difference between the rich and poor in the way they practice SLM. Relatively wealthy land users have the capacity to hire labor for constructing SLM structures. Off-farm income for the land users who apply the SLM technology is less than 10% of all income.

Impacts of the technology

Production and socio-economic benefits and disadvantages

With or without SLM	Main crop	Production (q/ha/yr)
With SLM	Sorghum	2
Without SLM		6

Offsite impacts

The technology is not intended to provide significant off-site benefits. Nevertheless, it indirectly provides offsite effects by trapping all the rain received. The technology is best described as traditional and has been used since generations

Economic analysis

Without SLM the gross production value in US dollars (US$) per hectare per year around the SLM Technology area is less than 100 US$/ ha / yr. With SLM Technology the gross production value of the land per hectare per year is over 150 US$/ ha / yr. Compared to the situation without conservation percentage gross production value increase 10 years after implementing SLM by considering also the area occupied by conservation measures and assuming current input and prices is greater than 300%.

Adoption and adaptation

Land users have applied the SLM Technology without incentives. Land users who have implemented the technology, have done it wholly voluntarily, without any incentives other than technical guidance. There is strongly growing spontaneous adoption of the technology. The technology started over 400 years and it has become an in integral part of the farming.

There is enough local skill to expand the SLM Technology because the technology is used for generations and land users have the skill. The SLM Technology is set up in a way that it will be durable. Changes have been made to the technology. Since the area is a rainfall deficit, the need to increase soil moisture apparently has motivated farmers to practice it. In the opinion of field technicians, the measures have evolved to the present stage larger ridges and wider basins to enable harvest more rainwater from the early smaller ridges and basins.

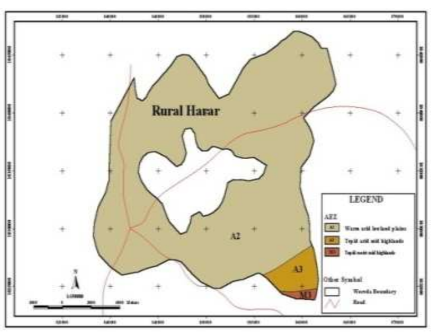
Conclusion

Since the digging of new ridge and basin requires a lot of labor it is time consuming and costly. Maintenance is made at least 3 times a year as mentioned above. The embankment could be planted with crop mixed with fodder legumes to overcome livestock feed problem prevailing in the area and also to stabilize the structure. The use of animal drawn implements for digging scraping and forming ridge would ease the labor problem.

Chat ridge bunds of the Hararghie Highlands (photo 2004)

12. Chat strips and rectangular bunds (Harerghie)

Common Name of SLM Technology: Chat Ridge bund
Local or other name: Chat Katara (Hararghie)
Associated Approach: Self Help
Contributing SLM specialist: Daniel Danano and Moges Girma, Harari Bureau of Agriculture and Rural Development, Harari Regional State
Date: 10/20/2005 Updated: 2006
Area information
State: Harari
Area of the Technology 5,00 Sq km



Agroecolgy of Harar

Location of Harar

Definition

It is a land management practice where chat strips are developed in combination with a basin and a ridge or sometimes mixed with bunds for planting chat along a line that may or may not follow a contour line.

Description
It is an earth structure formed by digging soil to form a basin and ridge to plant chat. Chat (Khata edulis) is a plant whose leaves and soft stem is used as a stimulant. Mechanical and vegetative soil conservation measures are applied in combination. Chat strips are planted as a barrier to soil erosion and to trap runoff. Chat ridge bund is formed from earth excavated to form the basin and embankment. Ridges and basins are placed as inter-bund moisture conservation measures and as a measure to control soil movement within the bunded area /strips

The aim is to conserve rainwater for growing chat; a plant of high economic value and other cereals together with chat. In a well established chat-ridge there is absolutely no or little runoff escaping the field and the soil loss is negligible.

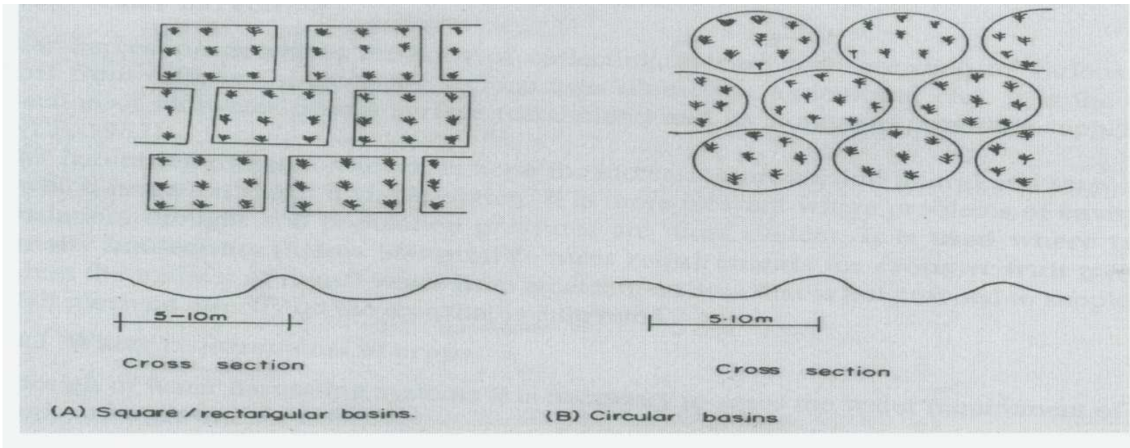
Chat ridge bund is a structural measure formed by combining stone /soil bund. Ridges and basins are placed as inter-bund moisture conservation measures and as a means to control soil movement within and outside the bund area. Today, the traditional practice is widely experienced and almost all chat-growing farmers practice it. Free grazing animals damage structures but the common practice is that livestock are stall-fed. A lot of labor is needed to establish the measures but farmers are encouraged to invest on it because of its scope to offer high economic return. The bunds need to be maintained regularly and upgraded when need arises. Increase the number of stone/soil bund in the field. Lead more runoff water to the field from outside

Construction: A line is marked and soil is dug out to embank it on an area of about 75x50 cm area. Chat cuttings are planted on the trench. The purpose of the technology is to collect as much rain water as possible. The embankment protects soil from erosion. Water is collected in the trench. Households using family labor make the ridge bund. The ridge is strengthened while performing cultivation. Maintenance is required when there are breaks on the ridge. The technology is suitable to semi-arid areas with rainfall ranging from 500 to 700 mm/annum. Farmers grow chat as the main means of finance/capital generation.

Picture of the technology

Chat ridge bund with strip cropping of sorghum in between: Near Awoday (Harar) (photo 2004)

Technical drawing



Technical function

Main	Secondary
Water harvesting	Reduction of slope length
Increase of infiltration	Control of dispersed runoff (retain/trap)
Increase /maintain water stored in soil	

Purpose and classification

The major land use problems in the area without SLM are land shortage, continuous cropping, land degradation, and open grazing

Land use types	% total area utilized by land users
Cropland: annual cropping	20
Cropland: tree / shrub cropping	60
Grazing land: extensive grazing	5
Woodland: plantations, afforestation	3
Mixed land: agro forestry	10
Total	100

The technology combats land degradation through: increasing and maintaining water stored in soil, increase of infiltration, water harvesting, and reduction of slope length and control of dispersed runoff.

The technology is best described as indigenous. The technology has locally originated. The SLM practice has existed since very long. Today, the indigenous SLM is widely experienced and almost all chat-growing farmers are practicing it. The appearance of the applied technology has been changing over time. The spacing is made narrower to enhance more rainwater to be stored. The technology is suitable to semi-arid and sub humid climatic conditions. Farmers grow chat as the main means of capital income. Cultivation is done twice or three times a year.

Construction

A line is marked and a pit (trench) is dug and the soil embanked on about 75x50 cm. Chat cuttings are planted on the basin. The purpose of the technology is to collect as much water as possible. The embankment protects rain water from running off the field and also save the soil from erosion. Water is collected in the trench. Households using family labor make the ridge bund. During cultivation the ridge is strengthened. Maintenance is done in case of breaks on the ridge and every cropping season. Old chat trees are pollarded or cut and replaced by young plants. Chat is planted as the major cash crop. The space between the plants is cropped with annual crops such as sorghum and maize and legumes are intercropped to improve fertility.

Constraints: land shortage, low and erratic rainfalls and possible improvements could include: the enhancing of the effectiveness of the ridges to trap as much rainwater as possible.

Specification of vegetative measures

Type and alignment of vegetative measures (m)

Strips/blocks	Material	Plants/ha	Space between rows/blocks	Space within rows/strips
Vegetative measures	Chat	2000	3-4	2-3
	Fruit trees	1250	4-6	4-6

Fruit tress raised in the nursery ready for distribution to land users (photo 2005)

Land users participating in nursery management (photo 2005)

Important constraints during establishment are labor, elongated dry spells

Construction and maintenance

I) Field activities for agronomic measures				
Activity	**Energy**	**Equipment**	**Timing**	**Frequency**
Digging	Manual labor	Dengora/Harar spade	Before rains	Each cropping
Cultivation and weeding			Mid of rains	Twice a year
Seedbed preparation		Dengora, spade	Dry season	Two-three times per crop
Preparing cuttings		Metcha	Rainy season	
Cuttings plantation		Spade		
Cultivation				
II) Maintenance activities for vegetative measures				
Replacing of dead seedlings	Manual labor	Spade	Onset of rains	
Cultivation		Hoe	After rain	
Ridging of breaks				

Specification of structural measures
Type and layout of structure (m)

Structures (bund /bank)	**Material**	**Vertical interval**	**Length**	**Depth**	**Height of ridge**
Basin	Earth and plants	0.3-0.5	3-5	0.3-0.4	
Ridge	Mulch/earth	0.3-0.5	3.5-5		0.3-0.70

Natural Environment

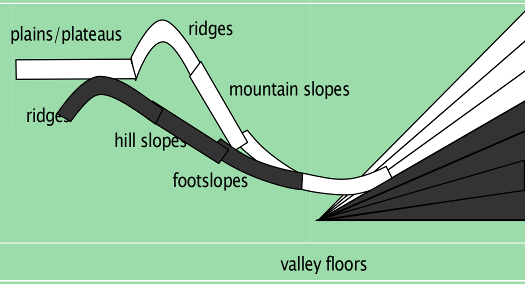
Average annual rainfall (mm)

>4000
3000-4000
2000-3000
1500-2000
1000-1500
750-1000
500-750
250-500
less than250

Altitude (m a.s.l.)

>4000
3500-
3000-
2500-
2000-
1500-
1000-
100-500
less than250

Landform



Slope (%)

very steep (>60)
steep (30-60)
hilly (16-30)
rolling (8-16)
moderate (5-8)
gentle (2-5)
flat (0-2)

Soil depth (cm)

0-20
20-50
50-80
80-120
less than120

Growing season:
Soil fertility: low, medium, very low
Soil texture: coarse (sandy), medium (loam)
Surface stoniness: abundant loose stone
Topsoil organic matter: low (less than1%)
Soil drainage: good
Soil erodibility: very high, high
Soil water storage capacity: low, medium

Number of erosive water storms per year is less than 10. The storms occur in the beginning and middle of growing seasons. Rainfall in growing season is usually insufficient and not well distributed.

Human environment and land use

Typical household size of the land users is 5 persons. Population density is 100-200 persons/km^2. Land size per household is decreasing. No trends towards privatization of land. Land ownership and land use rights did not affect SLM. Although land is under state ownership, farmers feel that it is theirs. Therefore, ownership of land has not affected SLM activities. Furthermore farmers have been issued user rights, which build sense of ownership. Subdivisions of land did not affect the implementation of the SLM Technology since this takes place in the households by their own. Moisture shortage is the main constraint since the area receives low amount of rainfall. Rain water harvesting and compost application are recommended to improve soil fertility and increase crop production.

There is moderate difference between the better-off and poor land users in how they practice the technology. Almost all land users want to practice SLM technologies. But labor is the major constraint. The average farmer has relatively better interest than the poor to invest on land. Off-farm income is less than 10% of all income for the land users who apply the SLM technology. Land users who have SLM measures on their land have lower off-farm income compared to those who have no SLM measures on their land.

The level of technical knowledge required for implementation of the technology is moderate for technical staff and moderate for the land users. The use of the SLM Technology is not hindered, when land users cannot read and write. About 90% of land users cannot read and write. The majority cannot read and write because of non-existing adult education program and support from outside.

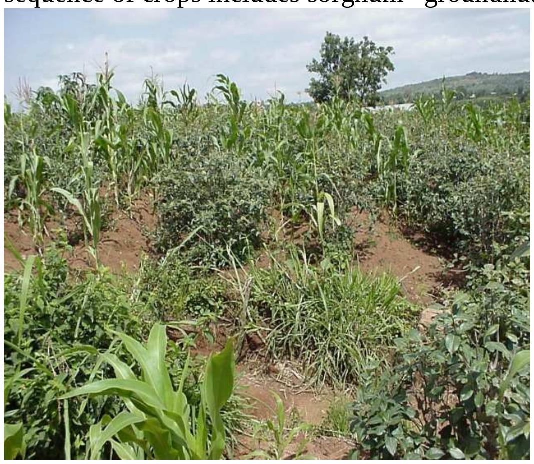
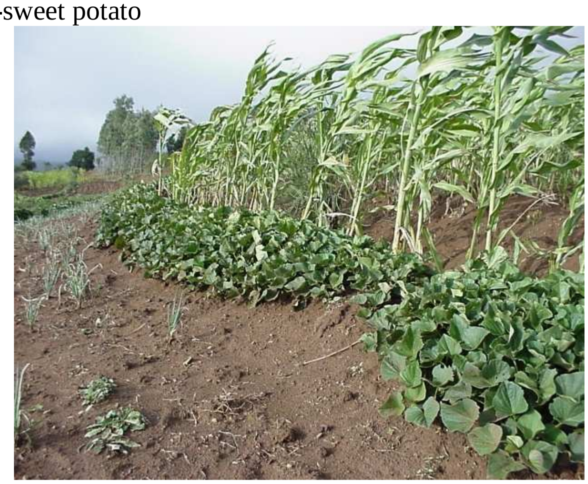
Crop and livestock production

Land cultivation is performed by manual labor, few land users use drought animals.

Type of cropping system

Type of cultivation	**Cropping systems**
Rain fed	Continuous cropping
Mixed rain fed	Ley cropping
Irrigated	Perennial cropping (Khat)

Intercropping is practiced widely. Crops intercropped are sorghum, chat, and beans/ground nut. The sequence of crops includes sorghum –groundnut-sweet potato

Chat – sorghum – sweet potato, beans intercropping in the Harerghie highlands (Daniel 2004)

The trend is towards enhancing vegetative practices owning to trends in increased fruit trees and chat growing. Drought tolerating characteristics of chat is very much encouraging apart from being a high value crop. The cultural practices associated with managing chat makes it the most appreciate vegetative measure for SLM

Other land uses

The woodlands are extremely denuded as a result of exploitation such as charcoal making, cutting trees for fuel wood and over browsing.

Crop and livestock production

Livestock (cows, goats) are mostly stall-fed. In lower parts of the technology area livestock are left to graze openly. This part is a very dry area and there is large area for grazing. Goats browse on open woodlands with acacia trees. The woodlands are getting extremely degraded as a result of heavy exploitation such as charcoal making, cutting trees for fuel wood and over browsing by small stock and camels.

Costs (US$)

Estimating cost recovery period of investment in soil and water conservation technologies. The Technology is Chat Ridge Bund and the crop planted is chat combined with cereals and pulses

Cost recovery (US$)

Year	1	2	3	4	5	6	7	8
1	678	-	281	330.2	112.4	1401.4	-	-678
2	-	339	281	330.2	112.4	1062.6	-	-339
3	-	168	153	165	112.4	598.4	3000	+1845
4	-	100	153	165	112.4	530.4	3900	+3800
5	-	80	153	165	112.4	510.4	4500	+4420
6	-	80	153	165	112.4	540.4	6000	+5920
7	-	80	153	165	112.4	510.4	6000	+5920
Total	678	847	1277	1485.4	786.8	4396.2	23400	19858

Note: 1 = establishment, 2 = maintenance, 3= seedbed preparation, 4= seed and fertilizer, 5 weeding and cultivation, 6 = total cost, 7 = gross production and 8 net benefit.

Cost is calculated on the basis of: volume of earth excavated and moved. Daily wage of hired labor to implement SLM is 0.85 US $ per person per day

Onsite and offsite benefits and disadvantages

Production and socio-economic benefits		**Socio-cultural benefits**	
Crop yield increase	High	Community institution strengthening	High
Fodder production increase	Medium	Improved knowledge SLM/erosion	High
Wood production increase	Negligible	off-site benefits	
Farm income increase	High	Reduced downstream flooding	High
Ecological benefits		Production and socio-economic disadvantages	
Increase in soil moisture	High	Increased labor constraints	High
Increase in soil fertility	Negligible	Increased input constraints	Little
Soil loss reduction	High	Hindered farm operations	Negligible

Economic analysis

Without SLM the average gross production value in US$ per hectare per year around the SLM Technology area is 3000 US$ / ha / yr (Chat). Chat is one of the cash crops providing the highest financial income per hectare for land users. With SLM Technology, the gross production value of the land per hectare per year is 6000 US$/ ha / yr. No area of land is assumed to have been lost as a result of SLM measures in this case of technology.

Adoption and adaptation

Ridges are integrated with field bunds of soil and stone spaced widely. The widely spaced ridges are liked by farmers. The SLM Technology is designed in such a way that it allows changes by the land users to adapt to changing land use practices. 100 % of land users that have applied the SLM Technology, have done it without incentives in an area accounting to 70 % of the SLM Technology area. There is a positive trend towards growing spontaneous adoption of the technology. More and more land users are getting engaged with the technology. There is enough local skill to expand the SLM Technology. Farmers are increasingly involved in the technology and a lot of improvements have been made by farmers themselves. The SLM Technology is not set up in such a way that it will be durable. But the position and dimensions are kept changing. Land users have adequately maintained and managed the technology. Farmers have seen that by practicing ridge bunds, production increased mainly due to more rain water harvested and soil erosion significantly reduced.

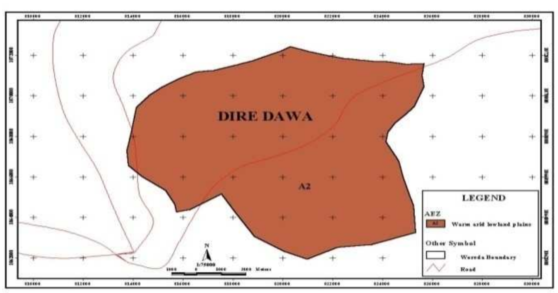
Sorghum stone terraces of Harerghie (photo 2005)

Good sorghum harvested from terraced filelds (Photo 2005)

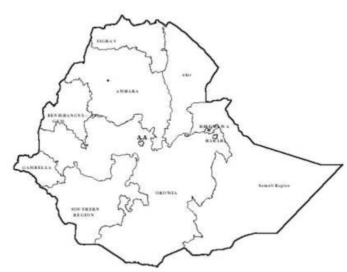
13. Sorghum terrace (Harerghie)

Common Name of SLM Technology: Sorghum Terrace
Local name: Daga (Oromifa)
Associated Approach: Self Help
Contributing SLM specialist: Daniel Danano Dale, Ministry of Agriculture and Rural Development. Email: ethiocat@ethionet.et, danieldanano@ethionet.et

Area information



Agroecology of Diredawa



Location of DireDawa

Definition
It is a physical land management measure constructed across the slope to control soil erosion and initiate infiltration of rain water into the ground.

Description
Sorghum terrace of Harerghie and Dire Dawa, locally known as Daga is constructed by placing stonewalls across a slope along a contour line. The development of Sorghum terrace involves activities of creating an embankment at a given spacing, which depends on slope. Cultivation in the terrace is done by the help of Dengora (local name for spade like hand tool) if the land is sloping, and by oxen if land slope is gentle (less than 8%).

The purpose of establishing Sorghum Terrace is to collect or arrest rainwater as much as possible for growing sorghum, which is planted by broadcasting. Sorghum is the staple food in the area. Since rainfall is erratic, the terrace allows more water to be stored in the soil.

Stone bunds are constructed in soils with very shallow soils, Diredawa (Photo 2005)

It is maintained every year and also upgraded while performing different farm activities (plowing, weeding, etc.). Every time maintenance is made breaches in the terrace are repaired and additional height given to the terrace until it forms bench terrace. The high walls of terraces are the result of upgrading made year after year.

It is suitable to areas with low and erratic rainfalls, sloping cultivated fields and lands having abundant stones for construction. It is also suitable to areas with semi-arid to arid climatic conditions and in wide ranging soil types.

In the technology area livestock are tethered near the cop plots to be fed with grass and weeds collected from the cropland. This is a good livestock management practice in relation to natural resources management and to the quality of livestock production.

The technology is entirely traditional. Daga (local name) is a stone embankment constructed along the contour for erosion control and moisture retention on cropland. It is aimed at controlling soil erosion from slopes and enhancing soil moisture by saving soil from running down the slope. This is attained by reducing the slope angle. Land users have experienced improved land productivity and increased their production by constructing Daga. Daga is properly established and maintained on croplands. Without Daga little or no production is expected. Daga enhances rainwater infiltration into the soil.

Land users started it because of its merit to increasing productivity. A land user having a well-established Daga is usually a better-off farmer in the community and the poor find it difficult to have

Daga constructed on their land. Land users start with a Daga of small height and every year they put an additional height while undertaking maintenance or upgrading. It starts with a height of 0.3-0.5 m and more height added every year. About 0.2 m and more additional height is given every year. In some areas the height reaches to 1.8-2.0 m. This height is attained in about 10-12 years continuous upgrading.

The structural measures considered in this technology are (1) Stone embankment (2) Ridges and basins in between for storing rainwater. Basins bigger in size are prepared for Chat and relatively smaller basins are prepared for sorghum. Digging the foundation becomes difficult during the dry season because the soil is very dry. Stone collection is laborious. If the household has few members, maintenance becomes laborious especially when the breach in the embankment is bigger. To maintain the basins every year it requires more labor. Land users need support from neighbors or get paid labor. To overcome these problems land users need to (1) organize themselves in workgroups (2) ovoid livestock entering to the field and practice stall-feeding. The management measures include fencing of cropped field and protecting it from livestock.

Chat is planted at the early rainy season and sorghum planted when early rains are received. Small amount of soil moisture in the soil is sufficient for sorghum to germinate but more water is required in the early seasons and during flowering.

The SLM Technology is mainly indigenous, including new practices such as placing bunds at intervals. Indigenous SLM Technologies have been used before the current SLM technology has been introduced and is known as Daga (local name). Today the indigenous SLM is used more. Farmers/land users have experienced improved land productivity and increased production as a result of practicing Daga. Daga is properly established and maintained on croplands.

The major constraint to agricultural production in the technology area is moisture stress. Sorghum and Cahta edulis are relatively moisture stress tolerant crops but sorghum requires adequate water during the early establishment period and grain filling. Chat also endures moisture stress once it has established well. Constraints include: stalk borer and disease for sorghum and high evaporation losses owning to hot climate.

Possible improvements: 1) Enhance the establishment of structures for retaining more water in the soil (2) Early weeding avoids weed and disease infestation (3) Strengthen runoff farming and floodwater spreading (4) Introduce short duration high yielding verities. Research undertakings have not been able to provide improved varieties for the technology area, hence strong research work is required.

Land degradation

Types of land degradation on the land surrounding the SLM area

Land use	**Type of degradation**	**Degree**	**%**	**Landform(s)**
f	Water erosion	m	100	H, F
g		s	85	H, R
c		s	75	V, F
c	Chemical deterioration (e.g.)	s		
g	Physical deterioration (e.g.)	s		

The landform in Dire Dawa is predominantly hill slopes, and is characterized by erratic rains and high evapo-transpiration rate.

Purpose and classification

The major land use problem in the area without SLM is overgrazing and over browsing by livestock especially by the small stock. Goats over browse shrubs in hill slopes making the land bare and enhancing erosion. Cutting trees/shrub for firewood and declining status of the vegetative cover led to wood shortage for construction and fire wood.

The technology combats land degradation by: reducing slope angle, increase of infiltration, maintain water stored in soil and water and sediment harvesting. The technology also provides significant off-site benefits.

Specification of vegetative measures

Type and alignment of vegetative measures (m)

Strips/blocks	Material	Plants/ha	Spacing between rows	Spacing within rows
Aligned: contour	Sorghum	17500-20000	0.2-0.3	0.2-0.3

Field activities for agronomic measures

I) Field activities for agronomic measures				
Activity	**Energy**	**Equipment**	**Timing**	**Frequency**
Tillage	Manual labor	Dengora	Dry season	2-3
Sowing season	Animal traction			Each cropping
Cultivation season	Manual labor		Dry season	
Weeding		Plough	Early rains	
Cultivation		Sickle	After flowering	
harvest			When crop matures	
II) Establishment activities for vegetative measures				
Chat planting by cutting	Manual labor	Dengora	Early rains	Every year
Sorghum planting		Dengora		
Sorghum planting	Animal traction	Plough		
Sowing	Manual labor	Dengora	During rains	
Sowing	Animal traction	Plough		
III) Maintenance activities for vegetative measures				
Activity	Energy	Equipment	Timing	Frequency
Cultivation	Manual labor	Dengora	During rains	2
Weeding			Withdrawal of rains	1

Sorghum is widely grown and is a staple food crop in Harerghie and DireDawa. Households that manage their lands with appropriate SLM measures get increased production. Substantial part of the crop produced is used for consumption. Good quality also brings a good amount of money for the household. Chat is also grown on strips together with sorghum.

Constraints during establishment: Chat is propagated by cuttings and it requires adequate soil moisture to establish. Low soil moisture content affects the survival of chat saplings especially in the early stages. Constraints during maintenance: frequent cultivation and weeding is needed and often land users face difficulties in getting labor. Possible improvements could include: letting more runoff or floodwater into the field. Therefore, efficient structures for runoff diversion, conveyance and storage are of extreme importance. Secondly, include mulch to reduce soil moisture losses.

Specification of structural measures

Type and alignment of structure (m)

Structures	Material	Vertical interval	Spacing	Length	Width	Height
Terrace	Stone	1-2	4 -8	50-300	1	0.5-2
	Earth					
Bund: level	Stone				0.5	0.3-0.5
	Earth					
Wall / barrier	Stone					1

Construction and maintenance

I) Construction activities for structural measures			
Activity	**Energy**	**Equipment**	**Timing**
Contour marking and layout	Manual labor	Line level, poles	Dry period
Digging foundation		Dengora	Early rains
Stone collection		Head and back load	
Stonewall placement		Hand	
Earth support upslope		Dengora	
II) Maintenance activities for structural measures			
Stone collection	Manual labor	Hand	Before planting
Repairing breaks			After rains
Add stonewalls height/upgrading			During rains
III) Establishment activities for management measures			
Clear vegetation	Manual	Axe	Dry period
Construct Daga		Manual/spade	Dry season
Land preparation		Oxen	
II) Maintenance activities for management measures			
Planting useful trees and fruit trees	Manual	Dengora	After rains
Cultivation and weeding		Dengora	During rains

The structural measures considered in this technology are (1) stone embankment (2) ridges and basins in between the stone bunds for storing rainwater. To ensure that each crop planted on the terrace gets sufficient water, inter-bund management measures such as ridges and basins are applied together. Basins bigger in size are made for Chat and relatively smaller ones for sorghum and other crops.

Constraints during establishment: Digging the foundation becomes difficult during the dry season because the soil is very dry. Stone collection is laborious. If the household has few members then they need support from their neighbors and relatives. Maintenance becomes labor demanding especially when the damage in the embankment is bigger. Maintaining the basins every year requires more labor. Possible improvements include: (1) Farmers need to organize themselves in workgroups to overcome labor shortages. (2) Control livestock entering to the field and exercise stall-feeding.

Management measures include fencing of cropped field and protecting it from livestock. Constraints during establishment and maintenance are: low and erratic rains, labor, and shortage of planting material.

Natural Environment

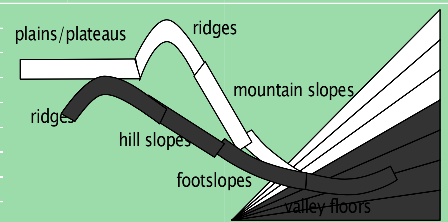
Average annual rainfall (mm)

- >4000
- 3000-4000
- 2000-3000
- 1500-2000
- 1000-1500
- 750-1000
- 500-750
- 250-500
- less than250

Altitude (m a.s.l.)

- >n4000
- 3500-
- 3000-
- 2500-
- 2000-
- 1500-
- 1000-
- 100-500
- less than250

Landform **Slope (%)**



- very steep (60)
- steep (30-60)
- hilly (16-30)
- rolling (8-16)
- moderate (5-8)
- gentle (2-5)
- flat (0-2)

Soil depth (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- less than120

Growing season:
Soil fertility: coarse (sandy), medium (loam)
Soil texture: coarse (sandy), medium (loam)
Surface stoniness: abundant loose stone
Topsoil organic matter: low (less than1%)
Soil drainage: rank, good
Soil erodibility: high, medium, very high
Soil water storage capacity: low, medium, very low

Number of erosive water storms per year is less than 10. They occur in the beginning of the growing season. The rainfall in growing season is usually insufficient and not well distributed. Number of growing seasons per year is 1.

Human environment and land use

Typical household size of the land users is 5 persons. Population density is 50-100 persons/km^2 and annual population growth including migration is 2-3 %. Land size per household is showing a decreasing trend owing to more people demanding land. No trends towards privatization of land. Land is public owned and there is no indication so far for privatization despite the growing demand for land from all corners and groups of society.

Land ownership and land use rights did not affect SLM. Although land is owned by the state, land users have no feeling of insecurity. They consider that the land they are cultivating is theirs. The current land certification has encouraged farmers more to invest on SLM. Similarly, land users did not feel that reallocation of land will take place as it did not happen after the first land redistribution that took place immediately after nationalization.

There is great difference between the rich and poor in the way they practice SLM. The better-off farmers are seen to have established the technology well compared to the poor who have few measures undertaken on their land. Off-farm income is less than 10% of all income for the land users who apply the SLM technology. Land users who have SLM on their land spend more time in agricultural activities compared to those who have not applied SLM measures.

The technical knowledge required for implementation of the technology is moderate for extension workers and also moderate for land users. The use of the SLM Technology is not hindered, when land users cannot read and write, although land users who cannot read and write are 90%. There is no adult education at the moment. In the early 1980s, there was a program known as Illiteracy campaign by which farmers were forced to participate in basic education. Many adults got the opportunity to get basic education at that time.

Crop and livestock production

Land cultivation is performed by: 1) Manual labor; on steeper slopes where terraces are closer, and 2) Animal traction; on gentle slopes

Types of cropping systems and major crops

Water supply	Type of cultivation
Rain fed	Continuous cropping
Post-flooding	

Major crops grown are: sorghum, sweet potato, beans. Intercropping is practiced and crops intercropped are sorghum, potato, sweet potato beans. Cropping system: Sorghum-beans intercropped. Sorghum is cropped in alternating strips of Chat.

Crop production in the technology area is highly dependent on the amount of rainfall received every year. The valley bottomlands depend more on runoff water and flood coming from the nearby uphill in the upper catchment. In years of good rains there is better production and vice versa. If it rains up on the hills, floodwater is diverted to the cultivated lands in the bottom lands. The valley bottoms are therefore highly dependent on the rains coming from the hills up

Flood (spate) irrigation practiced in Diredawa (photo 2005)

Animal production

The current trend in herd types is more small stock. The number of livestock units per household is 4 small stock and 2 large stock. The current trend in livestock numbers shows slight reduction. A substantial area has been closed around the technology area. Livestock owners are given the opportunity to cut grass from enclosures and carry home to stall-feed animals. Most farmers are used to stall-feed their animals.

Individual households plant trees (fruits, shade trees, hedgerows) in the homesteads and on field boundaries. Trees naturally grown are maintained in a scattered manner in crop fields. These are primarily used as shelter for animals that are tethered and also used as fodder.

Costs (US$)

Establishment and recurrent costs

Category	Input	Establishment costs (per ha)			Recurrent costs (per ha)		
		Quantity	US$ Equivalent	% borne by land user	Quantity	US$ Equivalent.	% borne by land users
Agricultural	Compost / manure	300		100			
	Seeds (kg)	20	5				
Equipment	Tools	4	4				
	Animal traction	60	20				
Labor	Person days	334	272	50	50	40.7	100

Most important factors affecting costs are: 1) slope: As the slope increases cost of construction increases since the construction involves high volume of cut and fill.
2) Soil depth: - when the soil depth is shallow digging the foundation becomes difficult. Costs are calculated for construction and maintenance of the structural measures. Daily wage cost of hired labor to implement SLM is 0.705 US $ per person per day.

With increase in slope, cost of construction increased. When the soil depth is shallow digging the foundation becomes more costly. The cost is mainly for construction and maintenance of the structural measures and cultivation. Interview with some households revealed that, production from SLM is at least one fold higher. But experts' observations show that the increase in production could be up to 150-200%.

Benefits, advantages and disadvantages

With or without	Main crop	Production (t/ha/yr)
Without SLM	Sorghum	0.6
With SLM		1.3

The On-site and off-site benefits of the technology

Production and socio-economic benefits		**Socio-cultural benefits**	
Crop yield increase	High	Community institution strengthening	High
Fodder production/quality increase		Improved knowledge SLM/erosion	
Farm income increase			
Ecological benefits		**Off-site benefits**	
Soil cover improvement	Medium	Reduced downstream flooding	High
Increase in soil moisture	High	Reduced downstream siltation	
Increase in soil fertility	Low		
Soil loss reduction	High		
Production and socio-economic disadvantages		**Ecological disadvantages**	
Loss of land	Medium	Water logging	Negligible
Increased labor constraints	High		
Increased input constraints	Little		

Economic analysis

No data is available on the economic returns resulting from conservation measures. However, without SLM, the gross production value in US$ per hectare per year around the SLM Technology area is 150 / ha / yr. With SLM Technology, the gross production value of the land per hectare per year is 350 US$ / ha / yr. Compared to the situation without conservation, percentage gross production value increase in 10 years after implementing SLM is over 125% considering also the area occupied by conservation measures and in assuming current input and prices.

Adoption and adaptation

Since moisture stress is the major constraint to crop production in the area, land users practice the storing of rainwater in the soil by making basins and furrows. The traditional stone embankment, which is established nearly along a contour line, is being improved to follow the contour. Furthermore, improved techniques of storing water in crop field by forming small barriers and diverting the runoff water from other places improved the effectiveness of the measures and land productivity.

The SLM Technology is designed in a way that it allows changes by land users. About 80 % of land users who have applied the SLM Technology have done it with incentives and 20 % of land users that have applied the SLM Technology, have done it wholly voluntarily, without any incentives other than technical guidance. There is a growing trend for spontaneous adoption of the technology. There is enough local skill and support to expand the SLM Technology**.** The SLM Technology is set up in a manner that it will be durable, or can be easily maintained and kept in good shape.

Acceptance and maintenance

External support	**Groups**	**Type of incentives**	**Reason for acceptance**
Paid labor	Poor	Food for work	poor
Paid labor	Women headed households	Food for work	
Paid labor	Old people	Food for work	
Without (financial, material) assistance	Better-off households	------------	Have the labor and willingness

Maintenance

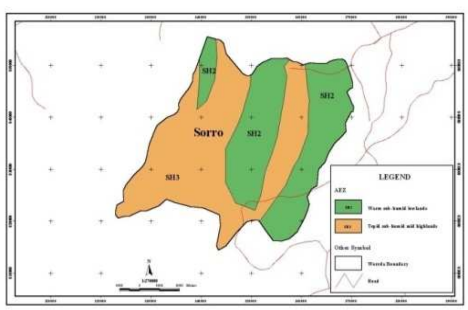
Land users have adequately maintained and managed what has been carried out for over 25 years.

IV. Vegetated structural land management measures

Terrace stabilizatiom by Desho grass (left): Raising Desho in the nursery for planting out in crop fields (right) (photo 2005)

14.1. Desho –Bund and Strips (Sorro, SNNPR)

Common Name of SLM Technology: Desho -Bund
Local or other name: Desho Erken (Amharic)
Associated Approach: Integrated Watershed Management Approach
Contributing SLM specialist: Daniel Dentamo, Sorro Woreda Agriculture and Rural Development Office, Hadiya Zone Sorro Woreda, SNNPR
Area information
Basin: Omo River Basin



Agroecological map of Sorro Woreda *Location of Sorro Woreda*

Definition

Desho bund or Desho strip is a measure integrating Desho grass with bund or growing Desho strip on contour as SLM technology for erosion control and feed improvement.

Description

Desho grass is established by planting tiller cuttings. Desho grass is a high quality and good source of fodder for animals. It establishes easily with little soil moisture. Desho is a perennial herbaceous grass which has massive fibrous root system that anchors the plant to the ground. It provides better cover to the bund and establishes aggressively. It grows upright with a growth potential of 90-120 cm high depending on the fertility of the land and regenerates quickly. It can grow and matures (ready for harvest) at least once in a month and it requires only one season rain to provide proper cover to the bund. The purpose of Desho grass strip is to form a barrier for erosion on cultivated lands, stabilize the bunds and provide nutritious fodder for animals. The soil should be moist during establishment of Desho grass. Desho grass can grow at 1500-2800 masl and it best performs at an altitude of 1700-2500 masl.

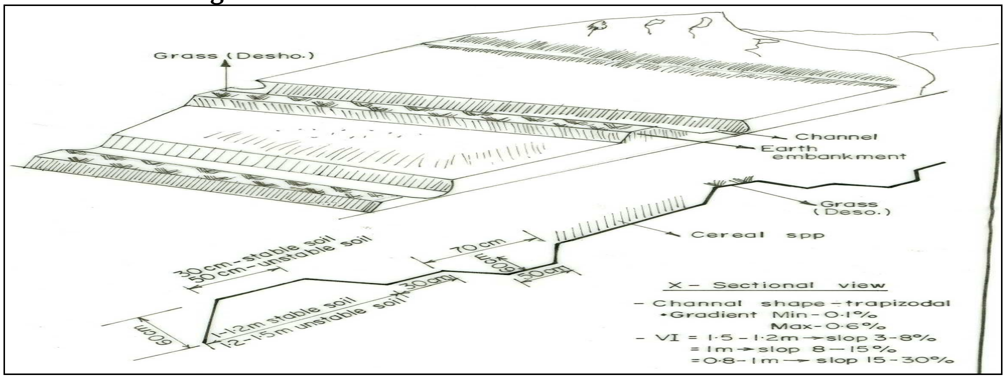
The importance in bund stabilization of Desho (Pennisetum pedecillatum Trin) grass is not well known until recently. The use of Desho is growing fast and it is currently found to be the best grass for soil bund, fanaya juu stabilization and grass strip formation on crop lands and offers multiuses. Desho grass increases the productivity of land taken away by the bund. It is a good source of fodder. It also supports food security efforts by offering possibilities to be a potential substitute of Enset for animal feed. Enset is often used as livestock feed during the dry seasons where grass or hay availability gets diminished. Land users are forced to feed their animals with enset which should have been otherwise processed as Kotcho, the most widely used food, for more than 12 million population in the country. At present Kotcho is widely eaten in the major cities in the country.

Picture of the technology

Desho planted soil bunds in Kembata Tambaro, SNNPR

Desho in the nursery ready for out planting in Chencha (photo 2004)

Technical drawing



Land degradation

Types of land degradation on the land surrounding the SLM area

Land use	**Type of degradation**	**Degree**	**%**	**Landform**
Grazing land	Water erosion	s	90	H
Cropland	Water erosion	s	90	H,P

Source of data: Sorro Woreda Agriculture and Rural Development Office

Purpose and classification

Major land use problems in the area without SLM are: Population pressure, lack of land management skills, and shortage of farm land, decline of soil fertility and low income, low productivity of land and drought recurrence. The technology consists of: vegetative, structural, agronomic and management measures. The technology combats land degradation through: control of concentrated runoff and reduction of slope length .

The technology is best described as program implemented. The SLM Technology is new to the area and is introduced in the last 10 years. The technology was first introduced by another project implemented in the nearby woredas. The project introduced Desho grass to be planted on bunds for stabilization and fodder development in its Integrated Watershed Management Approach implemented in the SLM Technology Woreda. Indigenous SLM Technologies have been used before the current SLM Technology was introduced. Graded ditches are constructed every cropping season on cultivated lands. It is constructed diagonally or along the slope of the field. The aim is to drain surplus water from cultivated lands. Today, the indigenous SLM is used less because it seen to accelerate soil erosion and land users are now practicing the new technology introduced.

Constraints are: backward farm tools, low level of awareness, and lack of training. Possible improvements: provision of improved farm tools, create awareness and provide training, provision of Desho grass free of charge for poor farmers. Integrated Watershed Management and Participatory Planning and Implementation Approach are being pursued to enhance land user's participation.

Specification of vegetative measures

Type and layout of vegetative measures (m)

Vegetative measure	**Between rows / strips / blocks**			**Within rows / strips / blocks (between plants)**		
	Material	Plants/ha	Vertical interval.	Spacing	Vertical interval	Width (m)
Contour	Grass	750	1	0.1	1	
Aligned	Trees /shrubs	250-400				
Aligned	Fruit trees	50-100				

Desho is an indigenous grass species that has originated from the GamoGofa Highlands of Ethiopia. It is a multipurpose grass providing multi-benefits, which include: very effective in erosion control, establishes fast and is a quality fodder crop. Organizations and individuals involved in land management activities are advised to use it in the highlands with relatively fertile soils and low risk of moisture stress.

Constraints during establishment: lack of sufficient soil moisture during planting, establishment may be delayed or it could totally fail. The cost for planting material is beyond the purchasing capacity of the poor and therefore the poor will need to be subsidized. Constraints during maintenance: shortage of planting materials and free grazing animals. The grass is palatable and animals uproot the grass while grazing as it is very sensitive to overgrazing. Cut and carry is recommended and sometimes with limited controlled grazing. Possible improvements include: expanding Desho grass technology as a potential planting material for erosion control and source of animal feed, provision of planting material, avoiding open grazing as a necessary condition for scaling up its expansion and adoption.

Specification of structural measures

Type and alignment of structure (m)

Structures	**Material**	**Vertical interval**	**Spacing**	**Ditches**		**Bunds**		
				Depth	**Width**	**Length**	**Height**	**Width**
Cutoff drain	Earth		100	0.3	0.5	100	0.3	0.5
Bunds	Earth	1	20	0.3	0.5	100	0.6	1.5

After construction of soil bund, it is advisable to plant Desho grass immediately to stabilize the bund and produce animal feed in the first year. Constraints during construction: lack of awareness, shortage of planting materials and labor. A major constraint during maintenance is labor. Possible improvements: raise awareness, skill training, provision of planting materials, experience sharing, monitoring and evaluation

Natural Environment

Average annual rainfall (mm)	Altitude (m a.s.l.)	Landform	Slope (%)

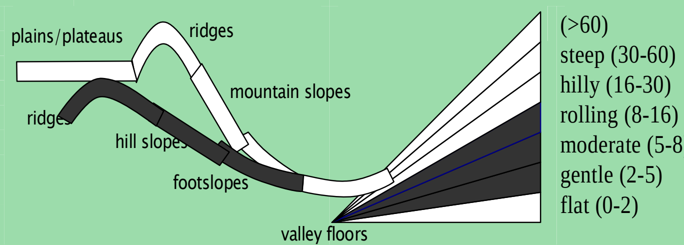
Average annual rainfall (mm)

>4000
3000-4000
2000-3000
1500-2000
1000-1500
750-1000
500-750
250-500
less than250

Altitude (m a.s.l.)

>4000
3500-
3000-
2500-
2000-
1500-
1000-
100-500
less than250

Landform **Slope (%)**



Soil depth (cm)

0-20
20-50
50-80
80-120
less than120

Growing season:

Soil fertility: medium, low
Soil texture: loam soils, clay
Surface stoniness: no loose stone
Topsoil organic matter: low, medium
Soil drainage: good
Soil erodibility: high, very high

Number of erosive storms of rain per year is 15-30. They normally occur in the beginning and middle of growing seasons. Rainfall in the growing seasons is usually sufficient but not well distributed. Drought recurrence period is getting shorter in recent years and that has threatened livelihoods which are dependent on agriculture.
The number of growing seasons per year is 2.

Human environment and land use

Typical household size of the land users is 6 persons. Population density is over 400 persons/km^2 and the annual population growth including migration is 3%. The trend in land size per household shows a decreasing trend because of population pressure and land degradation. Land ownership and land use rights affected SLM activities. Some land users were not interested to invest on their land because they think that the land they cultivate today may not be theirs' in the future in fear of possible land reallocation. All categories (poor, average, rich) and all age groups accept and adopt the SLM practice that is carried out on their land.

Off –farm income is less than 10% of all income for the land users who apply the SLM technology. There is little difference between the categories. Land users who cannot read and write are about 50% and this has constrained to some extent the adoption in the initial stage until they have seen the benefits of the Desho grass planted on bunds.

Crop and livestock production

Land cultivation is performed mainly by animal traction. Oxen are used for plowing and manual labor is used on steep slopes. Intercropping is practiced and crops intercropped include: Coffee with Enset, Enset with cabbage, Irish potato or haricot bean with wheat or barley. The sequence of crops is Irish potato or haricot bean with wheat, barley or teff.

Types of animals raised include: cattle, horse, mule, donkey, sheep, and goat. The current trend in herd types is 3 small stock and 2 large stock. The current trend in livestock shows slight reduction because of lack of fodder and disease outbreaks. After the introduction of Desho grass, the trends of grazing system changed from open grazing to stall feeding and as a result land degradation problem is getting reduced. Grass is used to feed animals by cut and carry. There is high interest among farmers and there is high demand on market prompting land users to cultivate cereal crops and plant Desho grass on a land with the land management technology. However, farmers should be trained on land use and its management more in depth. Integrated watershed principles should be applied to sustain land productivity in the Technology area.

Cost recovery

Estimating cost recovery period of investment in Desho Technology. Crop: Wheat .

Cost (US $)

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	***8***			**9**	**10**
								crop	**grass**	**Total**		
1	307	4	30	22	98	20	482	628		628	144	1:13
2	-	4	30	22	98	20	174	816	20	836	659	1:47
3	-	4	30	22	87	20	163	816	20	836	670	1:5
4	-	4	30	22	87	20	163	816	20	836	670	1:5
5	-	4	30	22	87	20	163	816	20	836	670	1:5
6	-	4	30	22	87	20	163	816	20	836	670	1:5
7	-	4	30	22	87	20	163	816	20	836	670	1:5
Total	307						1478			5644	4162	

Note: 1= Establishment, 2 = Recurrent, 3= Maintenance, 4= Land preparation 5 = Seed and fertilizers 6 = Weeding harvesting, and threshing, 7 = total cost, 8 = production 9 = net profit and cost benefit ratio

Benefits, advantages and disadvantages

Land productivity has increased at rate of 30% per year (Case study report) due to soil bund construction and stabilized with Desho grass.

Onsite benefits of the technology

Production		**Socio- cultural**	
Crop yield increase	Medium	Community institution strengthening	High
Fodder production/quality increase	High	Improved knowledge SLM/erosion	
Wood production increase	Little	off-site benefits	
Farm income increase	High	Reduced downstream flooding	
Ecological benefits			
Soil cover improvement	High	Production and socio-economic disadvantages	
Increase in soil moisture		Loss of land	Medium
Increase in soil fertility		Increased input constraints	Little
Soil loss reduction			

Adoption and adaptation

Desho grass requires a well-established embankment for best performance and quality fodder production. Land users need to know the benefit of the technology before they apply it. At present, most land users are multiplying the grass, which they plant in their backyards and also sell it. Land users who are engaged in this business have improved their incomes. About 66% land users that have applied the SLM Technology have done it with incentives and the number of land user families who applied it is 4145. This is on about 95% of the SLM area. Land users who have implemented the technology wholly voluntarily, without any incentives are 34% and this trend is increasing.

There is increasing trend towards spontaneous adoption of the technology as well. The grass is very fast growing, easily established and naturally palatable, good for stabilizing bunds. It is harvested once a month during rainy seasons and grows vertically in an upright position and therefore it does not hinder farm activities and is not also an invasive grass. There is enough local skill and support to expand the SLM Technology. The grass is expensive and scarcely available for land users who have not been provided with the planting materials. Supporting land users by providing planting material will solve the problem and help to replicate the technology further. The SLM Technology is set up in such a way that it will be durable and can be easily maintained and kept in good shape. Land users have understood the versatile use of Desho grass.

Supportive measures

Gitcha grass is seen in the photo (right) to form an obstruction to runoff. It is not easily grazed by livestock. It is best grass for house thatching

Gitcha grass bund as a supportive technology for Desho (photo 2005)

Groups of farmers working in Nurseries to raise seedlings for integrated Watershed Management interventions (photo 2006)

Terraces established with incentives based integrated watershed management approach in North Wello (photo 2007)

14.2. Integrated Watershed Management Approach

Common name of the Approach: Integrated Watershed Management
Contributed by: Daniel Dentamo
Address: Office of Agriculture Soro Woreda, SNNPR
Technologies associated with the approach: Desho stabilized bund.
Area information
Region: SNNPR (Southern Nations, Nationalities and Peoples Region
Localities: Sorro
Total area is 262 sqkm

Implementation of the technology started at two peasant associations as a pilot project and expanded later to other watersheds. It was financed by an NGO and implemented by Agricultural office of the woreda.

The SLM approach area is defined by watershed and administrative units. Socio-economic units are also important. SLM activities are implemented based on integrated watershed management principles pursuing participatory planning and implementation approach.

The incentive considered here for encouraging participation of land users in implementing the SLM technology is the provision of credit for purchasing sheep. The beneficiaries of this approach are largely poor women. They are given credit on conditions that the borrower pays 10% insurance payment and transfers the first born lamb to other poor women on revolving funds arrangements.

Definition

Integrated watershed management approach describes the implementation of SLM measures that include fodder development and crop husbandry by increasing production and productivity of land in a sustainable manner. The activities are planned on participatory basis and implemented following integrated watershed management principles.

Description

Overall purpose of the approach is to make best use of the land and water resources in the watersheds with the objective of improving agricultural production and attain sustainable natural resources development leading to the improvement of food security at household level and then contribute to the national goals of the Plan for Accelerated and Sustained Development to End Poverty (PASDEP) program of the government.

Specifically the objective is to improve food security of land users in the targeted areas by motivating community members with incentives to implement SLM activities. Promoting and implementing integrated watershed management practice encourages catchment based natural resources management practices and enhances fodder development for improving availability of feed for livestock and in the meantime stabilizes bunds with useful vegetation. Participatory planning and implementation approach is used through local institutions (groups), local leaders and community development committee. Stages of implementation: Project planning and initiation phase -project awareness creation and introduction – implementation, monitoring and evaluation.

The roles of stakeholders: An NGO financed the project implementation and planning by providing credit to land users. The Office of Agriculture and Rural Development implemented the plan, follow up implementation and was responsible for evaluating the achievements. The Community/land users undertake the actual implementation and participate in the evaluation of project activities. The approach has been introduced in 1999 in the area.

Problems addressed: Food insecurity, shortage of animal feed, severe land degradation. The major cause for all problems in the study area is land degradation. There are direct and indirect causes for land degradation.

Indirect causes

Lack of knowledge	**Lack of skill for soil management**
Lack of capital	Unable to use improved technologies
Land subdivision	Small in size and fragmented
Lack of enforcement of legislation	Legislation not in place

Direct causes

Agricultural causes	**Continuous farming without applying SLM**
Deforestation	Clearing forests and bushes for agricultural purposes
Over-exploitation of vegetation	No vegetation cover/complete denudation
Overgrazing	High population/cattle pressure on the resources

Constraints hindering proper implementation of the SLM technology

Main	**Specific**	**How to avoid**
Financial	Delay in allocation and transfer of budget	Direct budget transfer to the implementers
Institutional	High turnover of technical staff	Provide the necessary incentives to technical staff
Technical	No or low level of incentives and training for technical staff	Training, field visits

Objectives and target

To empower the community members for planning and implementing SLM measures by their own with some technical and incentive support. It aims further at improving food security at household's level, promote the implementation of integrated watershed management and increase fodder availability. The specific target is to attain food security through sustainable use of land resources.

Decision making

Decision on the choice of SLM is made mainly by land users supported by SLM specialists. During the community meetings land users choose proper SLM technology. SLM specialists help the land users to organize themselves in groups to implement SLM activities. Community Development Committee (CDC) is established to coordinate and lead the planning and implementation of SLM technologies. The CDC and other members of the community decide what, why, where, when to do SLM activities in the sub-watersheds. Land users make decisions on the methods of implementing SLM technology and SLM specialists' advice and support decision making. Decisions for implementing SLM technology at the household is made mainly by men. Men are dominant decision makers in the society on account of the traditions that have been prevailing in the area.

The resource poor are strongly involved in decision making at the community level. Both the poor and average land users are the majority in the community. The committee and the community make decisions on the number of working days in a week for SLM activities, who should be given chance for credit and penalize land users who breach the rules and regulations of the community.

Framework for the approach

Weak traditional rules for protecting and managing natural resources exist. Traditional rules are not effective in the protection of natural resources as seen over years. Rural communities follow the traditional rules and bylaws for conflict resolution in relation to land uses and other internal conflicts.

The Land Use and Administration legislation of SNNPR enforces land users to follow the rules and regulations. All land users are given right to use the land which is under their holding and are obliged to use it wisely by controlling land degradation and by maintaining productivity of the land. Currently land users are being provided with land certificates which assure user rights. The approach supports policy development in the sector and assists national and regional SLM programs.

An approach known as Cash for Work financed by the European Union was implemented prior to this approach in the Technology area. Its purpose was to provide cash for SLM activities undertaken by land users. A considerably large area was rehabilitated through the approach. Nevertheless, land users have not been encouraged to participate in the planning from the beginning and hence have not taken responsibilities for the protection and maintenance of the assets created by the approach. As a result most of the assets created were not sustained immediately following the phasing out of the project

Participation and target groups

Specific target groups: land users, SLM specialists, extension workers and politicians

The approach focuses mostly on individual land users, groups of land users organized by the project and groups of households in the watersheds. Land users implemented the SLM technology on individual basis and as well as in groups. The individual groups were mainly men.

Land users are categorized as poor, average and better-off in terms of wealth classification. Since the approach is based on providing incentives for the land users participating in the SLM technology, the poor are given priority. The poor and very poor are the major beneficiaries of the approach.

Land users attitudes
The attitude of the majority of land users towards the approach is positive. They have developed self-reliance and have been directly involved in the planning and implementing of the SLM technology. The technology provided multi-benefits such as increasing land and crop productivity, increasing fodder availability and control soil losses. Land users are seen to be keen to short term benefits but still some others aspire for long term benefits as well.

Land users' involvement in the approach

Phases of involvement	Type
Initiation	Passive
Planning	Interactive
Implementation	Payments/incentives

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Methods applied for involving land users at different phases

Phases	Methods of engaging	Action
Initiation	Rapid rural appraisal and experience sharing visit	Need assessment, problem identification, solution seeking, and demonstrations.
Planning	Participatory rural appraisal	Implement participatory planning approach
Implementation	Responsibility for minor steps	SLM structures are constructed by participation
Monitoring and evaluation	Measurements, observations, reports,	Committee of land users observe and measure what has been done. Report the accomplishments monthly and assess the impacts.

The difference in participation between women and men in the project activities is very little. Women involvement has been very interesting because they were the primary beneficiaries of the project credit scheme. Moreover, in the course of project implementation, women involvement has gradually increased and at present it has reached to the level where women participate more in the implementation of the SLM technology.

Financing

Responsible	Item	% contribution
National non-government	An NGO provided credit for women beneficiaries for work tools and training	40
Community / local	Voluntary labor	60
Total		100

Joint community and project contributions for the implementation of the SLM technology

Item	Per cent	Remarks
Labor	100 (community)	For constructing SLM structures and planting Desho grass on bund.
Material	30 community and 70 project	Hand tools provision by the project with 30% down payment.
Others	100 (project)	sheep credit provision with 10% insurance payment and first lamb transfer to others

Indirect subsidies

Land users knowledge was inadequate in the past for carrying out SLM measures without external assistance. However, during the recent years various trainings have been conducted on the methods of rehabilitating degraded lands by closing degraded areas, laying out and constructing physical and biological techniques to conserve soil and water and their maintenance.

Extension

The extension service is the conventional extension method involving household packages. The key elements for this are mass mobilization in the regular extension package, group work and family approach in the household package. Extension of SLM is carried out through the regular extension program of the government. Extension agents are trained in general agriculture and natural resources management in the past but at present DAs are trained in three major areas of crop science, livestock and natural resources management. The extension agents are mainly government staff but some projects operated by NGOs also have extension workers.

Target groups for extension awareness

Target groups	**Activities**
Land users	Practicing skills / techniques they are given
Politicians / decision makers	Coordination and facilitation
SLM specialists	Training and awareness

Monitoring and Evaluation Procedures

Indicators	**Type**	**Frequency**	**Indicators**
Technical	Measurements	Regular	Standards, quality, area coverage, contour
Area treated	Observation		Hectare of land treated, land cover, land use change
Number of land users involved			Number of participating land users in the work

Reporting procedures

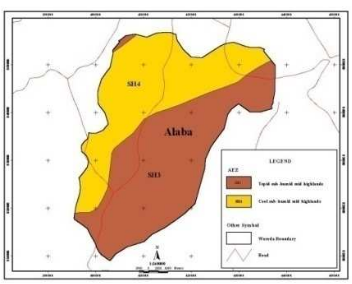
Type	**Addressed to**	**Specific procedures**
Regular reports	Woreda SLM specialists	Land user through their representatives and meetings
	Woreda offices	Collecting data, making field visits and report writing
Regular meetings	Politicians	Wereda activity achievements
	Planners	Field visits
	Donors	Field measurements, visits and report

Live and stone fences for protecting closure areas with integrated measures, Alaba, SNNPR (Photo 2006)

15.1. Biophysical measures integrated with area closures (Alaba, SNNPR)

Common Name of SLM Technology: area enclosure management
Local or other name: Yetegoda Meret endeagegem Madreg (Amharic), Kelu Kalua (Alaba)
Associated Approach: Local Level Participatory Approach
Contributing SLM specialist: Simeon Kismu, Agriculture and Rural Development Office, Alaba special woreda, SNNPR

Area Information
Watershed: Bilate Watershed



Agroecology of Alaba woreda

Location of Alaba Woreda

Definition
Activities that help maintain the productivity of land through the prevention and reduction of erosion and enhancing rehabilitation, by practicing measures such as micro basins, trench, eyebrow terrace, terraces, pitting and plantation of trees in a degraded area that is protected.

Description
The SLM technology comprises a combination of measures, which include agronomic, vegetative, structural and management measures. The implementation of the SLM technology focuses on

combination of measures such as contour cultivation, grass strips, soil and stone bunds on the catchment area of a degraded land. Area closure and improved grazing are applied in integration to rehabilitate degraded lands and restore productivity. The purpose is to improve food security of land users by controlling erosion, harvest rainwater and restoring productivity of land by planting useful trees and fodder plants through structural, vegetative and management measures applied in combination. Unproductive and waste lands are changed to productive land by practicing the technology.

The SLM technology is continuously maintained and improved to meet standards and quality such that soil erosion is minimized and vegetative cover improved. The technology is suitable to degraded and unproductive lands which have been abandoned as a result of low productivity and were previously under cultivation or open grazing. Closure of the area is followed by vegetative and structural measures, which help in speeding up the recovery and regeneration rate.

Farmers plant live fences and also construct ditchra, an earth embankment and a ditch to prevent animals from entering to plantation areas (Picture right). Ditchra is constructed mostly on farm boundaries to prevent livestock and people from entering, a cultivated area or a plantation for grazing or cutting trees. Today, the traditional SLM is continued and maintained. The aim of the traditional practice is not for SLM purpose. Ditchra and cutoff drains are integrated to form the SLM technology (picture shown above). Area closure, trenching and eyebrow terraces are included to make the technology more effective. Live fences are also practiced to prevent animals from entering into closed areas.

Live fencing to protect closure areas from livestock interefernce (photo 2004)

Prior to the implementation of SLM techniques on the upper slopes, the downstream where most farmlands are found was threatened by flood and sand deposit. The implementing of the SLM technology helped in controlling the downstream community from being flooded.

Picture of the technology

Species that have disapeared are regenerating agin after closures (photo 2006)

The technolgy is aplicable in wide range of agroecological conditions and more suitable in semi-arid to to sub humid agroecological conditions

Purpose and classification

The major land use problems in the area without SLM: Improper land use, deforestation, overgrazing, lack of proper preventive measures to erosion, lack of awareness, poor practices of land preparation and lack of effective technology.

Some of the land degradation problems in the area (photo 2003)

Types of land degradation on the land surrounding the SLM area

Land use	Type of degradation	Degree	%	Landforms
Cropland	Water erosion		10	P,M
Mixed land		l	15	P,M,H
Woodland		m	35	P,M,H
Grazing land		m	40	P,M,H
Cropland	Chemical deterioration		10	P,M
Mixed land		m	15	P,M,H
Woodland		m	35	P,M,H

Source of data: Alaba Special Woreda MERET Project.

Structures for water harvesting and sediment trap along roads in Alaba (photo 2004)

Tillage is performed about 3-4 times. Pests and plant diseases are controlled by means of chemicals and through mechanical methods. Other agronomic activities include: weeding, sawing, broadcasting, planting, and row planting. Weeding is performed once or twice depending on the intensity of weeds. Some farmers use herbicides. Planting is done by broadcasting and some farmers' apply row planting. Constraints include: poor cultural practices, insufficient and erratic rains. Improvements suggested are: apply improved agronomic techniques such as improved tillage practices, improved water harvesting measures and additional techniques for soil moisture retention.

Type and layout of vegetative measures (m)

Vegetative measure	**Material**	**Plants/ha**	**Within rows / strips /**		**Between plants**	
			Vertical interval	Spacing	Interval	Width (m)
Aligned: contour	Grass	10,000	1.5	0.5	0.3	0.25
Aligned: against wind	Trees/shrubs	40000	1	1	0.5	0.5
Scattered/dispersed	fruit	111	6	6		
In blocks	Trees/shrubs	40000				

Sisal is planted as a vegetative measure and sometimes indigenous grasses are broadcasted on trenches and eyebrow terraces. Trenches and microbasins are constructed with stones mostly, and in places where there is no stone are established by soil. Stone microbasins are more durable than the soil when the latter is not stabilized in particular. Constraints during maintenance: Stone bunds collapse easily, if are not supported by soil embankment on the upper side or not supported by trees planted on the down slope side. Hence, stone bunds require frequent maintenance.

Specification of structural measures

Type and alignment of structure (m)

Measures	**Material**	**VI**	**Ditches**			**Bunds / bunks**		
			L	W	D	L	W	**H**
Diversion ditch	Earth	1	50	0.8	0.6	80	0.8	0.5
	Stone	1	50	0.8	0.6	80	0.8	0.5
	Concrete	1	50	0.8	0.6	80	0.8	0.5
Waterway	Earth		100-400	3-5	0.5-1			
Terrace backward sloping	Earth	1	50	0.5	0.5	10	0.5	1
Terrace forward sloping	Stone	1	50	0.5	0.5	10	0.5	1
Bund / bank level	Earth	40	0.5	1	0.8	1		
Bund/bank graded	Earth	20	0.5	1	0.8	1		

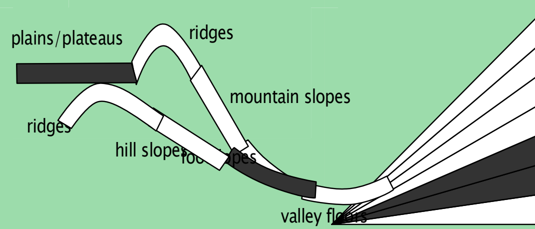
L= length, W= width, D = Depth and H = height

Structural measures include: stone and soil bunds, trenches, stone eyebrow terraces constructed where the soil is shallow and stone is available, checkdams and cutoff drains are part of the technology. Constraints during establishment: Shortage of hand tools, stone and low level of skill. Possible improvements include provision of hand tools, awareness creation and training.

Stone bunds retain moisture and trap soil and the planted trees benefit from this (photo 2005)

Natural Environment

Average annual rainfall (mm)	Altitude (m a.s.l.)	Landform	Slope (%)
>4000	>4000		very steep (>60)
3000-	3500-		steep (30-60)
2000-	3000-		hilly (16-30)
1500-	2500-		rolling (8-16)
1000-	2000-		moderate (5-8)
750-1000	1500-		gentle (2-5)
500-750	1000-		flat (0-2)
250-500	100-		
less than250	less than250		



Soil depth (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- less than120

Growing season:
Soil fertility: medium, Low
Soil texture: coarse (sandy), medium (loam)
Surface stoniness: some loose stone, loose stone
Topsoil organic matter: medium (1-3%)
Soil drainage: Good, well drained
Soil erodibility:: very high

Number of erosive storms per year is 20-30. They mainly occur in the beginning and middle of the growing season. Rainfall in growing seasons is usually insufficient and not well distributed. Number of growing seasons per year is 2.

The technology is suitable to degraded areas, experiencing seasonal intense rains. Trenches, micro basins and eyebrow terraces trap rainfall effectively and reduce runoff. The structures are stabilized by vegetative measures and hence provide strong protection from soil erosion and gullies.

Human environment and land use
Typical household size of the land users is 6 persons. Population density is about 300 persons/km^2. The annual population growth is 3.5%. Land size per household is showing a decreasing trend because of fast growing rural population who need land for cultivation. Land ownership and land use rights did not affect SLM because farmers believe that land is owned by the government but they still know that they have the user rights.

There is a slight difference between the rich and poor in how they practice SLM. The better-off have bigger land sizes, and are prompted to undertake SLM measures on their land. They are able to pay labor needed for the work. Off -farm income is 30-50% of all income for the land users who apply the SLM technology. Land users who practice SLM measures get better production. Their income has increased compared to land users who have not applied SLM. Percent land users who cannot read and write is 90%.

Crop and livestock production

Land cultivation is performed by animal traction. Oxen are used for plowing mostly and manual labor is also used for cultivation. Maize, and haricot bean or cabbage is intercropped. Haricot bean is planted after maize is planted and has attained some height. Cultivation is fundamentally rain fed.

Types of animals are cattle, donkey, goat and sheep. The current trend in herd types has shown no change. The number is 2 small stock and 4 large stock on the average. The current trend in livestock numbers has shown slight reduction because of shortage of grazing lands. Woodlands are mainly communal, so, replanting forests is done by the community. Individual woodlands are very few and small in size since there is shortage of land for trees planting.

Some years back people used to cut natural trees for fire wood and to construct their houses. This has resulted in loss of vegetation and consequently aggravated soil erosion. After the implementation of SLM technology bare lands have recovered. At present, substantial achievements have been made in terms of area rehabilitated. Many communities who have been involved in the implementation of the technology have benefited from the income generated from cutting grass and planting trees.

Costs

Cost recovery period of investment in soil and water conservation technologies**.** Crop: Eucalyptus. Cost on hectare basis (US$).

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	421	21	23	-	18	12	-	2	497	-	-421
2	-	7	8	84	6	4	16	2	129	-	-626
3	-	-	-	21	-	-	16	2	35	116	-510
4	-	-	-	-	-	-	-	2	2	125	-381
5	-	-	-	-	-	-	-	2	2	172	-207
6								2	2	672	463
7								2	2	672	1135

Cost items: 1- Year, 2 - establishment cost, 3- seedlings, 4- maintenance, 5 – seedling transportation, 6- planting, 7 – weeding and cultivation, 8- guarding, 9- fence maintenance, 10 - total cost, 11 – benefit, 12- net profit

Benefit is obtained from selling grass and timber. Important factors affecting the costs are tools and transport facilities, fuel and food grain. Daily wage cost of hired labor to implement SLM is 0.87 US $ per person per day.

On -site benefits of the technology

Production and socio-economic benefits	
Crop yield increase	High
Fodder production/quality increase	Medium
Farm income increase	
Ecological benefits	
Increase in soil moisture	High
Soil cover improvement	
Increase in soil fertility	Medium
Soil loss reduction	High
Hydrologic and socio cultural benefits	
Improved knowledge SLM/erosion	
Reduced downstream flooding	

The technology could be improved to achieve more benefits by exercising controlled grazing, increase planting of high value trees (fruit trees and vegetables) along rivers using water pumps.

Economic analysis

Without SLM the gross production value in US dollars (US$) per hectare per year around the SLM Technology area is less than 100 US$ / ha / yr from grass and 116 US$ / ha / yr. With SLM Technology, the gross production value of the land per hectare per year is over 300 US$ / ha / yr.

Compared to the situation without conservation, percentage gross production value increase 10 years after implementing SLM considering also the space occupied by conservation measures and in assuming current input and prices is over 200% for cereals and over 1000% for trees planted such as eucalyptus, cupressus and grevillea

Adoption and adaptation

Ditchra is a structure similar to stone / soil bund and is built for fencing enclosed areas. This is upgraded to improved SLM structures such as stone bunds, checkdams etc. Some tree species are planted to provide shade and wood for construction. About 90% of land users that have applied the SLM Technology have done it with incentives. These are about 4680 land users and this occurred in about 80 % of the area under the technology. About 10% of land users that have applied the SLM Technology have done it wholly voluntarily without any incentives other than technical guidance. These are about 520 land user families and this is achieved in the 20% of the technology area.

There is a moderately growing trend towards spontaneous adoption of the technology. Nowadays land users have better understanding of the SLM technology. They are protecting their farm lands from erosion and degradation with vegetative measures mostly and some combine them with structural measures. There is enough local skill and support to expand the SLM Technology. Many land users have been trained in SLM technologies layout and construction. They participate in planning, implementing, managing and evaluating the SLM measures. The SLM Technology is set up in a way that it will be durable, or can be easily maintained and kept in good shape. The technology is well adapted by land users and they are able to make substantial benefits by implementing the technology.

Particpatory planning and implemenetation approach exercise in Alaba (Photo 2005)

15.2. Local Level Participatory Planning Approach

Common name of the Approach: Local Level Participatory Planning Approach
Contributed by: Simeon Kismu, Office of Agriculture, Alaba
Technologies associated with the approach: Rehabilitation of degraded lands, Area enclosures
Area information
Region: SNNPR (Southern Nations, Nationalities and Peoples Region
Basin: Bilate and the lakes basin
Localities: Alaba
Total area is 4000 sqkm in Alaba only

Sites operating with the approach are 13. One site represents 1 or 2 kebeles and the approach is functional in 17 Kebele associations in the woreda. The SLM approach area is defined by watershed and administrative units. Socio-economic units are also important.

Definition

The approach involves the use of incentives to motivate the participation of communities in the planning and implementation of SLM activities

Description

The aim of implementing the technology is to subsidize the labor of participating households in land management activities, which aims at encouraging the participation of the land users in preventing and controlling soil erosion by conserving soil and water, improving soil fertility, enhancing production and productivity of land. The purpose is to increase the income of the households and improve livelihoods. The specific objective of the approach is to enable each individual land user to be aware of land degradation problem and the impact of SLM. The activities in the approach include: discussions in general meetings, consultation of SLM specialist with community members, demonstration, and conducting training. The stages for implementation include: site selection, conducting participatory work plan, selection of participants, and construction of structures and planting trees. Communities participate in planning, management and implementation of the technology, which consists of land management and stabilizing bunds by planting suitable plant species. The approach was introduced in 1991 in the area.

Problems: lack of knowledge on the existing land legislation regulation. The causes of the problem are: 1) Indirect; lack of knowledge on the existing land legislation and regulation, land subdivision and lack of knowledge / awareness and 2) Direct; agricultural causes, deforestation, over exploitation of vegetation and overgrazing.

Constraints hindering proper implementation of the SLM technology

Main	**Specific**	**How to avoid**
Cultural / religious	Participation of women was limited in the past due to religious and cultural reasons	Encourage women to get involved more in SLM activities using incentives
Financial	Lack of hand tools and operational costs	Provision of hand tools and allocation of budget
Technical	Lack of knowledge	Training, field visits and participatory involvement at all levels

Objectives and target

To alleviate food insecurity problems and rehabilitate degraded lands by involving the communities in planning and implementation of SLM activities. The specific targets are to: i) improve the productivity of land by undertaking SLM activities, which control erosion and rehabilitate degraded lands and ii) increase community income and availability of wood / timber for fuel wood, construction, and feed and iii) improve grazing lands.

Decision making

Decision on the choice of SLM is made mainly by land users supported by SLM specialists. During the community meetings, land users choose suitable SLM technology. The SLM specialists give explanation on the use of the technology. Decisions on the methods of application of SLM technology is made mainly by land users supported by SLM specialists. Land users make decisions on the methods of implementing SLM technology and SLM specialists' advice and provide technical support.

Decisions for implementing SLM technology at the household is made by men only. The tradition is that men are dominant and make all decisions. Women should accept the decisions men make. The resource poor are strongly involved in decision making at the community level. In this approach priority is given for the poor and they are the immediate beneficiaries.

Framework for the approach

There is a strong traditional rule for protecting and managing natural resources. Land users have bylaws, which provide for dismissing a member from Idir (social organization) if in case a member does not abide by the rules of the community bylaws. Any person letting cattle in the closed areas will be punished. Land users respect more, follow and observe their own byelaws than externally enforced laws and regulations. There is land use and administration policy but not yet enforced.

The Woreda Department of Agriculture provides technical and material support to kebeles and communities engaged in SLM activities. For implementing SLM activities community members are organized in SLM groups and they participate in planning, implementing, monitoring and evaluation. Efforts have been made to empower communities for taking decisions and encourage them to adopt participatory approach.

The basic principles and steps for the methodology have been adopted from experiences of other countries. These have been adapted to local conditions with new elements added. National, regional and woreda specialists were involved in the process. The approach is specifically designed to support national and regional SLM program.

An approach known as Food for Work was implemented prior to this approach. Its purpose was to provide food for all SLM activities undertaken by land users. A considerably large area was rehabilitated by applying the approach. Nevertheless, land users were not involved in the planning and hence have not taken responsibilities for the protection and maintenance of assets created

Participation

Community development plan map for SLM in South Gonder (photo 2004)

Target groups

Specific target groups: land users, SLM specialists, extension workers and decision makers. The approach focuses on communities and groups of land users. The approach encourages land users to work in groups than individually.

Land users attitudes

The attitude of the majority of land users towards the approach is very positive but few land users were seen to be reluctant to participate in the approach and provide voluntary labor contribution, which the approach requires. Nevertheless, still large percentage of land users liked the approach. Women headed households and households who experience labor shortage benefit most from this approach.

Land users involvement in the approach

Methods applied for involving land users at different phases

Phases	**Methods of engaging**	**Action**
Initiation	Public meetings interviews/questionnaires workshop/ seminars	At this stage public meeting is important to change land users attitudes
Planning	Participatory rural appraisal	During the planning stage the communities appreciate the approach and select their planning team members to make SLM activities plans
Implementation	Undertake activities planned	Priority is given to highly degraded areas for treatment.
Monitoring and evaluation	Measurements/observation, reporting and interviews/questionnaires	The SLM activities are based on person days required which can be measured and verified by field observation.

There is no big difference in the way women and men participate in all phases. In the inception of the project, women involvement was very low owing to cultural and religious limitations. Nevertheless, in the course of project implementation women involvement has gradually increased and at present it has reached to a level that women participate more in the implementation of SLM activities.

Women particicpation in SLM activities in Alaba (photo 2005)

Explantaion on the plan of activities and on the methods of implementing the technology is made for the community. The development plan is prepared by the committee assigned by the community. The pricture on the right shows one of the sessions on community plan expalnation. The man explaining the plan of the community development is a member of the community. Community members discuss on the plan and is approved by the general assembly of the community. Then the action plan is prepared which explains resoureces needed to implement the plan

Financing

Responsible	Item	% contribution
Development partners	Food incentives	80
Land users	Voluntary labor	20

Indirect subsidies

Land users awareness was inadequate in the initiation for carrying out SLM measures without external assistance. However, in recent years trainings have been conducted on the technologies of rehabilitating degraded lands by closing degraded areas, laying out and constructing physical and biological measures to conserve soil and water. The form of training included: on-the-job training, public meetings and demonstration areas.

Training conducted to the varying target groups

Target groups	Training	Number of courses	Men	Women
SLM specialists	SLM technologies design and implementation	2		
Land users	Lay out and construction of structural measures	2	70%	30%
Extensionists	Techniques of implementing and planning the technologies	Several		
SLM specialists	Planning and implementation techniques	Several		

Extension

The extension services provided are the conventional extension package and the household package. The key processes in these include: mass mobilization for regular extension package, grouping land users in work groups for participatory planning approach in the household package.

Extension of SLM is carried out through the regular extension program of the government. Extension agents are trained in crop production, livestock production and natural resources management. The extension agents are mainly government staff but projects operated by NGOs also have extension workers.

Target groups for extension awareness

Target groups	Activities
Land users	Practicing the skills and techniques they are given as model farmers
Politicians and decision makers	Coordination and facilitation
SLM specialists	Training and awareness

Research

No research in SLM has been conducted in the woreda but there is one research site about 80 kms away from the technology area. The research center in Gununo is envisaged to provide support for land management activities in the woreda but the linkage with the research center is weak.

Target groups in the extension and awareness promotion are: 1) land users, who are given skills training on land management activities 2) SLM technicians and SLM specialists who are given continuous skills training so that they are able to train other land users and planners. The extension service has provided quite substantial awareness promotion to the land users on the problem of soil erosion and it is believed that land users will get engaged in SLM even when external support is withdrawn. As a result, large area of degraded lands have been rehabilitated and made productive.

Direct subsidies

There are direct subsidies for the SLM approach. Food incentives are provided to land users through Food for Work (80%). However, land users are expected to offer voluntary labor and material support valued at 20% of the total cost. The costs needed for the approach is covered in this way. Hand tools and planting materials (seeds and seedlings), motor cycles / transport facilities/, and insecticides are provided by the government and donors. The approach has greatly encouraged the establishment and functions of local institutions.

Monitoring and Evaluation

Monitoring Procedures

Aspect	Type	Frequency	Indicators
Technical	Measurements	Every month	Standards, quality, area coverage, contour
Area treated	Observation	Every month	Hectare of land treated, land cover, land use change
Number of land users involved	Records	Regular	Number of participating land users in the work

Reporting procedures

Type	Addressed to	Specific procedures
Regular reports	Land users	Their representatives and meetings
	SLM specialists	Collecting data, making field visits and report writing
Regular meetings	Politicians	Wereda meetings to discuss on activities achieved
	Planners	Field visits
Regular reports	Donors	Field visits and report

Impact

The approach has helped land users greatly to improve land management. Some of the positive impacts include: protection of soil erosion by improved methods, water is conserved in the soil by the use of micro-basins, flood hazard decreased by combined measures and soil fertility increased using compost.

Water stored in micobasins helps in getting high survival and establishment of trees and shrubs planted (Photo 2004) at the right.

Changes are observed in gully management and developing better soil structure for land productivity improvement. The approach has led to changes in the management of crop lands.

Farmers are more aware of the benefits in planting fodder trees on their farms. Their willingness increased to construct micro-basins and bunds because they realized that these protect soil erosion and improve survival rates of trees. Open grazing is minimized, cut and carry system is encouraged and the number of livestock owned by land users has decreased and it is getting to manageable size. Trees that adapt degraded land conditions are planted and have enhanced rehabilitation of degraded lands.

One of the previously degraded but rehabilitated now using the approach (Photo 2006)

Community forests and woodlots have been established, bare lands have recovered by planting trees and the problem of fuel wood, farm implements and construction materials solved. Planting of improved fodder species has increased fodder availability and quality.

The approach has helped land users to improve grazing lands productivity. Forest and woodlands are also addressed by this approach and a large area of plantation undertaken. Communities have benefited by selling wood for construction and made savings in bank from the proceeds; grasses cut from enclosure areas through cut and carry increased feed availability for livestock at home.

Grass availability has increased after area enclosure management (Photo 2006)

Grass from the enclosures is used for thatching house and the communities get money by selling grass for house thatching. Live fencing, vegetables growing and fruits development, fodder tree planting, have been adopted and are further replicated.

Implementation progress

The implementation progress is growing at an increasing rate. Moreover, the approach has helped in strengthening and encouraging the formation of local institutions such as associations and various social groups. At the beginning the plan was only for physical structures and closure areas, but today homestead development planning is widely being practiced. This is a positive scaling up indicator.

Land ownership and use rights

The existing land ownership did not affect much the approach because most of the activities are carried out on communal lands by the communities. In Alaba, unlike other areas in the country community members prefer communal management to privately managed area enclosures and plantations. The Land Use and Land Administration Policy and legislation helped to solve the problem of property misuse to a certain degree. The land certification regulation is expected to motivate land users sense of increased security for user rights that did not exist before. The approach has little to influence the land tenure policy of the government.

Dependency on livestock rearing has changed to focus more on crop intensification as a result of land getting more productive because of conservation. Moreover, dependency on food incentives is reducing as a result of farmers' getting more income from on-farm activities.

Benefits

Elementary schools, health posts and peasant association offices have been built by the income generated from closure areas. Moreover, communities are getting more income by selling grass and wood/timber of eucalyptus (fast growing species). Land users have greatly adopted the methods and procedures of the Local Level Participatory Planning Approach (LLPPA) in all development plans of villages, communities and Kebeles. Similarly, many NGOs and government organizations have adopted the approach. A series of trainings were conducted on LLPPA methods. Moreover, training on SLM measures (theoretical and practical) and training on evaluating and monitoring of project activities and impacts have been conducted.

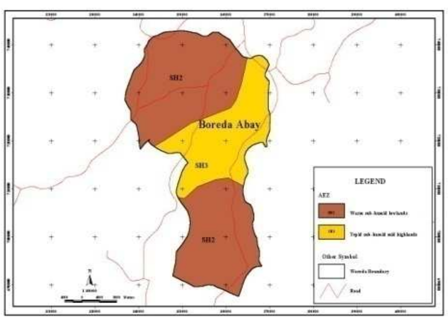
Conclusion

Land users have continued implementing the approach without external support because they have perceived the benefits coming from development in SLM. Land users understand that income generated from closed areas is of the community, not of the government. This has encouraged the community to get involved more in conservation activities. The approach has promoted the sense of user rights of land users on assets created such as the community forests, grass, terraced fields etc. They are aware that they are the ones to decide on the use of the assets. Some land users anticipate incentives for constructing conservation measures, even though they are aware that erosion has a damaging effect on land this does not justify any sort of external remuneration.


Contour soil bunds on cultivated lands (left) and soil bunds planted with Desho grass; right (photo 2004)

16. Stabilized soil bunds (Boreda, SNNPR)

Common Name of SLM Technology: Soil bund
Associated approach: Food for Work
Contributing SLM specialist: Melaku Mesfin, Gamo Gofa Zone Rural Development, Arbaminch, SNNPR
Area information
Basin: Rift Valley Lakes Basin and Omo River Basin



Agroecolical map of Boreda Abaya Woreda *Location of Boreda Abaya Woreda*

Definition

A structural measure laid out on a contour line and formed by digging a shallow channel on the upper side and placing the excavated soil on the down slope side.

Description

An embankment constructed across the slope and along the contour by excavating the soil. The embankment is stabilized by grass which is planted during the rainy seasons. Construction is carried out in by group or by individual households, without external incentives. The purpose is to reduce soil erosion, and drain excess runoff during heavy storms which cause over flow on the land. Grass or fodder plants are planted on the embankment to provide fodder for animals and in the meantime stabilize the bund. Soil deposited behind the bund improves soil fertility. Bunds are continuously repaired during and after heavy storms especially in the first two years after construction. Cut and carry and controlled grazing are practiced to protect the structures from damage by animals.

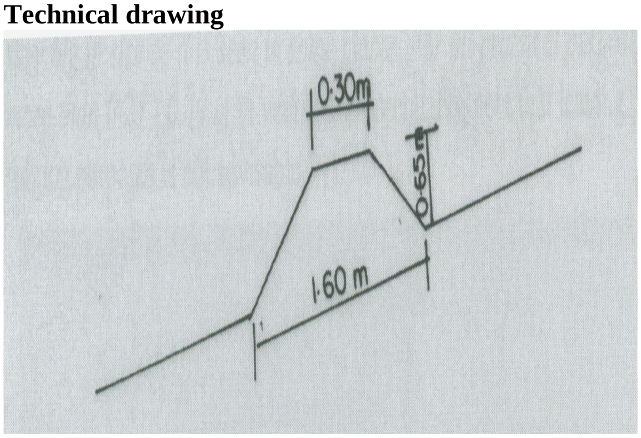
The technology is suitable to a cereal cropped field, protects from erosion and improves productivity. Traditional way of managing the land involving cutting all vegetation from and around farm plots is seen to have aggravated soil erosion. Some of the practices that cause problem include up and down slope farming and traditional furrows placed on steep slopes.

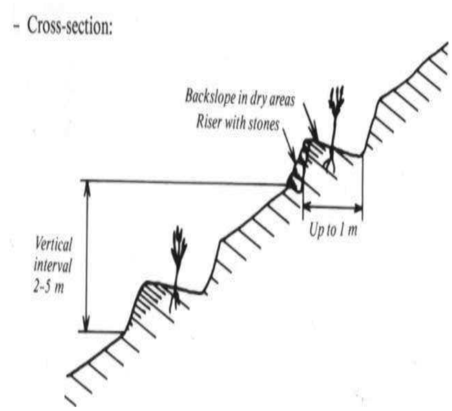
Picture of the technology

Soil bunds constructed 7 years ago (Wolaita Soddo) forming bench terrace (Photo 2006)

Soil bunds constructed 15 years ago (Chencha) forming bench terrace (Photo 2007)

Technical drawing





Land degradation

Types of land degradation on the land surrounding the SLM area

Land use	**Type of degradation**	**%**	**Landform(s)**
Forest land	Water erosion	45	FH
Grazing land		90	PHR
Crop land		85	HR
Crop land	Chemical deterioration	100	HRP

Source of data: Survey

The technology is best described as a project implemented. The SLM Technology is mainly new but is based on previously introduced technologies.

Traditional SLM practices have been used before the current SLM Technology was introduced. Land users in the area practice farmland ditches/furrows placed on cultivated fields at a graded gradient immediately after the crop (mostly cereals) is planted. The aim of the traditional technology is mainly to dispose excess water from cropland and control erosion. Today, the traditional practice SLM is used less because in most cases the ditches are placed at steep gradients and aggravate soil erosion

A farmer maintaining soil bund on his plot also places a furrow for discharging runoff (Gamo highland) (photo 2006)

Implementation

Type and alignment of vegetative measures (m)

Strips / blocks	**Spacing between rows**	**Within rows / strips / blocks**
Grass	0.3-0.5	0.3
Fodder trees	6-15	2-4

Material for vegetative measures

Vegetative measure	**Material**	**plants/ha**	**Vertical interval.**	**Spacing**	**interval**
Fodder trees planted on bund	Leuceana	500-1000	1-1.5	5-15	0.30
Grass	Desho	300-5000 splits	1-1.5	5-15	3-5

Establishment activities for vegetative measures

Activity	**Energy**	**Equipment**	**Timing**
Raising seedlings	Manual labor	Hoe, shovel	Dry season
Transplanting		Hoe	Rain season
Weeding		Hoe	End of rain season

Maintenance activities for vegetative measures

Activity	Energy	Equipment	
Replanting	Manual labor	Hoe	

Establishment activities for agronomic measures

Activity	**Energy**	**Equipment**	**Timing**
Land preparation	Oxen / manual	Plough / hoe local digging tools	Wet seasons
Green manure application	Manual labor	Sickle	Rain season
Manure application		Back load	During planting
Weeding		Hand	Late rainy seasons

Grass planting is carried out by using grass splits and the planted grass is used for animal feed and house thatching. Constraint during establishment is shortage of grass and the constraint during maintenance is free grazing and poor cultural practices management. Improvements for this include controlled grazing and planting more fodder trees mixed with the grass species.

Applying manure on land prepared for planting crop (photo 2004)

Green manure management by Lupin (photo 2004)

Specification of structural measures

Type and layout of structure (m)

Layout	**Material**	**Vertical interval**	**Embankment**				**Ditches**		
			Spacing	D	W	L	H	W	**L**
Level bund	Earth	0.8	15	0.5	0.6	62	0.6	0.5	62
Graded bund	Earth	1	13	0.6	0.7	58	0.65	0.5	60

Note: D= depth, W = width, L = length, H= height

Construction activities for structural measures

Activity	**Energy**	**Equipment**	**Timing**
Surveying	Manual labor	Line level	Dry season
Digging of channel		Hoe	
Build embankment		Shovel	
Bund stabilizing		Hoe	Rain season

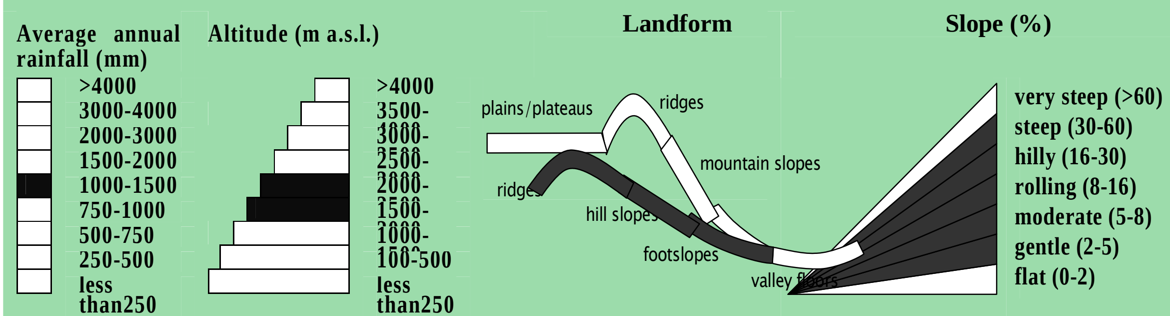
Maintenance activities for structural measures

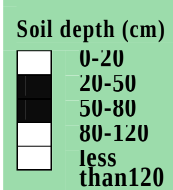
Activity	**Energy**	**Equipment**	**Timing**
Removal of silt	Manual labor	Shovel	Dry season
Planting on bund		Hoe	Rainy season

Bunds converted the land to nearly bench terrace in 5-6 years. Without these structures no crop production is possible on steep slopes in the area. Constraints during construction or establishment are labor shortage and pests while constraints during maintenance include shortage of labor.

Improvement measures include stabilize the embankment using different planting materials, reach into consensus with land users on the spacing / vertical interval / and improve productivity of land by improving soil fertility.

Natural Environment





Growing season:
Soil fertility: low - medium
Soil texture: no loose stone, some loose stone
Surface stoniness: no loose stone, some loose stone
Topsoil organic matter: low (less than1%), medium (1-3%)
Soil drainage: medium, good
Soil erodibility: high

Number of erosive water storms per year is 20 -30 and they occur mainly in the beginning and middle of growing seasons. Rainfall in the growing seasons is usually sufficient but not well distributed. The number of growing seasons per year is 2.

Human environment and land use

Typical household size of the land users is 7 persons. The Population density is over 300 persons/km^2. Annual population growth is 3%. Land ownership and land use rights did not affect SLM. Similarly, subdivisions of land did not affect the implementation of the SLM Technology. There is no marked difference between the better off and poor in the way they practice SLM. Off-farm income for the land users who apply the SLM technology is less than 30% of all income. Level of technical knowledge required for the implementation of the technology is high for field staff / extension workers and moderate for land users.

Crop and livestock production

Types of cropping system and major crops

Crop	Cash crop	Food crop
Enset		x
Barley		x
Maize		x
Teff	x	x
Pulses (beans and peas)	x	x
Sorghum		x
Taro		x
Sweet potato		x
Irish Potato	x	x
Local potato		**x**

All crops are grown rain fed and intercropping is very common. Crops intercropped are beans with sorghum or maize.

Costs per ha (US$)

Input (Material)	Unit	Quantity	Establishment costs (per ha)		Recurrent costs	
			cost	% by land users	Cost	% by land users
Earth embankment (Pd)	PD	250	176		60	50
Planting on bunds (Pd)	PD	28	20	100		75
Equipment Tools (number)	Number	5	15	100		100
Total			211		60	

Benefits, advantages and disadvantages

Estimates of production

With or without SLM	Main plant type	Production in t/ha/yr
Without SLM	Wheat	0.8
	Barley	0.9
With SLM	Wheat	1.4
	Barley	1.2

Source: Woreda Department of Agriculture and Rural Development

On site benefits

Production and socio-economic benefits	Degree and explanation
Crop yield increase	Medium
Fodder production/quality increase	Little
Socio-cultural benefits	
Improved knowledge SLM/erosion	Medium
Ecological benefits	
Increase in soil fertility	Medium
Soil loss reduction	High

The technology could be improved to achieve more benefits by: Reinforcing the embankments with stones at the lower side, planting fodder trees and other local grass species and placing proper spillway to structures conveying runoff

Economic analysis
Without SLM the gross production value in US$ per hectare per year around the SLM Technology area is 160 / ha / yr. With SLM Technology the gross production value of the land per hectare per year is 240 US$/ ha / yr. Compared to the situation without conservation percentage gross production value increase in 3 years after implementing SLM is 50% and 10 years after implementing SLM considering also the area occupied by conservation measures and assuming current input and prices is 80%.

Adoption and adaptation
Changes have been made to the technology in terms of design, layout and construction to suit to the needs of land users and to enable easy filed operations using oxen plow. Land users who have implemented the technology with incentives are 62 % of land users that have applied the SLM Technology and are 1367 households. The technology is implemented in 70% of the SLM technology area.

Land users who practice the technology by their own with some technical backstopping (photo 2005)

The positive results obtained from the managed land encouraged land users to apply the technology by themselves without any external support. There is enough local skill and support to expand the SLM Technology

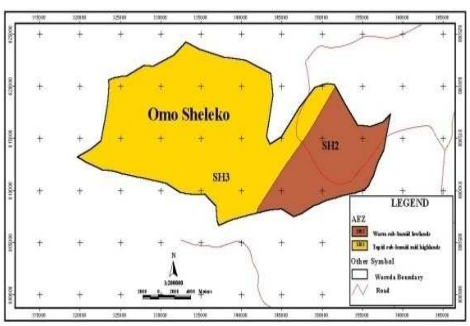
Supportive measures: 1) grass strip: it is planted on the embankment to stabilize the bund and to be used as a source of feed 2) manure application: animal droppings and household garbage is collected throughout the year and applied on cultivated lands 3) mulching: crop stalks left on the farmland are used as mulching materials and 4) vegetable growing

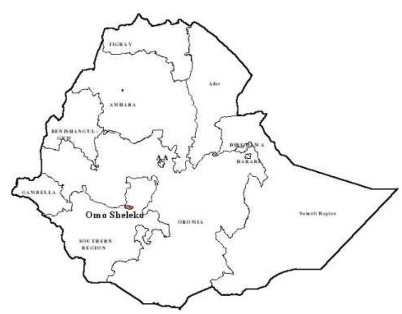
Vegetable growing (left) and nursery management (right) for income generation

Farmland terraces vegetated by various vegetative measures in Omo Sheleko Woreda (Photo 2005)

17. Vegetated Fanya juu (Omo-Sheleko, SNNPR)

Common Name of SLM Technology: Vegetated Fanya juu
Local or other name: Kaba (Tambarssa)
Associated Approach: Incentive Based Participatory Approach
Contributing SLM specialist: Mesfin Mentase Ouwito, Office of Agriculture and Rural Development, Omo Sheleko, SNNPR
Date: 10/9/2005 Updated: 2007
Area information
Basin: Omo-Gibe River Basin
Total SLM Technology area: 1510.8 sqkm





Agroecological map of Omo Sheleko Woreda ***Location of Omo sheleko Woreda***

Definition

Soil embankment constructed along the contour with the embankment above the trench dug to trap runoff.

Description

Fanya juu is stabilized with biological measures such as grasses, fodder trees and shrubs, fruit trees and cereals of high economic value. Grass, legumes and tree species are planted on the sides and top of the embankments of fanya juu bund. The structures are supplemented by cutoff drains. Fanyau juu is implemented in integration with cutoff drains and agronomic measures such as inter cropping, crop rotation and green manure. The technology provides multiple benefits of controlling runoff velocity and soil erosion, change the slope steepness, recharge ground water, retain soil moisture and increase land productivity. Maintenance is done on self-help bases. When the trench is filled up with sediment or it is damaged by over flowing runoff, maintenance is undertaken to repair it.

Picture of the technology

Fanya juu terrace in Omo Sheleko(photo 2005)

A cutoff drain placed on the top of the field terraced by Fanya juu to drain surplus rain water to waterways (photo 2005)

Land degradation

Types of land degradation on the land surrounding the SLM area				
Land use	**Type of degradation**	**%**	**Degree**	**Land form**
Grazing land	Water erosion	30	m	HP
Forestland		5		HP

I) Cropland including mixed land	**Degree and explanation**
Sheet/rill erosion	Great: steep slopes are cultivated
Gully erosion	Moderate mainly on footpath and animal tracks
Yield decline/increased inputs needed	Great because of shortage of manure
II) Grazing land including mixed land	
Sheet/rill erosion	Great: because overgrazed fields
Gully erosion	Great caused mainly on cattle track
Reduced ground cover	Great owing to overgrazing
III) Forest/woodland	
Quantity decline (density, area)	Great: indigenous trees disappearing fast
Quality decline	Great: useful trees disappearing
Reduced ground cover	Great: low undergrowth
Reduced number of species	Great: wood collection

Land degradation on the land surrounding the SLM area

Land use	Type of degradation	Degree	%	Land form
Grazing land	Water erosion	M	20	H, R
Cropland annual		V	70	R, H, V
Cropland perennial		M	10	R,H,V

Purpose and classification

Major land use problems in the area without SLM are low soil fertility, land degradation, and decline in productivity, high amounts of inputs required to improve soil fertility. Types of land degradation mainly addressed by the technology are: water erosion (loss of topsoil by water), gully erosion and chemical deterioration (fertility decline and reduced organic matter content).

The technology combats land degradation through: control of runoff, increase of infiltration and water harvesting. The technology consists of structural, vegetative, agronomic and management measures. The technology is best described as project implemented. The SLM Technology is mainly new, based on previously introduced technologies in the country. The technology is introduced from other countries. Indigenous SLM Technologies have been used before the current SLM Technology was introduced. Boundary plantations and hedgerows are practiced on field boundaries marking boundary of two land users or planted on intervals between plots of a land user to mark boundaries of strips under different land uses. The aim of the technology is to prevent livestock from entering to cropped fields and also control soil erosion by blocking runoff movement. Today the traditional SLM is also used.

Land users have the tradition of planting live fences, hedgerows and boundary plantations basically for two main reasons as explained earlier (boundary between two plots, prevent livestock interference). The appearance of the traditional and applied technology has greatly changed over time. Bunds are transformed to terraces and cultivation is performed along the contour as it can be seen in the picture right. The traditional practice of hedgerow planting is being improved by including new techniques which increase productivity. The current SLM technology is designed by national specialists. The woreda specialists are trained by national experts in the technology and the woreda specialists in turn train the land users on the techniques of laying out and construction of the technology. Development agents are trained by the woreda specialists to provide close follow up and technical support to land users.

Land cultivation

Animal traction	**Most of the land users (80%)**
Manual labor	Few land users (20%)

Due to poor agronomic practices such as monoculture, crop production is declining. Individual implementation approach of the technology is the most appropriate for the land users to maintain and well manage the assets created.

Tillage is performed up to 4- 5 for teff and wheat, while for perennial crops weeding and cultivation done at least twice annually. Homsteads with perennial crops such as enset are less exposed to erosion because of the closed canopy of enset and the mulch underneath. Enset and Coffee are are fertilized by manure and household garbage. Enset requires a closer cultural management and a very fertile ground. Land users with about 1/5th ha of area with good enset plants are a well off in the community and does not encounter food shortage all year round. Crops such as teff, sorghum, wheat and maize are fertilized using chemical fertilizers

Constraints: Lack of agricultural inputs, erratic rainfall, pests and diseases. Possible improvements include: promote awareness to the public at large on the effect of land degradation on production and train land users on improved technologies to rehabilitate degraded lands.

Specification of vegetative measures
Type and alignment of vegetative measures (m)

Measures	**Between rows**			**Between plants**		
	plants/ha	Vertical interval	Spacing	Spacing	Interval	Width
Trees/ shrubs	1000	1	7	10	5-10	5-8
Fruit trees	250-400	>3	33	5-8		5-8
Grass strips	-	1	5-10			

Vegetative measures are used for soil fertility improvement and to provide firewood, fodder, fruit and additional income sources.

Nurseries where tree seedlings are raised in OmoSheleko (photo 2005)

Vetiver and elephant grass production in OmoSheleko (photo 2005)

Constraints during establishment include: Lack of planting materials, free grazing, and lack of proper management and constraints during maintenance include free grazing, shortage of labor

Structural measures stabilized with vegetative measures require very little maintenance. Land users who have better perception of the benefits carry out regular maintenance by themselves. Possible improvements include: more awareness activities avoid or minimize free grazing by encouraging cut and curry system, provision of different planting materials and introduce multipurpose tree species in order to increase productivity of the land.

Specification of structural measures
Type, layout of structure and dimensions (m)

Structure			**Bund / embankment**				**Channel**	
	Material	Vertical interval	Spacing	Height	Width	Length	**Width**	**Depth**
Diversion ditch	Earth		100	0.75	1.5	300	0.75	0.50
Level fanya juu	Earth	1-1.5	10-15	0.5	0.5	100	0.6	0.50

Most of the structures constructed are level terraces combined with cutoff drains, vegetative and agronomic measures, which increase the stability of the structures and also improve the productivity of land. Constraints during construction: Lack of farm tools, lack of trained land users, low level of awareness and human diseases. Constraints during maintenance include: Lack of planting materials, free grazing. Possible improvements include: intensification of grazing areas with improved techniques. Use live fences that could be used for fodder.

Constraints during establishment: lack of follow up, lack of planting materials, free grazing and for maintenance the major constraint is labor. Possible improvements include provision of improved livestock breeds; encourage cut, carry, and control grazing.

Natural Environment

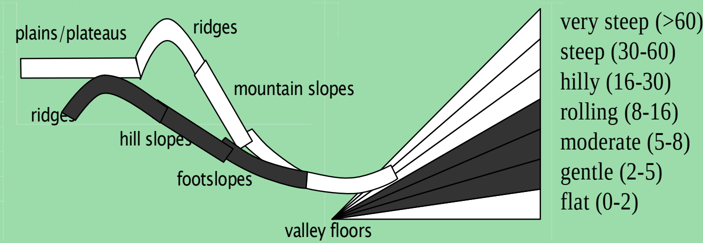
Average annual rainfall (mm)

>4000
3000-4000
2000-3000
1500-2000
1000-1500
750-1000
500-750
250-500
less than250

Altitude (m a.s.l.)

>4000
3500-
3000-
2500-
2000-
1500-
1000-
100-500
less than250

Landform **Slope (%)**



Soil depth (cm)

0-20
20-50
50-80
80-120
less than120

Growing season:

Soil fertility: medium, low
Soil texture: loam soils

Surface stoniness: no loose stone

Topsoil organic matter: low, medium

Soil drainage: good

Soil erodibility: high, very high
Soil water storage capacity: medium

Number of erosive water storm is more than 10 per year. Heavy storms mainly occur in the beginning and middle of rainy seasons.

Fanya juu is constructed during the dry season after crop harvest and plantation is undertaken during the rainy season. There are short and long rainy seasons. The short rains are extremely erratic and fail in most years. When the short rains fail shortage of food is a common phenomenon and when short rains and the long rains are properly received it is relatively a good year in terms of food availability. Erosion is a serious problem in the area and the technology is rapidly being adapted by farmers themselves.

Human environment and land use

Typical household size of the land users is 6 persons. Population density is 500 persons/km^2 and the annual population growth is 2-3 %. The trend in land size per household is showing a decreasing trend mainly due to high population growth. Land owned by a farmer is distributed among family members when the young members get married and establish their own families. Land ownership and land use rights affected to a lesser extent the SLM activities. Subdivision of land has not affected the implementation of the SLM Technology.

There is no big difference between the better-off and poor in practicing the SLM Technology but the better-off farmers implement the technology on their land by engaging labor assistance from neighbors and these farmers are more aware of the advantage of the technology. Off-farm income is less than 10% of all income for the land users who apply the SLM technology. Most of the people in the area are engaged in agricultural activities and only few people are engaged in off-farm activities.

Level of technical knowledge required for the implementation of the technology is moderate for extension workers and high for land users. The use of the SLM Technology is hindered moderately if land users cannot read and write. About 75% of land users cannot read and write in the woreda.

Due to poor agronomic practices such as monoculture, crop production has been declining in the past but since the introduction of SLM measures productivity of land has been improved. Individual maintaining approach of the technology is the most appropriate for the land users to maintain and well manage the assets created.

Costs

Cost of construction increases with increase in slope. Cost estimate is made for linear measurements of bund on a hectare of land. Crop considered is maize. Daily wage cost of hired labor to implement SLM is 0.7 US $ per person per day

Benefits, advantages and disadvantages

Estimates of production

Treatment	**Main crop**	**Production (t/ha)**
Without SLM	Maize	0.8
With SLM		1.6

Erosion on cultivated lands without SLM measure is subject to surface wash (picture right). Some land users prefer oxen furrows placed diagonally but these do not control top soil wash away as can be seen from the field. Prior to the SLM technology was implemented substantial land area was exposed to water erosion. In steep slopes, the top fertile soil is eroded easily and as a result productivity declined. After the implementation of the technology, runoff is controlled, infiltration is enhanced and land productivity improved.

On-site and off-site benefits

Production and socio-economic benefits		**Socio-cultural benefits**	
Crop yield increase	Medium	Community institution strengthening	High
Fodder production increase	High	Improved knowledge SLM/erosion	
Farm income increase	Medium		
Ecological benefits		off-site benefits	
Soil cover improvement	Medium	Reduced downstream flooding	High
Increase in soil moisture	High	Increased stream flow in dry season	
Increase in soil fertility			
Soil loss reduction			

The technology could be improved to achieve more benefits by: improving the quality and technical standards of measures implemented, combining structural measures with biological measures, follow up the activities, monitor and evaluate activities and in the meantime include supportive SLM structures.

Economic analysis
Without SLM the gross production value in US dollars (US$) per hectare per year around the SLM Technology area is 200 /ha/yr. With SLM Technology, the gross production value of the land per hectare per year is 500 US$/ha/yr. Compared to the situation without conservation, percentage gross production value increase in 10 years after implementing SLM is over 100% considering also area occupied by conservation measures.

Adoption and adaptation
Land users who have implemented the technology with incentives account to 85% of land users that have applied the SLM Technology.

Useful tree species are raised in the woreda agricultural office run nurseries. Some of these seedlings are planted in communal lands demarcated for rehabilitataion. Grasses and fuit trees seedlings are given to individual land users who have prepred pits in the homesteads. Young land users who came to take seedlings to plant them on their plots receive seedlings free from the nursery site, OmoSheleko (photo 2005)

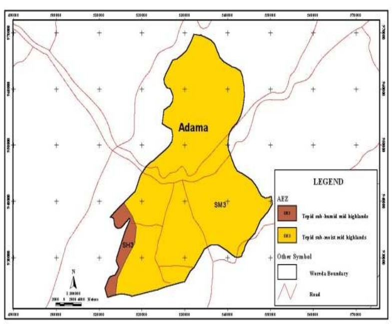
About 15% of the land users who have applied the SLM Technology have done it wholly voluntarily, without any incentives other than technical guidance. There is a moderate trend towards growing spontaneous adoption of the technology. There is enough local skill and support to expand the SLM Technology. Land users are able to layout contours, construct measures and maintain them.

Stabilized Soil bund and fana juu on cultivated lands in Adama (photo 2005)

18. Soil bund and Fanya Juu stabilized with useful vegetation (Adama)

Common Name of SLM Technology: Terrace
Local or other name: Irken
Associated Approach: Food for Work
Contributing SLM specialist: Daniel Danano Dale, Ministry of Agriculture and Rural Development
Email: danieldanano@ethionet.et

Area information
The area in which the SLM Technology has been applied
State: Oromia, Nazareth
Basin; Awash Basin



Agroecology of Adama *Location of Adama*

Soil and water conservation activities started in the area about 30 years ago by the extension program of the Ministry of Agriculture. Systematically planned SLM measures, however, were launched recently after the integrated micro watersheds planning and implementation approach was introduced in the late 1980s.

Definition
Soil bund and Fanya Juu are constructed in alternating sequences along the contour lines in a micro watershed to attain maximum possible level of soil moisture retention an erosion control.

Description
Soil bund and Fanya Juu are constructed in combination in an alternating sequence in a micro watershed for retaining maximum possible rainwater in the soil by obstructing runoff. Soil bunds are suitable for steeper slopes compared to fanya juu terraces which are more effective in gentle and flatter slopes. Land users in the SLM Technology area prefer to combine the two physical structures for many reasons. One important factor is the cost of establishment, which is a function of labor needed for the construction. Fanya juu, which means throwing soil upslope in Kiswahili entails throwing soil upslope and is therefore more laborious than throwing soil to down slope in soil bunds. The other reason is that cultivated lands with fanya juu terraces are not easily accessed by free grazing animals. The ditches placed in the downslope side of the embankment (fanya juu) is not easily crossable but in soil bund although not that easy livestock are seen to walk over the embankment and jump the ditch, which is placed in the upslope side. The other advantage farmers consider is that Fanya juu is more effective in controlling runoff because the water that overtops the embankment is trapped by the ditch.

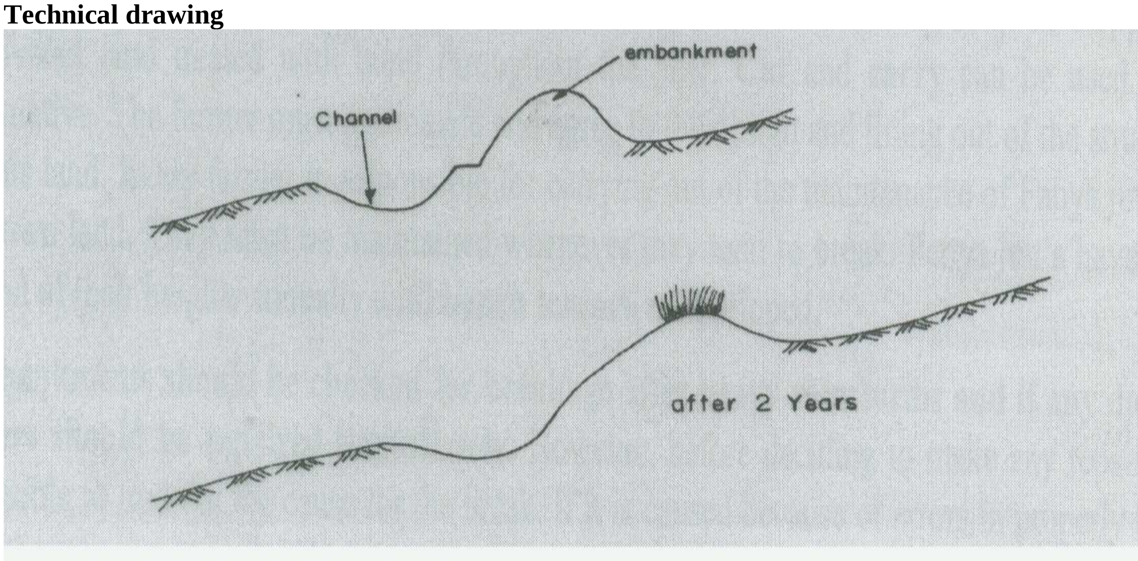
Fanya Juu despite its high cost is preferred to be applied in combination with bunds because of the advantage that it provides in forming bench terrace rapidly. The major purpose is to trap as much rain water as possible and also control soil erosion. Cultivated lands with Soil bund and Fanya Juu together have shown remarkable improvement in soil moisture availability to crops compared to fields with no measures and to those with only soil bunds. Soil bund and Fanya Juu are established in the same way by digging soil and embanking it on a contour line. A contour line is laid out by following a zero gradient. Once the soil is dug and embanked it is lightly compacted to avoid breaching. To further ensure bund stability useful trees or shrubs are planted. The planted tree/shrub species offer multiple benefits such as fodder, fertility improving and fuel wood availability.

Maintenance is done by repairing breaks and managing planted trees on the structure or by upgrading the structure in increasing its height and planting productive trees or fruit tree species. The technology is suitable to semiarid climatic condition which is characterized by erratic rains and where crop production is 0ften affected by soil moisture stress.

Photo of the technology

A newly constructed soil bund with a tie ridge on a cultivated land ready for planting, Adama (Photo 2010)

Technical drawing



The technology area has semiarid climatic conditions; rains are erratic and are often inadequate. Temperature is high and evaporation losses are high as a result.

The most suitable crop is Teff because it requires small amount of soil moisture and has short maturity period compared with other crops.
Maize provides high production in years of good rains. Hedge rows established on bunds are seen on the picture right.

Cassia siamea planted on bunds to stabilize (Photo 2004)

Land degradation

Types of land degradation on the land surrounding the SLM area

Land use	Type of degradation	Degree	%	landform
Croplands	Water erosion	m	100	Hilly
	Chemical deterioration	S	100	Valley floor
	Physical deterioration	m	90	Mountain ranges

Purpose and classification

The major land use problems in the area without SLM include: Severe gully, soil erosion, productivity decline, degraded grazing and forest lands, soil moisture stress, poor crop harvest, high fertilizer prices and lack of grazing land.

Severity of erosion and land degradtion in the SLM Technology area (photo 2004)

Types of land degradation mainly addressed by the technology are: Water erosion (loss of topsoil by water), water erosion mostly gully erosion, fertility decline and reduced organic matter. The technology combats land degradation through: control of dispersed runoff by retaining it in the soil, control of dispersed runoff by retarding the flow, reduction of slope length and reduction of slope angle.

The technology is not intended to provide significant off-site benefits, however, indirectly, the valley bottoms, which were seriously affected by soil burial and sedimentation are now safe because of controlled runoff flow in the upper watersheds as a result of implementing the technology.

The technology is best described as program promoted. The SLM Technology is mainly new, based on previously introduced technologies. The technology of Fanya juu is first practiced in Kenya and soil bunds are also exotic but experienced widely in Ethiopia over the past 35 years in many parts of the country. However, indigenous SLM Technologies have been used before the current SLM Technology was introduced.

Live fencing in between farm boundaries has been practiced which is more or less similar with the vegetation barrier implemented in integration with structural measures in the SLM technology area. The aim is primarily to control erosion and to arrest rain water running downstream. The SLM area experiences serious shortage of soil moisture owning to erratic rains. More often rains of high intensities are received during the rainy seasons in which case most of it runs off and hence not available for crops. The structural measures thus control runoff and encourage infiltration making soil moisture readily available to plants. Extra rainwater in case of heavy showers is conveyed by means cutoff drains to ponds built just below cultivated lands.


Ponds constructed below cultivated lands treated with the SLM Technology (photo 2005)

The traditional practices of establishing boundary plantations, planting hedge rows as live fences and leaving scattered trees on cultivated lands is maintained and continued. Nevertheless, high demand for cultivated lands has caused increasing need for cutting trees to establish farmlands and increasing populations demanded increased tree cutting for charcoal production and house construction. The appearance of the applied technology has greatly changed over time from soil bund and Fanya Juu to outward sloping terraces.

The technology is designed by SLM specialists and the woreda technicians make plans for implementation, layout and monitor the activities. National and regional specialists support them by providing technical backstopping and training. Land users maintain scattered trees on cultivated lands in addition to managing the vegetative measures established.


Trees are maintained on cultivated lands to support soil fertility (photo 2005)

Years back crop production was heavily dependent on chemical fertilizers but at present owning to high prices of chemical fertilizers farmers are applying farmyard manure in combination with chemical fertilizers. Compost preparation is expanding very fast. A number of farmers have developed the skills of making compost. Major constraints faced include increasing prices of chemical fertilizers, land shortage, continuous cropping of the field and lack of labor. Suggested improvement measures are: credit provision, improve the use of compost, plant leguminous plants, and use different methods, which increase soil fertility, reduce the use of animal dung and crop residue for fuel and other uses and expand wood lot plantations.

Type and alignment of vegetative measures (m)

Activities	**Material**	**Plants/ha**	**Between rows**		**Between plants**	
Vegetative measure			Vertical interval	Spacing	Interval	Width
Aligned: contour	Trees/shrubs	400	1	15-20	4-5	1
Dispersed	Trees	50-100	1	-	5-10	30-70

Vegetative measures

Trees planted on bunds are adequately protected where site guards are assigned. In areas where site guards are not assigned trees are cut or browsed by animals. But on sites where guarding is tight there is visible benefit from trees. Leaves and branches of trees planted on terraces and farm boundaries are used for fodder and fuel wood. In these areas bunds have stabilized properly and formed terraces.

Constraints during establishment and maintenance are: Soil moisture stress, interference of animals, late planting of seedlings, wrong choice of species, and low awareness level of land users, labor shortage and lack of awareness. Possible improvements for this include: combine structural and vegetative measures, use local grasses and trees and introduce high fodder value trees.

Specification of structural measures

Type, alignment and dimensions of structures (m)

Structures	**Material**	**Vertical interval**	**Spacing**	**Height**	**Top width**	**Length**	**Depth**	**Bottom width**
Cut-off drains	Earth and stone		200	0.75	1	150	0.75	1.2
Waterway	Stone paved		300-500	1-1.5	3	500	1.2	3
Level bund	Earth and stone	1-1.5	15-20	0.65				

Structural measures should be properly laid out and strictly placed on the contour. The channel as well must be leveled along the contour and quality maintained. Improperly designed, laid out and constructed structural measures face more problem. Protecting from free grazing animals is required as a whole but if not at least for few years until the structures are stabilized well. Placing cutoff drains and waterways is a prerequisite for effective functioning of the measures.

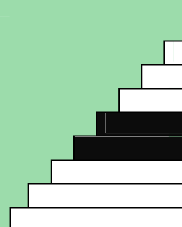
Constraints during establishment: Free grazing animals, loose and friable soils, shortage of soil moisture, and poor quality of measures, labor, and lack of awareness. Possible improvements include: Avoiding open grazing and practice zero grazing instead, maintain quality of measures. Community members should be given awareness and they have to fully participate in the planning. Getting farmers convinced of the benefits by showing them the activities undertaken in other areas through visit programs organized by projects will be useful. Establishing a pilot plots for demonstrating best practices will be helpful in this case. Maintenance is the most vital tool to attain sustainable land management practices to be in place.

Natural Environment

Average annual rainfall (mm)

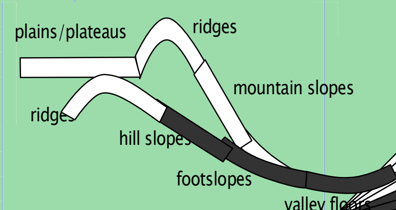
>4000
3000-4000
2000-3000
1500-2000
1000-1500
750-1000
500-750
250-500
less than250

Altitude (m a.s.l.)

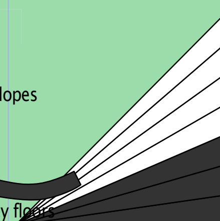


>4000
3500-
3000-
2500-
2000-
1500-
1000-
100-500
less than250

Landform



Slope (%)



(>60)
steep (30-60)
hilly (16-30)
rolling (8-16)
moderate (5-8)
gentle (2-5)
flat (0-2)

Soil depth (cm)

0-20
20-50
50-80
80-120
less than120

Growing season:
Soil fertility: low, very low
Soil texture: sandy, loam
Surface stoniness: some loose stones, no loose stone
Topsoil organic matter: Low (less than1%):
soils of shallow depth on hill slopes
Soil drainage: good
Soil erodibility: high, very high

Hillslopes are largely cultivated and have some grazing lands. Valley floors are generally cultivated lands and have high potentials for crop production when sufficient rains are received. Ridges are grazing and shrub lands. Cultivating valley floors depends on the amount of runoff water coming from the up land ridges. Sometimes the runoff coming from the hills up could be a threat as it carries with it a lot of silt and could conceal the fertile soil. Soils on gentle slopes where the technology is dominantly practiced are moderately deep (50-80 cm). Soils on hill slopes are predominantly shallow (20-50 cm) and soils in the valley floors are moderately deep to deep.

Soil fertility is very low for soils that are continuously cropped on gentle slopes, low for soils on steep slopes because of erosion and medium on soils on valley floors because of deposited soils. Number of erosive storms of water per year is greater than 10. Heavy storms occur in the beginning and middle of the growing season. Rainfall in growing season is usually insufficient and not well distributed. The number of growing seasons per year is only one and has 180 days for sorghum and 90 -120 days for teff.

The technology is labor intensive and assisting land users by subsidizing labor by way of incentives is recommended. The technology is suitable to semiarid climatic conditions where soil moisture stress is a limitation to crop production. The technology is a combination of structural, vegetative and management measures and is very efficient if properly planned and land users participate from the inception in the planning and implementation. It requires frequent maintenance and upgrading.

Human environment and land use

Typical household size of the land users is 5 persons. The population density is 100-200 persons/km^2. The annual population growth including migration is 2-3%. Land size per household is showing a decreasing trend. Land is shared among family members especially when the young get married and seek to establish their own families. Land ownership and land use rights affected strongly SLM. Land users felt in the recent past that land is owned by the state and it is not worth to invest on it but since the time they were entitled for user rights the perception changed and many at the moment to have one or the other form of land management practices on the land they hold. Still, a good number of small holders are hesitant to practice land management measures on the land they are given user rights certificates in the absence of subsidies.

Off -farm income is 10 - 50% of all income for the land users who apply the SLM technology. Land users who have implemented SLM measures have better income compared with land users who have not implemented SLM. The use of the SLM Technology is hindered, significantly when land users cannot read and write. 90 % of land users cannot read and write.

Crop and livestock production

Land cultivation is performed by animal traction using oxen plough. Cropping is rain fed and continuous cropping is usually practiced.

Sequence of crops: maize-teff-sorghum

Types of animals

Large stock	Cattle , pack animals
Small stock	Goat, sheep

The current trend in herd type shows no change and the number of livestock units per household is 2 small stocks and 3 large stocks. The current trend in livestock numbers shows slight reduction mainly due to decrease in grazing land.

Costs

The most important factors affecting the costs are slope, soil condition labor availability. Costs were calculated on the basis of length of terrace, number of trees planted. Daily wage cost of hired labor to implement SLM is 0.80 US $ per person per day

Estimate of cost and recovery period of investment in the technology. Crop is maize

Cost recovery

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1	188	-	16	79	20	253	120	6	-127
2	-	8	16	79	20	123	130	6	13
3	-	8	16	79	22	125	135	10	20
4	-	5	16	79	22	122	138	20	36
5	-	5	16	79	24	124	140	22	38
6	-	-	16	79	24	119	180	30	91
7	-	-	16	79	24	119	200	50	131
Total						985	1043	144	202

Note; 1= Establishment cost + total, 2= Recurrent cost 3= Land + seed bed preparation, 4= Seed + fertilizer, 5= Weeding, cultivation and harvesting, 6= total cost 7= total production value 8 = Benefit 9= net profit

Benefits, advantages and disadvantages

Estimates of production

With or without SLM	**Main plant type**	**Production (ton/ ha/yr)**
Without SLM	Teff	0.6
With SLM	Teff	1.2

On –site and off- site benefits

Production and socio-economic benefits		**Socio-cultural benefits**	
Crop yield increase	**High**	**Community institution strengthening**	**Medium**
Fodder production/quality increase	Medium	Improved knowledge SLM/erosion	High
Farm income increase	High		
Ecological benefits		off-site benefits	
Soil cover improvement	High	Reduced downstream flooding	High
Increase in soil moisture		Increased stream flow in dry season	
Increase in soil fertility	Medium	Reduced downstream siltation	
Soil loss reduction	High		
Production and socio-economic disadvantages		Ecological disadvantages	
Loss of land	High	Water logging	Negligible
Increased labor constraints			
Increased input constraints	Little		

The technology could be improved to achieve more benefits by considering: Inter-bund soil moisture retention measures (contour cultivation, row planting, crop residue mulching), zero grazing and stall feeding and increase planting of improved grass and fodder tree species.

Economic analysis

Without SLM the gross production value in US$ per hectare per year around the SLM Technology area is less than 100 / ha / yr. With SLM Technology, the gross production value of the land per hectare per year is 176 US$ / ha / yr. Compared to the situation without conservation percentage gross production value increase by implementing SLM is 80% taking into account production losses due to the area rendered non-productive because of the presence of the SLM measures.

Adoption and adaptation

Structural measures are stabilized by vegetative measures. The vegetative measures are implemented to provide multiple benefits. Cutoff drains and waterways are included to ensure effectiveness. About 95% of land users that have applied the SLM Technology have done it with incentives on about 90% of the area. About 5 % of land users that have applied the SLM Technology have done it wholly voluntarily, without any incentives other than technical guidance on about 10% of the area.

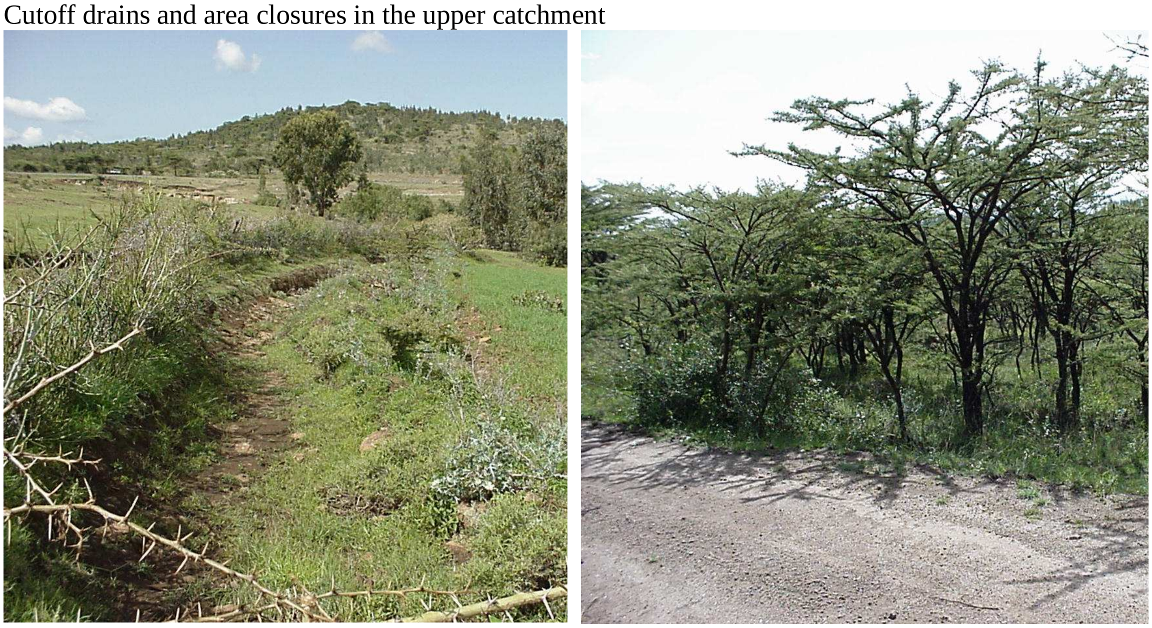
There is slightly increasing trend towards growing spontaneous adoption of the technology. Spontaneous adoption is being observed with the average in wealth in particular and in families who are better aware of SLM measures. There is enough local skill and support to expand the SLM Technology. Most land users are now able to mark contour lines and have the know-how of constructing bund and fanya juu in combination or separately.

Maintenance

Land users are able to adequately maintain and manage what has been implemented in some places. Nevertheless, most land users are aware of soil erosion problem and the benefits of soil conservation measures. There are also land users who are aware of the problem but are not willing to establish new SLM measures and are not interested in maintaining the structures.

Supportive measures

Cutoff drains and area closures in the upper catchment



Left (a cutoff drain) and area rehabilitated by enclosures. Natural vegetation regeneration after enclosures (right) (photo 2004)

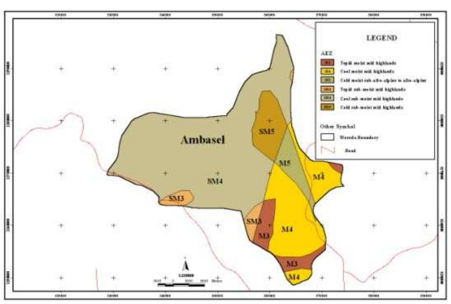
 

Vegetated stone-faced bunds (left) and runoff trapped by these bunds (right) [Photo 2004]

19. Vegetated stone – soil –stone bunds (North Wello)

Common Name of SLM Technology: Stone bunds
Local or other name: Kirit (Amharic)
Associated approach: 1. Self Help and 2. Food for Work
Contributing SLM specialist: Gebeyehu Dejen Alemu, Ambassel Woreda Agriculture and Rural Development Office, Ambassel Woreda, Amhara Regional State

Area information



Agroecology of Ambassel ***Location of Ambassel***

Definition

Vegetated stone-soil-stone bund is constructed from stonewalls at the upper and lower parts and soil is placed in between. It is laid out along the contour and is planted with food and fodder plants such as pigeon peas, sesbania, grevillea and other fodder crops.

Description

Vegetated stone-soil-stone bunds are established on cultivated lands and are primarily aimed at reducing slope length and inclination and thereby control soil erosion by enhancing water retention in the soils. The bunds are established along the contour by digging trench and placing stones on the excavated trench to establish a firm foundation. The measure is stabilized by planting crops such as pigeon peas. The structure is regularly maintained by repairing breaches. Some farmers put on additional height to the bunds every year. The technology is suitable to all agro ecological conditions, where stones are available for construction. The only variation is in the layout (graded for high rainfall areas and level in low rainfall areas)

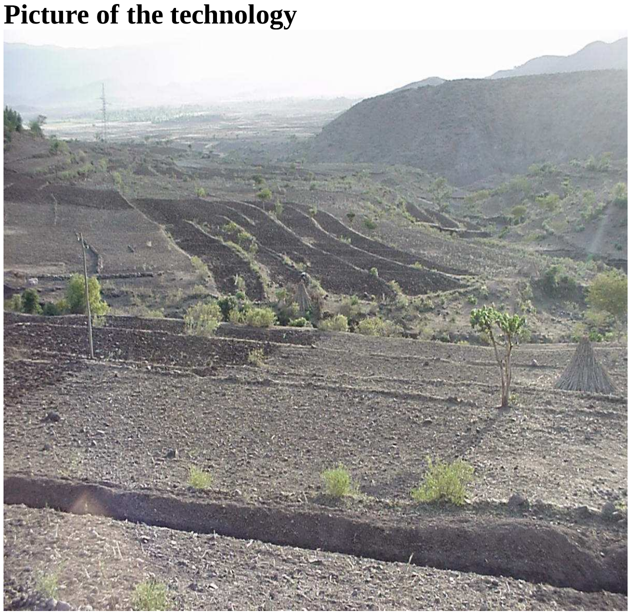
As a result of implementing this technology, flood problem has reduced with additional benefit of roads protected from damage. Communities benefited from food incentives, increased production of cultivated lands (both crop and fodder).

Vegetated stone-soil-stone bunds help retain moisture in the soil by trapping runoff. Stone faced soil bunds are suitable for steeper slopes compared to fanya juu terraces which are more effective in gentle slopes. Cultivated lands with fanya juu terraces are not easily accessed by free grazing livestock. The ditches placed on the down slope side of the embankment (fanya juu) are not easily crossed by livestock but soil bunds are crossed easily by grazing animals. The other advantage farmers consider is that Fanya juu is more efficient in trapping runoff because the water that spills over the embankment is trapped the ditch below it.

Maintenance is performed by repairing the breaches on the structure, tending trees planted on the structure, upgrading the structure by increasing its height and replant trees, shrubs and fruit trees that stabilize it.

The major purpose of the technology was not to provide offsite benefits, however, in the process of controlling soil erosion in the upper watershed, cultivated lands at the valley bottom, which were seriously affected by sedimentation are safe now owing to controlled runoff flow.

Picture of the technology



Stone faced bunds 10 years old forming terraces in South Wello (photo 2004)

Land degradation

Types of land degradation on the land surrounding the SLM area

Land use	Type of degradation	Degree	% area	Landform(s)
Forest	Water erosion	m	50	H, M
Grazing land		s	70	R, H
Cropland		s	60	H, F, P, R

Source of data: Ambassel Woreda Agricultural and Rural Development Office

Technical function

Main	Secondary
Control of erosion Improve land productivity	Reduction of slope length Control of dispersed runoff (retain/trap)

Purpose and classification

Major land use problems in the area without SLM are soil erosion, overgrazing, and deforestation. Shortage of land and continuous cultivation of the same field every year, land use conflicts, declining production, shallow soil depth, and spread of exotic invasive weeds from land users perspectives.

The technology combats land degradation by: reducing slope angle, reducing slope length, control of dispersed runoff, increase of infiltration and maintain water stored in the soil. The technology is intended to provide significant off-site benefits as well including, preventing flood hazard in the valley bottoms, recharge ground water and improve annual flow of springs.

The current status of the technology is best described as program implemented. The SLM Technology is mainly introduced. Stonewalls are used in the area for making barriers for runoff. Traditional SLM practices have been used before the current SLM Technology was introduced and could be defined as structural measures established from stones nearly on the contour to control soil erosion. The aim of the traditional practice is to control erosion and improve soil moisture. Today, the indigenous land management practice is used less due to improvements made by considering new techniques.

The current SLM technology is designed by experts and guidelines exist for training and implementing it while the actual construction work is done by the land users. The appearance of the applied technology has gradually changed over time. Vegetated bunds enhance rapid formation of bench terraces in addition to the other benefits they offer in increasing feed for animals.

Specification of vegetative measures

Type and layout of vegetative measures (m)

Strips/ blocks	Material	Plants/ha	Vertical Interval between rows	Spacing	Interval between plants
Contour	Trees/shrubs	1900	1	10	0.25-0.5

Construction and maintenance

Field activities for agronomic measures

Activity	Energy	Equipment	Timing	Frequency
Recycling crop residue	Manual labor	Hand tools	Dry season	Annual
Seed bed preparation				
Plowing	Animal traction	Farm equipment		
Manure	Manual labor	Hand tools	Beginning of rain	Annual
Weeding			End of rain	
Harvesting			Dry season	
Establishment activities for vegetative measures				
Activity	Energy	Equipment	Timing	
Production of planting materials	Manual labor	Hoe	Dry season	
Transporting planting materials	Truck	Truck	Onset of rain	
Planting	Manual labor	Hoe	Rainy season	
Maintenance activities for vegetative measures				
Activity	Energy	Equipment	Timing	Frequency
Replanting	Manual labor	Hoe	Rainy season	As required
Pruning		Axe, Machete	After rain	When trees grow

Farmers have reaped benefits by planting multipurpose trees such as pigeon pea. Pigeon pea is sold and also used by the land users themselves at home. Farmers use pigeon peas also as source of fodder for livestock and fuel wood. Important constraints during establishment include: pests, disease and related problems. Possible improvements could include: applying modern techniques to control pest and diseases, awareness creation and better land management.

Specification of structural measures

Type and alignment/layout of vegetative measures (m)

Structure	Material	Vertical interval	Spacing	Ditch		Bank		
				Depth	Width	Length	Height	Width
Bund	Soil /stone	10	50	0.5	0.5	250	0.8	2.5
Bund	Soil/ stone	5	25	0.5	0.5	150	0.8	2.0

Slope, which determines the spacing indicated above, is 5-10 %. The lateral gradient along the structure is 0%. For water harvesting the ratio between the area where water is applied and the total area from which water is collected is 1:1. Vegetation is used for stabilization of structures.

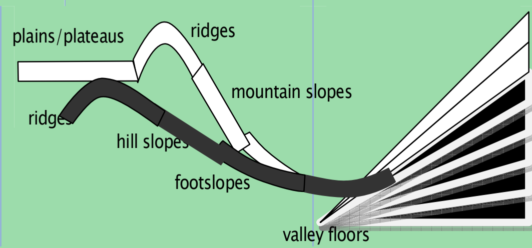
The structural measures reduce soil erosion, improve soil moisture and infiltration and hence improve production and productivity for securing food availability. Constraints during construction include: shortage of construction materials (stone) in some areas, shortage of hand tools, and lack of skilled labor and low level of community awareness. Constraints during maintenance: lack of community awareness to undertake maintenance by themselves and control free grazing. Recommended improvements are: awareness creation, skill training for farmers, provision of hand tools at household level, improve work norm.

Natural Environment

Average annual rainfall (mm)
>4000
3000-4000
2000-3000
1500-2000
1000-1500
750-1000
500-750
250-500
less than250

Altitude (m a.s.l.)
>4000
3500-4000
3000-3500
2500-3000
2000-2500
1500-2000
1000-1500
100-500
less than250

Landform **Slope (%)**



very steep (>60)
steep (30-60)
hilly (16-30)
rolling (8-16)
moderate (5-8)
gentle (2-5)
flat (0-2)

Soil depth (cm)
0-20
20-50
50-80
80-120
less than120

Growing season:
Soil fertility: low, very low
Soil texture: low (less than1%), medium (1-3%)
Surface stoniness: abundant loose stone, some loose stone,
Topsoil organic matter: low (less than1%), medium (1-3%)
Soil drainage: good
Soil erodibility: high on steep and hilly slopes, medium on rolling terrains, low on gentle slopes

Number of erosive water storms per year is less than 10 and they mainly occur in the beginning of growing season. Rainfall in the growing season is usually insufficient and not well distributed.

Human environment and land use
Typical household size of the land users is 5 persons. Population density is 100-150 persons km^2. Annual population growth is 2.7%. Land size per household is showing a declining trend due to increase in population. Land ownership and land use rights affect SLM moderately. Farmers do not feel secured to invest on land that does not belong to them.

There is little difference between the better-off and poor in how they practice SLM. The rich have opportunities to hire labor for SLM practice. Off-farm income is less than 10% of all income for the land users who apply the SLM technology.

The level of technical knowledge required for implementation of the technology is moderate for extension workers and moderate for land users. The use of the SLM Technology is strongly hindered, when land users cannot read and write and 90% of land users cannot read and write. Some farmers who cannot read and write are many because of no policy for adult education. Production is not subsidized.

Crop and livestock production
Land cultivation is performed by animal traction and manual labor
Cropping system and major crops

Water supply	**Type of cultivation**
Rain fed	Continuous cropping
Mixed rained - irrigated	
Intercropping	

Cost (US$)

Cost Category	Input	Establishment cost			Recurrent cost		
		Quantity	Cost	% borne by land users	Quantity	Cost	% borne by land users
Agricultural	Harvest		10	100			
	Animal traction		15				
	Seedlings (No.)	900	3				
	Seeds (kg)	30	10				
Equipment	Tools	18	0				
Labor	Person days	225	183		25	25	100
Total			221				

The cost of the technology is affected by slope, soil workability, and availability of labor. Cost is calculated for the length of structure per hectare of land treated .Daily wage cost of hired labor to implement SLM is 0.85 US $ per person per day.

Cost recovery period of investment for the soil and water conservation technology

Crop (Teff)

Year	Establishment cost							Total Cost	Gross production	Net profit
	1	2	3	4	5	6	7			
1	1174	-	30	70	12	27	8	1321	750	-571
2	-	44	30	70	12	27	8	184	750	566
3	-	44	30	70	12	27	8	184	880	616
4	-	20	30	70	12	27	8	160	880	720
5		20	30	70	12	27	8	160	888	720
6		20	30	70	12	27	8	160	888	720

Note: 1=Establishment, 2= maintenance, 3= Land preparation, 4 = Fertilizer, 5= seed, 6= seed, 7= harvest, 8 = total cost, 9= gross production, 10= net profit

Benefits, advantages and disadvantages

Measurements/Estimates of production

With or without SLM	Crop/plant	Production (t/ha)
Without SLM	Teff	4
With SLM		8

On-site and off-site benefits

Production and socio-economic benefits		Socio-cultural benefits	
Crop yield increase	Medium	Community institution strengthening	Medium
Fodder production/quality increase	High	Improved knowledge SLM/erosion	Medium
Farm income increase	Medium		

Ecological benefits		off-site benefits	
Soil cover improvement	Medium	Reduced downstream flooding	Medium
Increase in soil moisture	Little	Increased stream flow in dry season	High
Increase in soil fertility	Medium		
Production and socio-economic disadvantages		**Ecological disadvantages**	
Loss of land	Medium	Water logging	Negligible
Increased labor constraints	High		
Hindered farm operations	Negligible		

Economic analysis
Without SLM the gross production value in US$ per hectare per year around the SLM Technology area is 260. With SLM Technology, the gross production value of the land per hectare per year is 400 US$ /ha/yr. Compared to the situation without conservation percentage gross production value increase 10 years is 60% after implementing SLM considering also the area occupied by conservation measures and assuming current input and prices. The increase in production is largely attributable to availability in sufficient amount of soil moisture.

Adoption and adaptation
The traditional technology has been modified by including new techniques such as vegetating bunds, proper layout, better supervision, improving the design and monitoring the quality of measures. Soils in the technology area are susceptible to erosion and therefore land management structures should be stabilized by planting trees or grasses.

About 80 % of land users that have applied the SLM Technology have implemented the technology were given incentives. The number of families engaged is 2073 and this accounts to 80 % of the area requiring SLM measures. Land users have adequately maintained or managed what has been implemented since the introduction of the technology. There is enough local skill and support to expand the SLM Technology. Training and project support (finance, material and technical) are some of the support provided to land users.

Strength / advantage

Advantages	Sustain/improve
Decrease slope length	Continuous maintenance and upgrading
Increase infiltration	More agronomic measures
Decrease soil erosion	Integrated measures
Increase production	Enhance soil fertility

Supportive measures

Agronomic	Intercropping and plowing along the contour
Area enclosures	Upper catchment
Trenches with plantation	Upslope of cultivated lands

Supportive measures practiced on the catchment at Oromiya zone, Amahara Region: Trenches and microbasins (left), area enclosed and rehabilitated (right) (photo 2003)

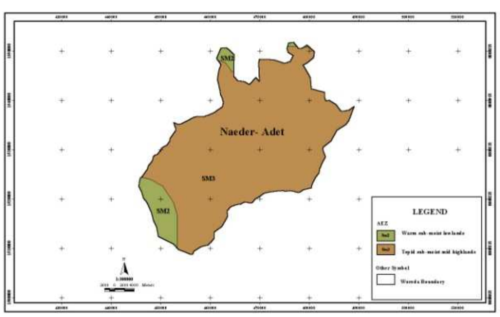
V. Introduced structural land management measures

Stone faced t*rench bund, Tigray (photo 2009)*

Outward sloping terraces developed from stone bunds in Adigrat (Tigray)

20. Stone-faced trench bund (Tigray)

Common Name of SLM Technology: Stone-faced trench bund
Local or other name: Emni Getsel metrebawizala
Associated approach: Food for Work
Contributing SLM specialist: Woldegabriel G/Hawaria, Bureau of Agriculture and Natural Resources, Tigray
Area information
State: Tigray
Total SLM Technology area: 320 Sq km



Agroecology of Naeder Adet

Location of Naeder Adet

Definition

An embankment of stone laid out on a contour and placed at the lower side of the trench dug to form a ditch where rainwater is collected.

Description
Stone faced trench bund is established first by digging a ditch on which the foundation of the bund is placed. The stone wall has a height of 60-70 cm after construction, and a trench is dug upslope to store runoff coming from above. The major purpose is to retain rainwater that becomes runoff and later causes erosion. It is essentially a water harvesting practice and is intended to store rainwater for crop production. The measure serves also to reduce slope steepness, slope length and break runoff velocity.

Establishment*:* a contour line is laid out using a line level and a trench 3 m long and 0.20 – 0.3 m deep is dug out. Stones are placed carefully at the downside to support the soil that is dug out from the trench and to form a barrier to runoff water. Fodder trees and grasses are planted in the trenches and on the embankment.

Environment: It is applied in areas with very low, erratic and intense rains with shallow soils. Rainwater stored in the trenches supports the vegetation planted on the trench embankment.

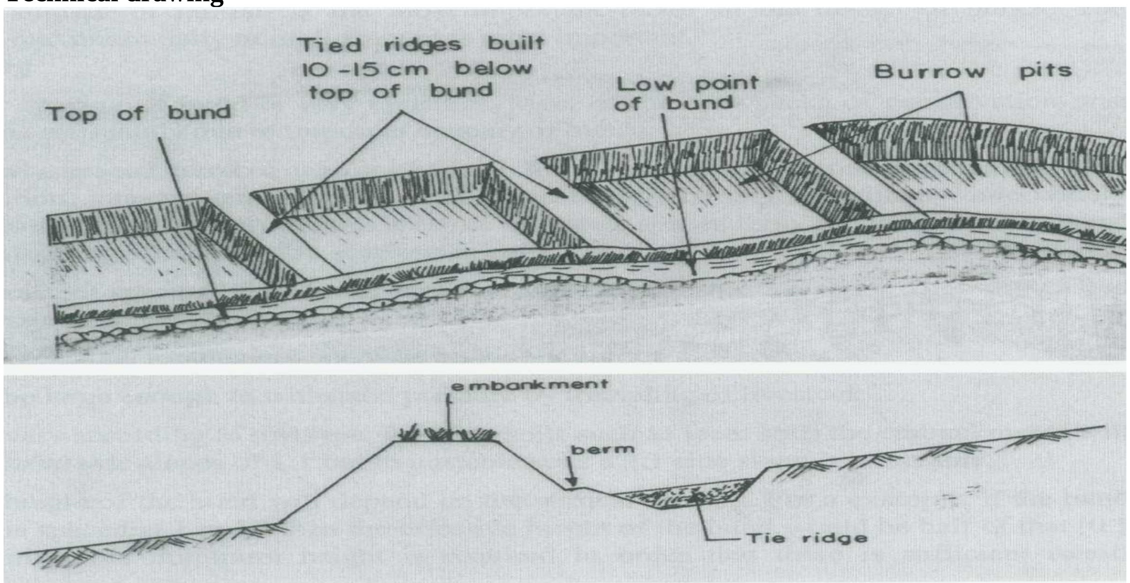
Terraces formed from bunds in Adigrat, Tigray (Photo 2003)

Stone faced trench bunds constructed in wukro, Tigray (photo 2009)

The stone faced trench bunds forming bench terraces later

High quality stone terraces in Tigray (photo 2009)

Technical drawing



Land degradation

Types of land degradation on the land surrounding the SLM area

Land use	Type of degradation	% area affected	Degree	Land form
Cultivated land	Water erosion Gully erosion	100	l	HP
Grazing land	Water erosion Gully erosion	75	m	
Forestland	Water erosion	30	m	

Purpose and classification

The major land use problems in the area without SLM include: soil fertility decline, soil erosion, deforestation and overgrazing. The problems from land users' point of view are: decline in production, low moisture, drought and afforestation.

The technology combats land degradation through: control of dispersed runoff by retaining it, increase infiltration, maintaining water stored in the soil, reduction of slope length and harvesting water. The technology is also intended to provide off-site benefits such as reducing sedimentation flow to bottomlands, control soil erosion and enhance ground water recharge.

The technology includes indigenous practices. The technology came as a result of adopting the experience of other countries and partly adapted to the conditions in the region. Indigenous SLM Technologies have been used before the current SLM Technology has been introduced. The aim of the traditional technology is to increase soil moisture and improve crop production. Today the indigenous SLM is continued and maintained. It is understood by the land users that the measures prevent land from erosion, help harvest moisture and increase production. In understanding these advantages, land users adapted and maintain them regularly.

The SLM technology is designed by regional and woreda SLM specialists. The appearance of the applied technology has moderately changed over time. Moreover, cultivation and inter bund erosion processes enhanced the development of bench terraces. Pesticides are applied to counter pests' infestation and some farmers use compost for improving soil fertility. Use of compost for improving productivity is increasing.

Trench soil bunds with plantation at the down the slope side on a pit dug for it (photo 2008)

Constraints: Shortage of inputs and labor, pest and diseases, weeds, moisture stress.
Possible improvements: Provision of pesticides, herbicides and agricultural inputs and introducing improved farming practices.

Local grasses establish on the bunds naturally. Constraints during establishment include free grazing, poor management and shortage of seedlings. Major constraints during maintenance are free grazing and labor. Possible improvement practices include: area closure, water harvesting techniques and cut and carry.

Specification of structural measures
Type and alignment of structures (m)

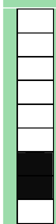
Material	**Spacing**	**Height**	**Vertical interval**	**Embankment**		**Channel**	
				Height	**Width**	**Depth**	**Width**
Earth and stone	60-80	0.5	1	0.5	0.5-1	0.50 - 0.35	0.50-1
Earth and stone	80-100	0.5-0.75	1	0.5-0.75	0.5-1		

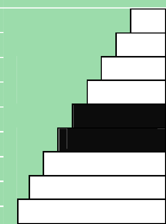
Source: Adet Naedir office of Agriculture and Natural Resources

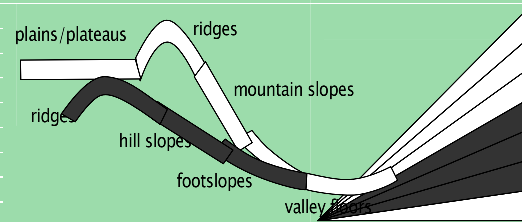
Slope which determines the spacing indicated above is 6-10%. For water harvesting, the ratio between the area where water is applied and the total area from which water is collected is 2-4:1. Constraints during establishment include: high labor demand, free grazing animals. Important constraint during maintenance: shortage of labor.

Natural Environment

Average annual rainfall (mm)	Altitude (m a.s.l.)	Landform	Slope (%)







Soil depth (cm)

Growing season:
Soil fertility: low
Soil texture: medium (loam), coarse (sandy) and fine (clay)
Surface stoniness: some loose stone, no loose stone and abundant loose stone
Topsoil organic matter: low (less than1%), medium (1-3%)
Soil drainage: medium, good, poor
Soil erodibility: high, very high
Soil water storage capacity: low, medium, very low

Number of erosive water storms of water per year is less than10. Rainfall in growing season is usually sufficient but not well distributed. Number of growing seasons per year is 1.

Human environment and land use

Typical household size of the land users is 4.5 persons. Population density is 150 persons/km^2. Annual population growth is 3%. Land size per household is decreasing although there is no land redistribution. Land ownership and land use rights did not affect SLM. Land users have realized that they have user rights on land. Similarly, subdivision of land did not affect the implementation of the SLM Technology.

There is no marked difference between rich and poor in how they practice SLM. Off-farm income is less than 10% of all income for the land users who apply the SLM technology. Household incomes come from employment as daily laborer in the towns and by participating in food for work projects and the Productive Safety Net Project activities.

Level of technical knowledge required for implementation of the technology is high for field staff and extension workers and also high for land users. The use of the SLM Technology is hindered moderately, for land users who cannot read and write. Percent land users who cannot read and write is 80%. Since over 80% of the community cannot read and write, difficulties exist in perceiving the importance of the technology unless the leadership is taken by knowledgeable farmers. Land cultivation is performed by manual labor and oxen plow. It is mostly rain fed with continuous cropping dominating. Intercropping is not practiced. Trees are not part of the cropping system.

Livestock production

Currently the number of livestock owned by land users is decreasing because of land shortage for grazing. The number of livestock units per household is 3 small stocks and 2 large stocks. The current trend in livestock numbers is slight reduction.

Establishment and recurrent costs (US$)

Category	Input	Quantity	Cost	% borne by land users
Agricultural	Tools	20	40	100
	Fertilizer (kg)	50	43	
	Animal traction	16	20	
	Seeds (kg)	30	25	
	Other costs		17.5	
Labor	Person days	200	118	
Total			263.5	

The most important factors affecting the costs are labor, slope and soil workability. Costs are calculated on the basis of length of the structure and tree seedlings planted per hectare. Daily wage cost of hired labor to implement SLM is 0.875 US $ per person per day. Exchange rate is 1 US $ to 8.5 Birr

Benefits, advantages and disadvantages

Estimates of production

Measure	Crop / plant	Production (t/ha/yr)
Without SLM	Teff	0.8
	Maize	1
	Sorghum	1.2
With SLM	Teff	1
	Maize	1.5
	Sorghum	1.7

Establishment and recurrent costs (US$)

Category	Input	Quantity	Cost	% borne by land users
Agricultural	Tools	20	40	100
	Fertilizer (kg)	50	43	
	Animal traction	16	20	
	Seeds (kg)	30	25	
	Other costs		17.5	
Labor	Person days	200	118	
Total			263.5	

The most important factors affecting the costs are labor, slope and soil workability. Costs are calculated on the basis of length of the structure and tree seedlings planted per hectare. Daily wage cost of hired labor to implement SLM is 0.875 US $ per person per day. Exchange rate is 1 US $ to 8.5 Birr

Benefits, advantages and disadvantages

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Measure	**Crop / plant**	**Production (t/ha/yr)**
Without SLM	Teff	0.8
	Maize	1
	Sorghum	1.2
With SLM	Teff	1
	Maize	1.5
	Sorghum	1.7

On-site and off-site benefits

Production and socio-economic benefits		**Socio-cultural benefits**	
Crop yield increase	High	Community institution strengthening	High
Fodder production and quality increase	Medium	Improved knowledge on SLM	
Farm income increase	High		
Ecological benefits		Off-site benefits	
Soil cover improvement	Negligible	Reduced downstream flooding	High
Increase in soil moisture	High	Increased stream flow in dry season	
Improved ground water recharge			
Increase in soil fertility	Negligible	Reduced downstream siltation	
Soil loss reduction	High		
Production and socio-economic disadvantages		Ecological disadvantages	
Loss of land	Medium	Water logging	Negligible
Hindered farm operations	Negligible		

Percolation pits are placed at the foothills in the watershed where the technology is implemented and these are seen in the picture right. These structures are meant to intercept runoff coming from the slopes up and force it to percolate down to enrich the ground water. Hand dug wells are constructed at the downstream to use the water for supplemental irrigation. The ground water level increase and the well water enrichment is seen to be remarkable as could be seen from the photo right.

Water is stored and used in many ways when the watershed is treated with appropriate physical and biological measures. The water is developed in different ways such as small dams, wells and weirs as could be seen in the picture right and is used for livestock watering and vegetables growing. The pictures right show some of the plots watered by the water conserved in the watershed at the down hills. Proper watershed management interventions involve integrated measures and show immediate results in improved watershed hydrology.

Economic analysis

Without SLM the gross production value in US$ per hectare per year around the SLM Technology area is less than 100 / ha / yr. With SLM Technology, gross production value of the land per hectare per year is over 250 US$ / ha / yr. Compared to the situation without conservation, percentage gross production value increase 10 years after implementing SLM is 150% considering also the land occupied by conservation measures and in assuming current input and prices.

Adoption and adaptation

Changes have been made to the technology in modifying the dimensions and introducing a new practice for placing a ditch to collect water above the bund. The SLM Technology is to a given extent designed such that it allows changes by the land users to adapt to changing land use practices. Some land users are applying the technology on their farmland by their own. There is enough local skill and local support to expand the SLM Technology. There are production cadres who are trained on the procedures and construction techniques of the measures.

Maintenance

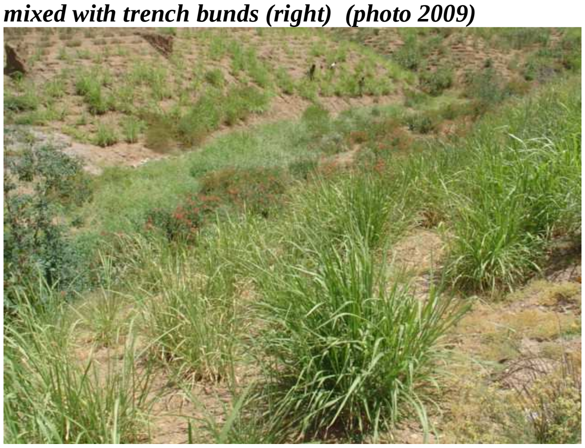
Land users have adequately maintained and managed what has been implemented. Maintenance is carried out during and before the onset of rains.

The picture (right) shows a properly maintained terrace developed from bunds constructed on a sloping agricultural land in the southern zone of Tigray. The watershed in the upper catchment is well treated and

Supporting measures

Stone faced trench bunds technology is supported by additional measures such as eyebrow terraces, micro basins and grazing lands rehabilitation. Some of these measures are shown in the pictures below.

Eyebrow terraces constructed in between stone faced trench bunds (left) and loose stone bunds at intervals mixed with trench bunds (right) (photo 2009)



Grazing land development with elephant grass along stream bank in the technology area (photo 2009)

Retention bunds to trap rainwater in the flat bottom lands (photo 2009)

Strength and weakness of the technology

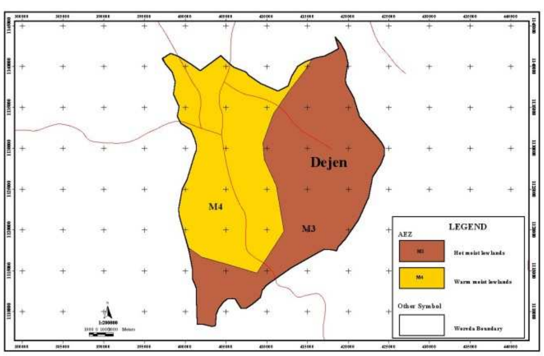
Strength	**Further improvement**
Reduced soil erosion	By integrating area closure with biological SLM measures
Increased moisture availability	Maintain the trenches regularly
Increase production	Increased use of fertility enhancements
Enhance vegetation growth	Planting and replanting
Decrease runoff velocity	Put inter-bund small structures for retaining water
Improve soil fertility	Apply biological SLM measures
Weaknesses / disadvantages	How to overcome
Labor intensive	Mobilization of the community
Hinder farm operation	Enlarge the spacing between bunds
Loss of cultivated land	Increase the land productivity by including biological measures

Terraces developed from stone walls in the Abay Gorge, Dejen (photo 2004)

Stone bunds (Photo WOCAT documentation)

21. Stone-faced bunds (Abay Gorge)

Common Name of SLM Technology: Stone terraces
Local or other names: Gidad, Irken
Associated Approach: Self Help and Social voluntary Labor Share
Contributing SLM specialist: Omer Wudu, Dejen Woreda Agriculture and Rural Development Office, Amhara regional State, Eastern Gojam Zone, Dejen Woreda Documented: 2005 Updated: 2008
Area information
Basin: Abay / Nile/ Basin



Agroecological map of Dejen

Location of Dejen

Definition

Stone bund is an embankment of stone constructed across the slope following the contour to control soil erosion.

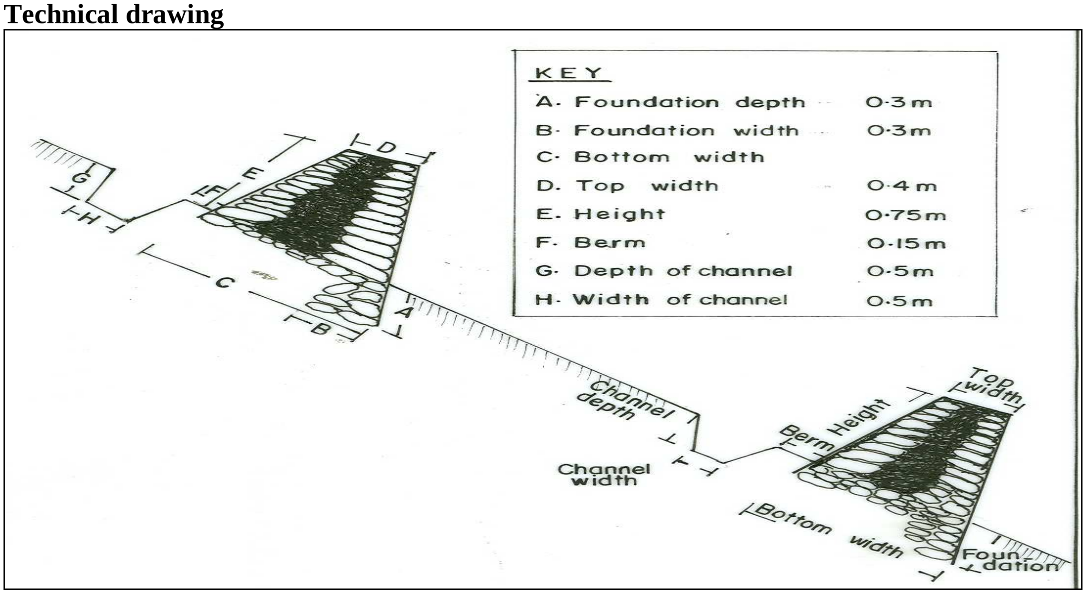
Description

Stone bunds are stabilized by planting trees or grass on either the upper side of the bund or at the down slope side. Its main purpose is to control soil movement by runoff, retain the water in the soil and control soil erosion. Establishment is made first by laying out contour lines, digging foundation and placing stones in a manner that they interlock to one another. Stone bunds placed on contour are known as level stone bunds. The purpose of level stone bunds is to form barrier to runoff and enhance soil moisture in the soil to increase availability of water to plants. It is also aimed at controlling soil erosion from cultivated fields such that plants have sufficient soil depth to establish well and grow comfortably. Stone bunds are good if they have a height of 0.60 m after establishment when spaced at 1 m vertical interval and a height of 0.75 m when spaced at 1.5 m and 2 m vertical intervals.

Maintenance is done every year especially before the rains. Maintenance continues for several years until the slope of the terraced land forms nearly bench or slightly sloping outward terrace. Land treated with the technology is protected from interferences; grass and fodder trees are cut from field to feed livestock.

To further improve the productivity of terraced lands, practices such as inter and relay cropping, composting and green manure application, mulching, small water harvesting structures should be applied in combination. Proper standards should be followed to maintain the quality of stone bunds. Stone embankments are constructed along the contour and reinforced by soil embankment in the upper side. Farmers who are better-off could use herbicides, pesticides and chemical fertilizers in crop fields. Chemical fertilizers are also used for soil fertility enhancement. Stone-faced bunds are constructed with a view that they form bench terrace some years after construction and if proper maintenance is made.

Technical drawing



Technical function

Main	Secondary
Control of dispersed runoff (retain/trap)	Water harvesting Reduction of slope angle Reduction of slope length Increase infiltration

Overgrazing on lands with denuded vegetative cover has exposed the land for erosion. Soil erosion induced soil fertility problem and surface stoniness are problems addressed by the technology.

Land degradation

Types of land degradation on the land surrounding the SLM area

Land use	**Type of degradation**	**Degree**	**%**	**Landform**
Forestland	Water erosion	L	12	H
Grazing land		M	25	R
Cropland		S	40	R, F
Other		M	23	F

Purpose and classification

The major land use problems in the area without SLM: Overgrazing on a land with little vegetation cover and exposed surface, cultivating on very steep slopes. The technology combats land degradation through: Control of dispersed runoff (retain/trap): Water harvesting, increase infiltration, reduction of slope length and reduction of slope angle. The technology is best described as a program implemented by the government and the communities.

Farmers, who have the financial means, apply herbicides and pesticides. Chemical fertilizers are used for soil fertility improvement. Manure is applied in smaller quantities to fertilize the soil around the backyards but most of the animal dung is used for fuel particularly on the plains of high altitudes. Farmers in the sloping lands in the Abay gorge use household garbage and fuel wood ash on cultivated lands near the homesteads. The major constraint in land cultivation is the lack of fertility enhancement measures and the dependence on industrial fertilizers. Possible improvements are: practicing inter and relay cropping, compost and green manure application, mulching, small rain water retaining measures and maintain quality of measures.

Specification of structural measures

Dimensions of bunds (m)

Structure	Material	Vertical interval	Spacing	Ditch depth	Ditch width	Bank length	Bank height
Diversion	Earth	2	10	0.4	0.3	58	
Bund/bank	Earth/Stone	2	10			58	0.75-1

Construction and maintenance

I) Field activities for agronomic measures				
Activity	Energy	Equipment	Timing	Frequency
Contour plowing	Animal traction	Oxen	Dry season	Three times
Harrowing	Manual labor	Digging hoe		Once a year
Planting		Digging hoe		
Temporary trashlines		Sickle		
Residue management		Sickle		Many times
Weeding		Hand		Two times
Harvest		Sickle	Dry season	Annual
II) Establishment activities for vegetative measures				
Preparation of seedlings	Manual labor	Shovel, hoe	Dry season	Once a year
Transporting of seedlings		Head load	Rainy season	
Planting on bund		Hoe	Rainy seas.	

III) Maintenance activities for vegetative measures				
Cutting /pruning	**Manual labor**	**Sickle**	**Dry season**	
Construction activities for structural measures				
Surveying	Manual labor	Line level, poles	Dry season	
Collecting of stones		Hand		
Constructing the bund		Hoe, spade		
Construction activities for structural measures				
Repair breaks	Manual labor	Spade, hoe	Dry season	
Guarding and fencing		Axe		

Stone-faced bunds are constructed with a purpose of forming level terraces after some years. Under conditions where bunds are well maintained and livestock interference is protected, terrace formation is enhanced. Slope changes to nearly gentle slopes and erosion risk is reduced. Constraints during construction and establishment are that dry season constructing requires much labor and stones are not easily available. Possible solution for this is forming group of farmers on labor exchange bases or support one another.

Natural Environment

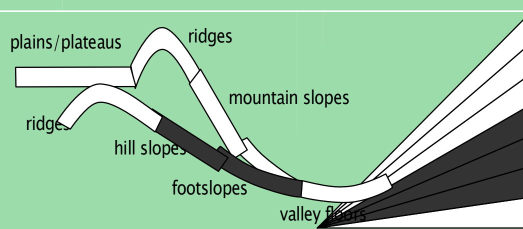
Average annual rainfall (mm)

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

Altitude (m a.s.l.)

- >4000
- 3500
- 3000
- 2500
- 2000
- 1500
- 1000
- 100o-500
- <250

Landform



Slope (%)

- very steep (> 60)
- steep (30-60)
- hilly (16-30)
- rolling (8-16)
- moderate (5-8)
- gentle (2-5)
- flat (0-2)

Soil depth (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- less than120

Growing season:

Soil fertility:
Soil texture: coarse (sandy), sandy loam
Surface stoniness: some loose stones, abundant loose stones
Topsoil organic matter: Low (less than1%)
Soil drainage: good, medium
Soil erodibility: high, medium
Water storage capacity: low, very low

Number of erosive storms per year is 15-20 and they occur at the beginning and middle of growing season. Rainfall in growing season is usually sufficient and well distributed. Number of growing season per year is 1.

The technology is suitable to humid and sub-humid climates with shallow soils. Stone availability is a condition.

Human environment and land use

Typical household size of the land users is 5 persons. The population density is 50-100 persons/km^2 and the annual population growth is 2-3 %. The land size per household is showing a decreasing trend owning to population increase. No trends towards privatization of land because it is state owned. Land ownership and land use rights affected SLM slightly. In the recent past, since land is owned by the State and the public, farmers were not encouraged to manage their land properly but at present these feelings are changing as most land users are given users certificates. Subdivision of land has seriously affected the implementation of the SLM Technology. Land is used to be reallocated in the region in the past but now this practice is not in place. It is the policy of the region that there will not be further land reallocation in the future.

There is some difference between the rich and poor in how they practice SLM. The rich can hire daily workers to treat their land while the poor do not. Off-farm income is less than 10% of all income for the land users who apply the SLM technology. In the land with proper conservation techniques the productivity increased by about two folds whereas in the land without conservation measures yield decreased.

Level of technical knowledge required for implementation of the technology is moderate for extension workers and moderate for land users. The use of the SLM Technology is not hindered, when land users cannot read and write. Percent land users that cannot read and write is 80%. Land cultivation is performed mainly by animal traction (65%) and manual (35%).

Crop and livestock production

Type of cropping system and major crops

Water supply	Rank	Type of cultivation	Rank
Rain fed	1	Continuous cropping	1
Mixed rain fed and irrigated	2	Ley cropping	2

Inter cropping is practiced. Crops inter cropped are teff with safflower.

Animal production

Large stock	**Cattle, donkey**
Small stock	Goats

There is very little change in the current trend of herd types; the number of livestock units per household is 2 small stock and 3 large stock. There is little increase in the current trend in livestock numbers.

Costs (Birr)

Category	**Input**	**Quantity**	**Costs (Birr)**	**% Borne by land users**	**Quantity**	**Recurrent costs (Birr)**	**% borne by land users**
Agricultural	Seedlings (No.)	500	58	100	50	30	100
Materials	Stone (m^3)	750	83		20	12	
Equipment	Tools	5	6				
Labor	Person days	200	236		50	30	
Total		383	383			72	
			40 US$			8 US$	

Cost recovery period of investment in soil and water conservation technologies
The Crop is Sorghum

Cost (Birr)

Year	**1**	**2**	**3**	**Input**				**Harvest**	**Total cost**	**Benefit**	**Net profit**
				4	5	6	7				
1	288	-	39	-	10	8	4	8	357	300	-57
2	95		39	-	10	8	4	8	256	350	56
3	95		39		10	8	4	8	164	380	216
4	50		39		10	8	4	8	115	400	285
5	0		39		10	8	4	8	69	550	481
Total	528		195	-	50	40	20	40	961	1164	981
									100 US$		100 US$

Note: 1 = Construction and maintenance cost, 2= Recurrent cost, 3= Land preparation, 4= Fertilizer, 5 = Manure application, 6= Seeds, 7= Herbicides, 8= harvest (production q/ha), 9= total cost, 10 = benefit, 11= net profit

The most important factors affecting the cost are slope and soil depth. Costs have been calculated on the basis of length of structure per ha of land treated.

Benefits, advantages and disadvantages

Estimates of production

With or without SLM	Main plant	Production (t/ha/yr)
Without	Sorghum	4
With		8

Information mainly based on estimates

The indigenous SLM practice started long ago and the introduced SLM technologies require 2 years to stabilize and then enhance land productivity improvement.

On-site and off-site benefits

Production and socio-economic benefits		**Socio-cultural benefits**	
Crop yield increase	High	Community institutions strengthening	High
Fodder production/quality increase	Medium	Improved knowledge SLM/erosion	Moderate
Wood production increase			
Farm income increase	High		
Ecological benefits		Off-site benefits	
Soil cover improvement	Medium	Reduced downstream flooding	High
Increase in soil moisture	High	Increased stream flow in dry season	
Increase in soil fertility	Negligible	Reduced downstream siltation	
Soil loss reduction	High		
Production and socio-economic disadvantages		Ecological disadvantages	
Loss of land	Medium	Water logging	Negligible
Increased labor constraints	High		
Increased input constraints	Little		

Socio-cultural disadvantages
Socio-cultural conflict is little due to some disagreements caused as a result of placing cutoff drains. This conflict can easily be resolved by planning at a community level for cutoff drains and similar activities that require community agreement and decisions.

Economic analysis
No data is available on the economic returns resulting from conservation measures. However, the gross production value in (US$) per hectare per year around the SLM Technology area, without SLM is less than 100 / ha / yr. With SLM Technology, the gross production value of the land per hectare per year is 300 US$ / ha / yr. Compared to the situation without conservation the percentage gross production value increase 10 years after implementing SLM is over 100% considering also the land occupied by conservation measures and in assuming current input and prices.

Adoption and adaptation
Land users modify the stone bunds during maintenance and narrow the width of the bund in order to minimize the land that is occupied by the bund. About 100 % of land users have implemented the technology, wholly voluntarily, without any incentives other than technical guidance. They are about 3200 land user families. There is a growing trend towards spontaneous adoption of the technology. Farmers in the nearby villages are gradually adopting lessons learned from farmers who have implemented the technology. As a result the technology is rapidly expanding in the area.

There is enough local skill and support to expand the SLM Technology. Most farmers have the required skill for laying out and constructing the bunds. This means that they can provide support to other farmers that need assistance to get the bunds constructed on their plots.

It has high durability. The technology is suitable to sub humid and semi-arid climatic conditions having steep to very steep cultivated lands. It is suitable to most annual cereal crops, perennial crops, fruit trees and cash crops. The technology is also recommended to humid and semi-humid climates with eroded hill-slopes of shallow soils where stone is available for construction. Lack of means for transporting seedlings, low survival rates, and unavailability of proper planting material and livestock interference are hindrances for proper establishment.

Maintenance
Land users properly maintain and manage the bunds whenever there is need and wherever the structures are damaged

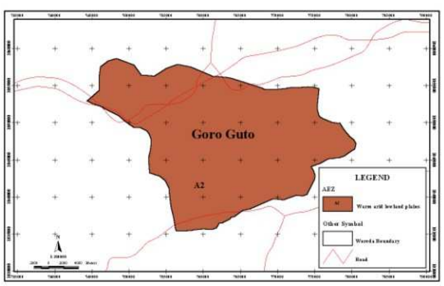
Strength	**Improve**
Reduction of slope degree	Frequent maintenance and avoid open grazing
Increase soil depth	Frequent maintenance and avoid free grazing
Weaknesses	Overcome
Conflicts	Discussion and resolving the deputes
Loss of land for few years	Make bund area productive

Supportive measures: Cutoff drains and waterways

Stone faced bunds for hillside plantations in West Harerghie (photo 2003)

22. Stone faced soil bund (Harerghie)

Common Name of SLM Technology: Stone Bund
Local or other names: Daaga Dhakaa (Oromifa)
Associated Approach: Food for Work
Contributing SLM specialist: Bekele Mamo, Office of Agriculture and Rural Development, Deder, Oromia
Area information
Basin: Wabi shebele river Basin
SLM Technology area: 100.6 sqkm



Agroecology of Deder Woreda

Location of Deder Woreda

Definition

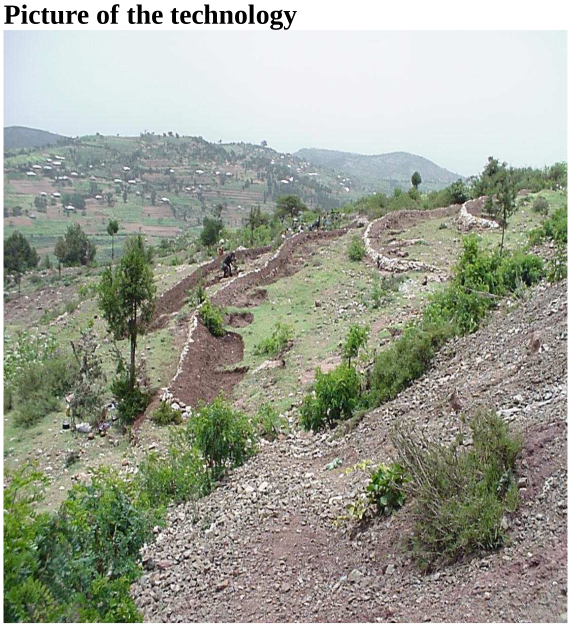
Stone faced bund is an embankment constructed along the contour to reduce soil erosion, harvest water and improve production.

Description

It is a structural measure constructed partly from stone on the downslope side and partly soil bund and is aligned along the contour. Stones are placed on a foundation dug along a contour line. A small ditch is placed on the upper side where rainwater is to be stored. The ditch on the upper side of the embankment has ridges placed at 10 m interval to control flow concentration and direct runoff to only one direction and is meant to enhance deep percolation of runoff water. A berm of about 15 cm is left between the embankment and the channel. The purpose is to control soil erosion, increase soil moisture, reduce slope length and steepness and thereby improve land productivity. It has dimensions of 0.5-0.6 m height, 0.5 – 1 m bottom width and a channel 0.3 m deep. It is spaced at 1 m vertical interval in gentle slopes and 1.5 – 2 m on steep slopes.

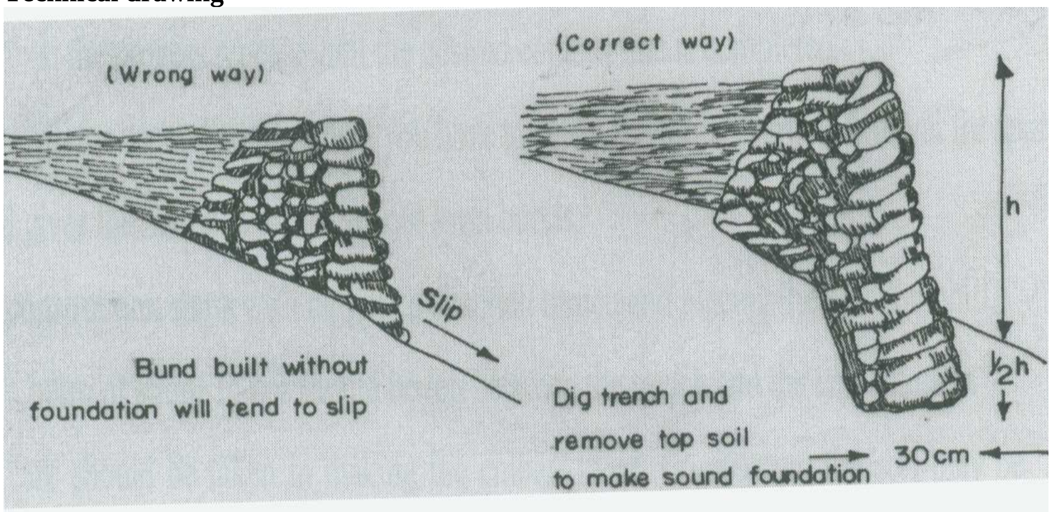
It is constructed on all slopes except level land where there is low risk of soil erosion. Stones are placed on the lower side of the bund to reinforce the earth embankment placed on the upper side. The soil embankment is lightly compacted during construction and later planted with useful trees or fodder grass. It is applicable in areas where land degradation is serious and stone is readily available.

Picture of the technology



Stone faced Soil bund with a ditch upslope to trap rain water and runoff (Photo 2005)

Technical drawing



Land degradation

Types of land degradation on the land surrounding the SLM area

Land use	**Type of degradation**	**Degree**	**%**	**Landform**
Cropland	Water erosion	m	15	F, H

Land use problems in the area without SLM: Population pressure, land fragmentation, small land holding, land taken by the structures.

Characterization and purpose

The technology combats land degradation through: Control of dispersed runoff, control of concentrated runoff, reduction of slope angle and increase of infiltration . The technology is intended to provide significant off-site benefits as well by reducing runoff that may have negative effect on the down-slope cultivated lands and properties.

The technology is best described as program implemented. The SLM Technology is mainly new, including indigenous elements. The technology is the outcome of national and international experiences put together. Traditional SLM Technologies have been used before the current SLM Technology was introduced. Traditional technology is established from stone walls. The aim of the technology is to control erosion, harvest water and trap sediment. Today, the traditional SLM is continued and maintained. The appearance of the applied technology has moderately changed over time.

Specification of vegetative measures

Type and layout of vegetative measures (m)

Vegetative measure	**Material**	**Plants /ha**	**Between rows / strips / blocks**	
			Vertical interval	Spacing
Aligned : contour	Grass	20000	0.1	0.15

Desho grass is introduced from Southern Ethiopia and it is found to be very effective in controlling soil erosion. It is fast growing and liked by animals since it is easily palatable. Constraints during establishment include: erratic rainfall and free grazing. Possible improvements are encouraging cut and carry, fencing, introduce other multipurpose plant species in order to increase the productivity of land per unit area.

Specification of structural measures
Type, alignment and dimensions of structures (m)

Measure	Material	Vertical interval	Spacing	Embankment			Channel		
				D	W	L	H	W	**l**
Level bund	stone	1.5	10	0.5	0.5	80	0.75	0.75	80

D= depth, W = width, L= length, and H = height

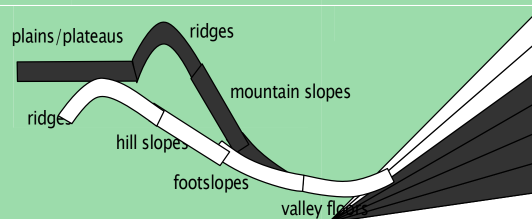
The spacing of terrace is based on the conventional methods used to determine vertical interval and also by taking into account the importance of considering the interests of the land users. In some cases the spacing of the terrace is dependent on the topographic conditions of the land. Strong terrace wall and stable foundation facilitate fast development of the terrace Constraints during establishment include: slope of land, labor, and shallow soils. Possible improvements are: control free grazing; improve the quality of the work every year.

Natural Environment

Average annual rainfall (mm)
>4000
3000-4000
2000-3000
1500-2000
1000-1500
750-1000
500-750
250-500
less than250

Altitude (m a.s.l.)
>4000
3500-
3000-
2500-
2000-
1500-
1000-
100-500
less than250

Landform **Slope (%)**



very steep (>60)
steep (30-60)
hilly (16-30)
rolling (8-16)
moderate (5-8)
gentle (2-5)
flat (0-2)

Soil depth (cm)
0-20
20-50
50-80
80-120
less than120

Growing season:
Soil fertility: low, medium, very low
Soil texture: medium (loam), fine (clay), coarse (sandy
Surface stoniness: some loose stone, abundant loose stone, no loose stone
Topsoil organic matter: low (less than1%), medium (1-3%)
Soil drainage: medium, good
Soil erodibility: medium, high

Information on the natural environment where the technology is applied
Number of erosive water storms per year is over 15. Rainfall in the growing seasons is usually sufficient and not well distributed for the main season and insufficient and not well distributed for the second season. The number of growing seasons per year is 2.

Human environment and land use
The typical household size of the land users is 5 persons. Population density is 100-200 persons/km^2 and the annual population growth is 2.7%. Land size per household is showing a decreasing trend

owing to population pressure and land fragmentation. Land ownership and land use rights affected SLM strongly. The ownership is not clearly defined; therefore farmers are not committed to invest on SLM activities due to suspicion that there will be land redistribution. Subdivision of land has similarly affected the implementation of the SLM Technology strongly.

There is a marked difference between the better-off and poor in how they practice SLM. The rich practice SLM activities by themselves whereas the poor needed incentives. Off-farm income is less than 10% of all income for the land users who apply the SLM technology. However, land users continue to appreciate getting incentives of FFW. About 95% of land users cannot read and write. Nevertheless, this has not hindered implementation because SLM specialists make the technology design that is agreed by the land users.

Crop and livestock production

Land cultivation is performed mainly by animal traction and also by manual labor. Intercropping is practiced and crops intercropped are beans or haricot beans with maize or sorghum.

Animals

Large stock	**Cattle, donkey, horse, mule**
Small stock	Sheep and goat

The current trend in herd types is more small stock. This is because of shortage of grazing land. The number of livestock units per household is 4 small stock and 3 large stock. The current trend in livestock numbers shows slight reduction. The reason is that livestock production is not integrated with other agricultural development and environmental protection activities. Grazing land size is getting reduced from time to time. Livestock production in not supported with improved management systems, which include controlled grazing and cut and carry.

Benefits, advantages and disadvantages

Estimates of production

With or without SLM	Main plant type	Production (q/ha)
Without SLM	Maize	15
With SLM	Maize	33

I*nformation mainly based on estimates*

At the establishment of the technology, yield increment was insignificant but through time the impact of SLM was clearly seen. The role of the technology is not only saving the soil but it also helped in protecting seeds and fertilizers from being washed away by runoff.

Benefits

<table>
<tr><th colspan="2">Production and socio-economic benefits</th><th colspan="2">Socio-cultural benefits</th></tr>
<tr><td>Crop yield increase</td><td>High</td><td>Community institution strengthening</td><td rowspan="2">High</td></tr>
<tr><td>Fodder production/quality increase</td><td rowspan="2">Medium</td><td>Improved knowledge SLM/erosion</td></tr>
<tr><td>Wood production increase</td><td></td><td></td></tr>
<tr><td>Farm income increase</td><td>High</td><td></td><td></td></tr>
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Ecological benefits		Off-site benefits	
Soil cover improvement	Medium	Reduced downstream flooding	High
Increase in soil moisture	High	Reduced downstream siltation	
Efficiency of drainage	Negligible		
Increase in soil fertility	Medium		
Soil loss reduction	High		
Biodiversity enhancement	Negligible		
Production and socio-economic disadvantages		**Ecological disadvantages**	
Loss of land	Medium	Water logging	Negligible
Increased labor constraints	High		
Increased input constraints	Little		
Hindered farm operations	Negligible		


Ground water recharge as a result of SLM technology in the area (photo 2004)

The technology should be improved to achieve more benefits by increasing effectiveness. Its sustainability also will increase if it is supported with land use policy, free grazing is controlled, SLM rules and regulations established and effected by land users and clearly defined land user rights and ownership is in place.

Production and socio-economic disadvantages

Disadvantage	Extent	Improve
Loss of land	Little	Use the area occupied by structures for production of fodder and fruit trees
Increased labor constraints	Negligible	Farming operation
Hindered farm operations	Little	Spacing of structures

Economic analysis

Without SLM the gross production value in US$ per hectare per year around the SLM Technology area is 200 / ha / yr. With SLM Technology the gross production value of the land per hectare per year is 460 US$ / ha / yr. Compared to the situation without conservation percentage gross production value increase in 10 years after implementing SLM is over 100% considering also the space occupied by conservation measures and assuming current input and prices.

Adoption and adaptation

Changes have been made to the technology in the process of adopting stone bunds and planting Desho grass on the bund and by increasing the height of bunds. About 90% of land users that have applied the SLM Technology have done it with incentive in 75% of the technology area. But 25% of land users that have applied the SLM Technology have done it wholly voluntarily, without any incentives other than technical guidance.

Maintenance

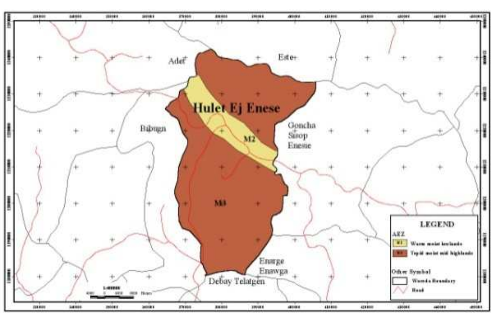
Land users have adequately maintained and managed what has been implemented. They maintain the terraces at least once a year, before the cropping seasons.

Graded bunds placed in alternating arrangements (Photo 2003)

Cutoff drain leading to a waterway (Photo, Daniel Danano 2001)

23. Graded bunds with disposal structures (East Gojjam)

Common Name of SLM Technology: Graded Soil bund
Local or other name(s): Tedafatama Yafer Erkenen / Feses (Amharic)
Associated Approaches: Local Level Participatory Planning Approach
Contributing SLM specialist: Ahmed Muhamed, Woreda Agricultural and Rural Development Office, Amhara Region, Hulet Eju Enese
Date: 2005 Updated: 2007
Area information
The area in which the SLM Technology has been applied
Country: Ethiopia
Basin: Abay basin



Agroecolgy of HultEju Enese Woreda

Location of Hulet Eju Enesse Woreda

Graded soil bund is applied in combination with cutoff drain, waterways and tree plantations.

Definition

It is a bank of soil aligned on a graded contour and stabilized with grasses, trees or shrubs.

Description

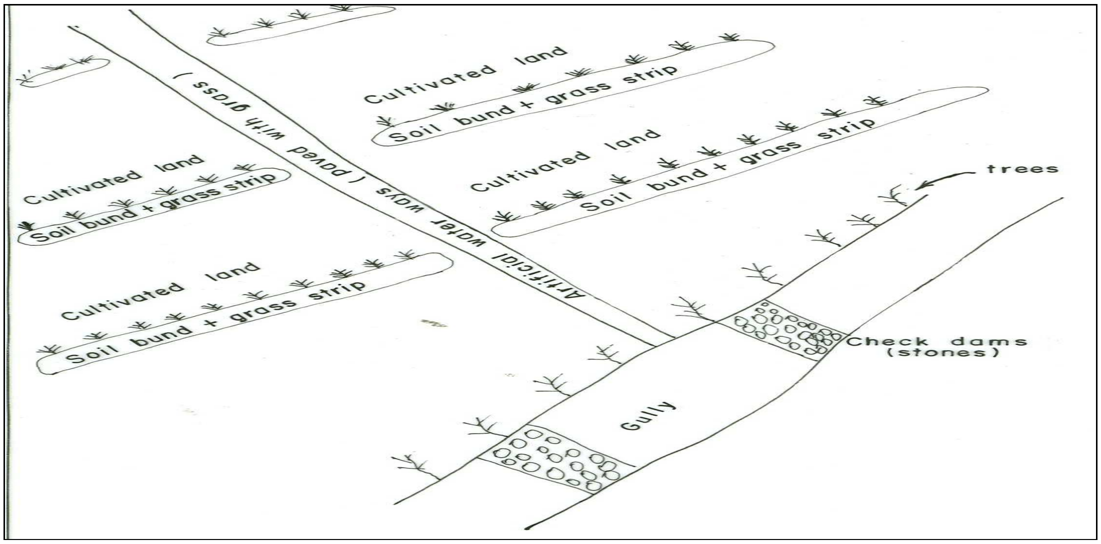
The technology encompass an embankment of earth laid out on graded contour line across the slope, cutoff drains constructed at a given interval, waterways for disposing runoff from the bunds and cutoff drains, vegetative measures and agronomic practices on cultivated lands implemented in combination on and around cultivated fields. The graded bunds are laid out on a gradient of 1 % in order to safely drain excess water. The immediate result expected is control of soil erosion, well-drained soils, controlled land degradation, decreased slope length and inclination and improved land productivity.

Maintenance is regularly done by removing silt from the channel and repairing the breached parts of the bunds/ banks and also stabilizing the bund by planting vegetation. The technology is suitable to high rainfall areas where crop fields experience seasonal water logging. The surplus water needs to be drained by means of graded channels of smaller gradients. The channels should be properly constructed so that no channel scour or sediment deposition takes place. Cutoff drains need to be placed at a given interval to reinforce the graded bunds. Waterways are paved with stone to avoid channel scour because of the higher gradients involved in a waterway construction.

Picture of the technology

A waterway constructed to convey runoff from terraces and cutoff drains

Technical drawing



Technical function

Main	Secondary
Control of concentrated runoff (retain/trap) Control erosion	Discharge excess water from cropland

Land degradation

Types of land degradation on the land surrounding the SLM area

Land use	Type of degradation	%	Landform(s)
Mixed land	Water erosion	22	P
Forestland		42	
Grazing land		25	
Cropland		95	
	Chemical deterioration	85	
Other lands	Water erosion	30	

The major land use problems in the area without SLM are expansion of gullies, loss of topsoil, fertility decline, and poor land productivity and free grazing.

Characterization and purpose

Land use types	% total area utilized
Cropland: annual cropping	94
Grazing land: extensive grazing	1
Mixed land: agro forestry	4
Other land settlements, infrastructure network	1
Total	100

The technology combats land degradation through: Control of concentrated runoff, improving drainage and safely dispose excess water from cropland. It controls dispersed runoff and retards flow velocity of concentrated runoff and then reduces erosion on the downstream cultivated lands.

Status

The technology is best described, as program implemented. The SLM technology is new to the area (introduced in the last 20 years). The technology was practiced by land users before but not designed properly. It is the result of improving the traditional practice by including some improved techniques. The indigenous technology consists of a furrow made by oxen plow to convey excess water from cultivated fields. The furrows are sometimes made along the slope and in some cases diagonally.

The aim of the indigenous technology is to remove excess water that is received in excess of the infiltration capacity of soils. Today, the traditional SLM is still used but is being replaced by improved techniques which are laid out on graded contours. Traditional farmland furrows are put every year and no maintenance is required. The furrows that were made in the previous year are plowed up and new furrows made after planting. Some land users are more skilled in making furrows of gentle gradients and these furrows drain runoff safely without any risk of erosion caused on the furrows. Others make steep furrows along steep slopes and these cause gullies. Shorter furrows are more effective than longer furrows. The current SLM technology is designed by national and regional specialists and the woreda technicians train land users and monitor the activities.

Conservation based agricultural extension strategy should be pursued and farmers need to be encouraged to manage their land, adopt improved technologies and undertake income generating non agricultural activities.

Specification of vegetative measures

Type and layout of vegetative measures (m)

Vegetative measures	Material	Plants per ha	Vertical interval	Spacing	Interval	Width
Graded strips	Trees/ shrubs	4000	1	20	0.25	0.5
Scattered dispersed	Trees/ shrubs	3000		10	1	1

Construction and maintenance

I) Field activities for agronomic measures			
Activity	**Energy**	**Equipment**	**Timing**
Contour tillage	Animal traction	Local plough	Dry season
Relay cropping			After 1st harvest each cropping season
Manure application	Manual labor		After 1st tillage
Mineral fertilizer			During planting
II) Establishment activities for vegetative measures			
Collecting seedlings/seed	Manual labor	Hoe, shovel	Onset of rain
Transplanting/sowing		Hoe	Rainy season
Planting		Hoe, shovel	

III) Maintenance activities for vegetative measures			
Fencing	Manual labor	Hoe	During harvesting
Replanting		Shovel, hoe	Rainy season
Pollarding	Manual labor		Before rains
IV) Construction activities for structural measures			
Lay out	Manual labor	Line level	Dry season
Construction		Shovel, hoe	
Planting on structures			Rainy season
V) Maintenance activities for structural measures			
Cleaning ditches	Manual labor	Shovel, hoe	Onset of rains

Vegetation established on the bunds is used for livestock feed and for fuel. Some of the vegetative species planted on structural measures and on hillsides have helped in improving soil fertility. Important constraints during establishment are shortage of seeds and free grazing and constraints during maintenance include free grazing, shortage of materials for fencing and the seedlings raised in the nurseries are not in the interest of land users. Possible improvements are controlled grazing, improved livestock management, establishment of community nurseries, and incentives to farmers to encourage them to manage their lands properly.

Specification of structural measures

Type and layout of vegetative measures (m)

Structure	Material	Vertical interval	Spacing	Ditch		Bank		
				Depth	Width	Length	Height	Width
Diversion ditch	Earth/stone	50	500	0.5	1	250	0.8	250
Waterway	Earth/stone /wood		200	0.7	3	500	0.8	500
Bun/bank	Stone	1-2.5	20	0.3	0.5	150	0.75	150

Most of the structures are graded and they should be integrated with cutoff drain and waterways. Natural waterways such as protected gullies and rivers are to be stabilized to be used as waterways or artificial waterways need to be constructed. Important constraints during establishment: lack of trained manpower and surveying equipments, shortage of land forced the farmers to reduce the original dimensions of the structures.

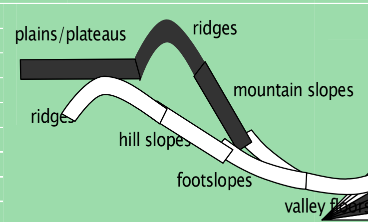
Land users have not maintained the bunds on regular basis and hence cleaning the ditches, cutoff drains and waterways will be of extreme importance. Possible improvements are: encouraging land users to maintain bunds after heavy storms, provision of hand tools to land users and enforcing the existing laws and regulations on land use and management.

Specification of management measures
Availability of labor determines the amount and quality work and getting it done in time.

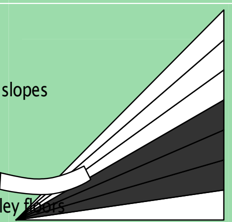
Natural Environment

Average annual rainfall (mm)	Altitude (m a.s.l.)
>4000	>4000
3000-4000	3500-
2000-3000	3000-
1500-2000	**2500-** (marked)
1000-1500 (marked)	**2000-** (marked)
750-1000	1500-
500-750	1000-
250-500	100-500
less than250	less than250

Landform



Slope (%)



Soil depth (cm)

- 0-20
- **20-50** (marked)
- **50-80** (marked)
- **80-120** (marked)
- less than120

Growing season:
Soil fertility: low (less than1%) use of chemical fertilizer is increasing every year
Soil texture: poor, medium
Surface stoniness: no stoniness
Topsoil organic matter: moderate
Soil drainage: poor, medium
Soil erodibility: medium, low
Soil moisture holding capacity: high

Number of erosive storms of water per year is less than 10. They occur in the beginning of growing season. The rainfall in the growing season is usually sufficient and well distributed. Number of growing seasons per year is 1.

Human environment and land use
Typical household size of the land users is 4 persons. Population density is 200-500 persons/km^2 and annual population growth is 2-3. The trend in land size per household is decreasing. Land ownership and land use rights did not affect SLM. All land users are required to apply appropriate SLM according to local rules. Land users have never felt that land is state owned and they do not practice SLM but use traditional drainage furrows, which are often causes of gullies. Subdivision of land did not affect the implementation of the SLM Technology. No further reallocation of land will take place in the future according to the Regional Land Use and Land Administration law. There is little difference between the rich and poor in how they practice SLM. Most poor farmers do not plant on bunds because they do not have livestock.

Off-farm income is less than 10% of all income for the land users who apply the SLM technology. Farmers have so far not been engaged in any form off-farm activities. Level of technical knowledge required for implementation of the technology is high for extension workers and moderate for land users.

The use of the SLM Technology is slightly hindered, when land users cannot read and write. 53% of land users cannot read and write. Production is not subsidized.

Crop and livestock production
Land cultivation is performed by animal traction using local plough and manual labor

Type of cropping system and major crops

Water supply	Type of cultivation
Rain fed	Fallow
Mixed rain fed - irrigated	Continuous cropping

Intercropping is practiced. Continuous growing of teff on the same plot of land aggravated soil erosion. Organic fertilizers (manure and dung) are used only at backyards.

The current trend in herd types is more of large stock, which is needed by land users for farming and market. The number of livestock units per household is 3 small stock and 4 large stock. The current trend in livestock numbers shows slight reduction. Livestock production is decreasing because of reduced grazing land and its productivity.

Costs and economic analysis
Cost (US$)

Category	Input	Establishment cost			Recurrent cost		
		Quantity	Cost	% borne by land users	Quantity		% borne by land users
Agricultural	Fertilizer (kg)	150	55	100	150	55	100
	Seeds (kg)	12	100	40	12	100	
Equipment	Oxen days	32	37	100	244	34	100
Labor	Person days	176	99	100	95	54	100
Total			203	100	155	100	

Duration of establishment phase is 2 years. Tools used are shovel, spade and local digging tools. The most important factors affecting the costs are labor and slope. Costs are calculated on a hectare basis. Construction cost is for the first year and recurrent costs are calculated starting from the second year for the same plot of land and the same production system. Daily wage cost of hired labor to implement SLM is 0.95 US $ per person per day.

Economic analysis
Without SLM, the gross production value per hectare per year around the SLM Technology area is 150 US$ / ha / yr. With SLM Technology, the gross production value of the land per hectare per year is 250 US$ / ha / yr. Compared to the situation without conservation the percentage gross production value increase in 10 years after implementing SLM is over 60% considering also the land occupied by conservation measures and assuming current input and prices.

Benefits, advantages and disadvantages

Estimates of production

With or without SLM	Main plant	Production (t/ha/yr)	Runoff as percent of annual rainfall
Without SLM	Teff	5	50
With SLM		7	30

Soil depth and color of the soil: The soils in the SLM area are brown in color and the soil without SLM is grey in color.

On-site and off-site benefits

I) Production and socio-economic benefits	Degree	III) Socio-cultural benefits	Degree
Crop yield increase	Little	Community strengthening	Medium
Fodder production/quality increase	Negligible	Improved knowledge SLM	High
Farm income increase	Little	**IV) Other benefits**	
II) Ecological benefits		Land border security is high because bunds are boundary of farm plots	
Soil cover improvement	Medium	**V) off-site benefits**	
Increase in soil moisture		Reduced flooding	Medium
Efficiency of excess water drainage		Increased stream flow	Little
Increase in soil fertility	Little	Reduced downstream siltation	Medium
Soil loss reduction	Medium	Reduced river pollution	Little
Biodiversity enhancement			

Adoption and adaptation

The use of a vertical interval of 1 m for spacing bunds has resulted in narrow terraces, which hindered farm activities. That is not appreciated by land users. Technical people involved in the design and layout should discuss with farmers and agree on the spacing of bunds and dimensions of the measures.

The SLM Technology is designed in such a way that it moderately allows changes by the land users to adapt to changing land use practices. Previous bunds were narrow and created difficulties when cultivation is done by oxen. Now, after consultation with farmers and by applying graded bunds the spacing is made wider and as a result cultivation by oxen is not a problem. Land users have implemented the technology without incentives. About 100 % of land users that have applied the SLM Technology have implemented it wholly voluntarily, without any incentives.

There is a moderately positive trend towards growing spontaneous adoption of the technology. In the SLM area more than 75% of the households have adopted the technology. They make soil bunds by supporting them with stonewalls to increase stability of bunds. There is enough local skill and support to expand the SLM Technology. Land users are able to implement the technology with little external support. It is durable but requires frequent maintenance.

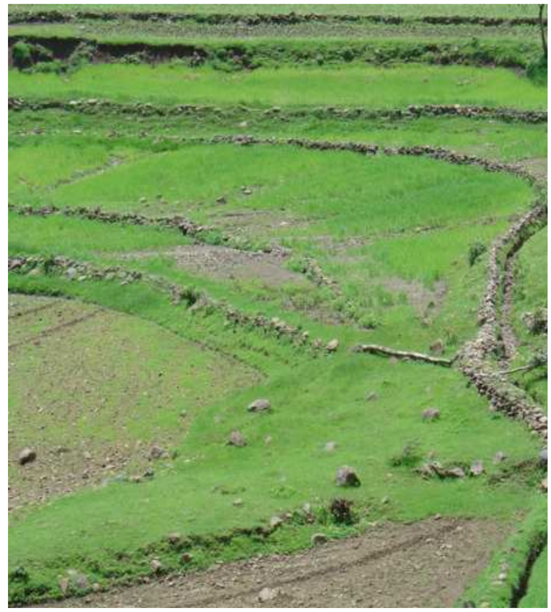
Maintenance

Land users have adequately maintained and managed what has been implemented. Maintenance is carried out once a year.

Strength	Improve
Provides adequate control of loss of top soil and water and enhances development of terraces	Follow proper layout and integrate with other production improving techniques
Sufficient soil moisture retention in the lower altitudes.	Protect the land from soil erosion
Weaknesses	**Overcome**
Land area is occupied by bund (Loss of land)	Increase the productivity of land per unit area by planting fruit trees, fodder plants on the bunds Use the bund area for productive uses
Rodent and pest problems	Use mechanical means to avoid the problem
Invasive grasses are easily multiplied	Proper management (weeding and cut and carry) of grasses could solve the problem

Supportive measures

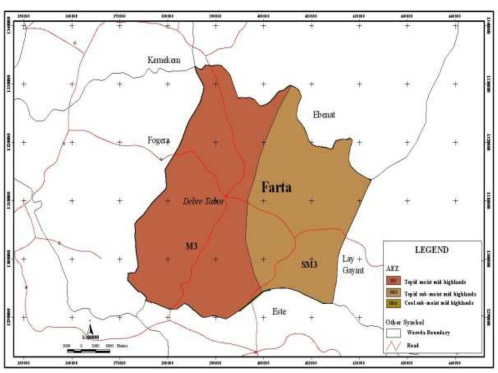
Measures	Description
Cutoff drain + plantation	Carry water from graded bunds
Waterways + checkdam	Natural waterways are planted with grass to avoid scouring
Contour farming + raw planting	Plots between bunds are contour cultivated



Waterways for disposing discharge coming from cutoff drains and graded terraces (Photo , 2004)

24. Paved and grassed waterways (Farta)

Common Name of SLM Technology: Paved and grassed waterways
Local or other name(s): Feses (Amharic)
Associated Approach: Incentive Based Participatory Approach
Contributing SLM specialist: Anley Goshie Haile, Agricultural and Rural Development Office, Farta Woreda Agricultural and Rural Development Office, Amhara Regional state
Date: 16/10/2005 Updated: 2007
Basin: Abay / Nile
Total SLM Technology area: The technology is practiced in 34 Kebeles in the Woreda (1500 sq km).



Agrecology of Farta Woreda

Location of Farta

Soil erosion, flood, decline of production and productivity are problems addressed by establishing waterways. The technology is suitable to areas receiving high rainfalls.

Definition

A waterway is an artificial drainage channel constructed along the steepest slope to receive runoff from cutoff drains and graded structures to drain it to natural drainage systems safely.

Description

A vegetative waterway is constructed in areas where stone is not available. They are suitable for gentle slopes. Paved waterways are suitable to steeper slopes and in areas where construction material (stone) is available. A waterway carries excess water to the river, reservoirs or gullies safely without creating erosion. It is applicable in areas where excess water is generated, during heavy rains which are beyond the intake capacity of soils. The excess water is disposed safely to natural outlets. Waterways are established a year or two before cutoff drains and field structures are constructed. Vegetative waterways are formed by digging earth channel across the contour in the direction of flow. After making the channel, suitable grass species are planted or are established naturally. Maintenance is very important in waterways management. Short growing grass is ideal particularly on the waterway bed. Regular maintenance is required by repairing breaks in the channel or an embankment, removing the silt deposited or keeping the grass shorter in order that it does not obstruct flow which is important for proper functioning of waterways. Vegetative waterways are stabilized by planting short growing grasses, sodding or in allowing natural growth.

Waterways are helpful to convey runoff from traditional ditches, terraces and cutoff drains, constructed for erosion control. The implementation of cutoff drains and waterways has improved the effectiveness of soil and water conservation measures implemented in high rainfall areas. National specialists provide training to technical staff and the local experts monitor and evaluate the activities.

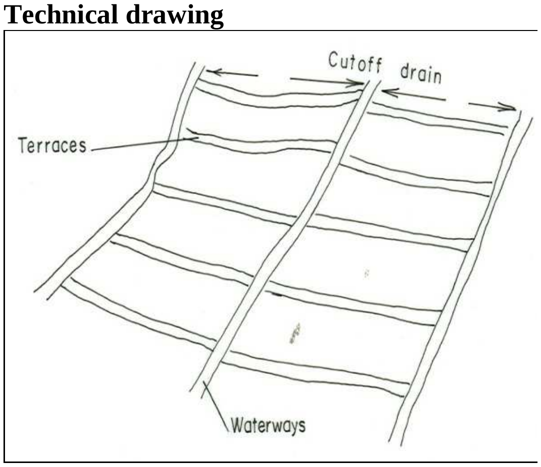
Traditional waterways have been practiced in the technology area and could be defined as grassed shallow runoff path constructed along the steepest slope. The aim of the traditional technology is to convey runoff from traditional ditches, banks and drains placed to control soil erosion. Today the traditional SLM is used less because of the introduction of cutoff drains and waterways, which are improved techniques. National specialists designed the technology and trained technical staff. Local experts monitor, evaluate the activities and train farmers. Land users make the layout and undertake actual construction work. The appearance of the applied technology has gradually changed over time from traditional ditches to graded terraces, improved cutoff drains and waterways. Constraints include open grazing, labor constraints and the possible improvements include working by group, keep away livestock from entering into the areas treated by the technology.

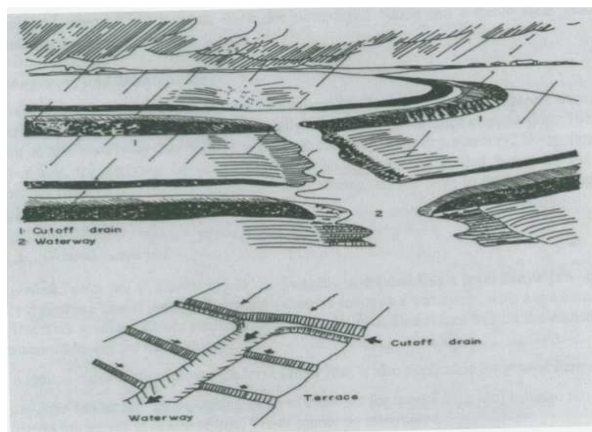
Picture of the technology

A small stone paved waterway along farm boundary in North Wello (photo 2004)

A natural waterway stabilized by stone riprap and checkdams, south Gonder (photo 2004)

Technical drawing





Technical functions

Main	Secondary
Control of dispersed runoff Convey safely surplus water to outlets	Control erosion

Land degradation

Types of land degradation on the land surrounding the SLM area				
Land use(s)	Type of degradation	%	Degree	Land form
Grazingland	Water erosion	45	m	R,F
Cropland		80	s	MH

Source of data: Observation and Woreda Office Documents

Purpose and classification

Major land use problems in the area without SLM are: soil erosion, flooding, decline of production and productivity. Shortage of feed and fodder and low productivity are problems identified by from land user's point of view. The technology consists of structural and vegetative measures. The technology combats land degradation through: control of dispersed runoff, control of concentrated runoff. The technology is best described as project implemented. The SLM Technology is mainly new, including indigenous elements. The technology has been introduced and farmers have been experiencing similar practices before.

Specification of vegetative measures

Type and layout of vegetative measures (m)

Vegetative measures	Material	Plants per ha	Vertical interval	Spacing	Interval	Width
Graded strips	Grasses	5000	1	20	0.25	0.5
Scattered	Trees/shrubs	500		10	1	1

The technology is applied in a wide range of slopes. The use of grass and vegetation in waterways is commonly practiced by farmers.

Specification of structural measures (m)

Structure	Material	Vertical interval	Spacing	Ditch		Bank		
				Depth	Width	Length	Height	Width
Cutoff drain	Earth	50	200	0.5	1.5	200	0.4	1
Waterway	Earth/stone	--	500	0.5-0.6	4-6	500	0.8	2-4

Paved waterways are more suitable in steeper terrains and in areas where stones are available. Constraints during construction / establishment: lack of skill, stone, lack of construction materials. Possible improvements include training and proper planning, and specification of management measures.

Establishment and maintenance activities for management measures

I) Establishment activities for vegetative measures			
Activity	**Energy**	**Equipment**	**Timing**
Produce planting material	Manual labor	Hoe, shovel	Onset of rain
Planting		Spade, hoe	During rain
II) Maintenance activities for vegetative measures			
Replanting	Manual labor	Spade, hoe	
Fencing		Hoe	
III) Construction activities for structural measures			
Stone collection	Manual labor	Hand	January-March
Gully reshaping		Hoe	January-March
Dig foundation		Hoe, spade	After crop harvest
Construction		Hand	
Fencing		Axe and hoe	
IV) Maintenance activities for structural measures			
Stone collection Undertake repairs on breach	Manual labor		
V) Establishment activities for management measures			
Fencing (live trees or wood)	Manual labor	Axe, hoe	Dry season
VI) Maintenance activities for management measures			
Repairing fence		Axe, hoe	Dry season

Important constraints during establishment: labor, planting materials for maintenance. Possible improvements may consider getting planting materials ready and undertake the construction by group.

Natural Environment

Average annual rainfall (mm)

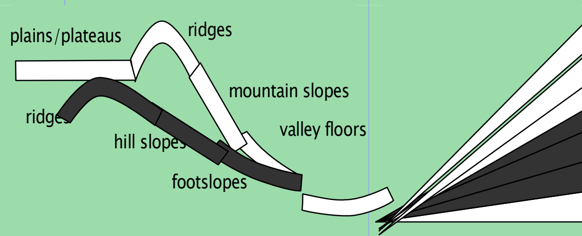
- >4000
- 3000-4000
- 2000-3000
- 1500-2000
- 1000-1500
- 750-1000
- 500-750
- 250-500
- less than250

Altitude (m a.s.l.)

- >4000
- 3500-
- 3000-
- 2500-
- 2000-
- 1500-
- 1000-
- 100-
- less than250

Landform

Slope (%)



- very steep (>60)
- steep (30-60)
- hilly (16-30)
- rolling (8-16)
- moderate (5-8)
- gentle (2-5)
- flat (0-2)

Soil depth (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- less than120

Growing season:
Soil fertility: low, medium
Soil texture: fine (clay), medium (loam), coarse (sandy)
Surface stoniness: some loose stone, no loose stone
Topsoil organic matter: low (less than1%)
Soil drainage: medium, poor
Soil erodibility: medium , high

Number of erosive water storms per year is less than 10. They mainly occur at the beginning of growing season.

The technology is applicable in all agro ecological zones, particularly in moist areas and areas prone to water logging. High runoff is produced in the highlands, owing to steep slopes (low intake rate) high intensity of rains and low evaporation losses.

Human environment and land use

Typical household size of the land users is 5 persons. Population density is 200-500 persons/km^2 and annual population growth is 2.9 %. No change is observed in the trend in land size per household in the recent years after the last land relocation was made.

Land ownership and land use rights have greatly affected SLM. When the land user is titled he is encouraged to manage his land. Subdivision of land did not affect the implementation of the SLM Technology. No further subdivision of land is foreseeable.

There is a slight difference between rich and poor in the way they practice SLM. Off-farm income is less than10% of all income for the land users who apply the SLM technology. The level of technical knowledge required for the implementation of the technology is moderate for field extension workers and high for land users. The use of the SLM Technology is moderately hindered, when land users cannot read and write. 40% of land users cannot read and write. Land users who read and write practice better SLM activities.

Crop and livestock production

Land cultivation is performed by animal traction and manual labor. Cropping is rainfed and continuous. Fodder trees are planted on gully sides to stabilize the waterways.

Types of animals

Large stock	Cattle, horse, mule
Small stock	Sheep, goat

The current trend in herd types is more small stock. Changes are observed, and the reason given by the herd owners is that there is feed shortage. The number of livestock units per household is 1 small stock and 4 large stock. The current trend in livestock numbers shows slight reduction because of increasing tend in conversion of grazing lands for other land uses.

Benefits, advantages and disadvantages

On-site and off-site benefits

Production and socio-economic benefits		**Socio-cultural benefits**	
Crop yield increase	Medium	Community institution strengthening	High
Fodder production increase		Improved knowledge SLM/erosion	
Farm income increase	High		
Ecological benefits		Off-site benefits	
Efficiency of drainage	High	Reduced downstream flooding	Medium
Increase in soil fertility	Negligible	Increased stream flow in dry season	
Soil loss reduction	Moderate	Reduced downstream siltation	
Production and socio-economic disadvantages		**Ecological disadvantages**	
Loss of land	Low	Excessive drainage	Negligible
Increased labor constraints	High		
Hindered farm operations	Negligible		

Cost recovery period of investment in SLM technologies

Waterway (grass and stone) traditional. Crop =Teff.

Costs (Eth Birr)

Year	**Costs**							**8**	**9**	**10**
	1	2	3	4	5	6	7			
1	1125	135	45	29.70	300	224	29.70	1884.4	2145	-256.6
2	-	100	45	29.70	300	224	29.70	728.40	2255	+1526.60
3	-	85	45	29.70	300	224	29.70	713.40	2365	+1651.60
4	-	60	45	29.70	300	224	29.70	688.40	2475	+1778.6
5	-	50	45	29.70	300	224	29.70	678.40	2585	+1906.60
Total					1500	1120	148.5	4693	11825	6263.4

Note: 1= Construction, 2 = Maintenance, 3 = Tillage, 4= Seed, 5= Fertilizer, 6= Weeding and cultivation and 7= Tools, 8 = cost 9= benefit, and 10= profit

Economic analysis
Without SLM, the gross production value in US$ per hectare per year, around the SLM Technology area is about 150 /ha/yr. With SLM Technology, the gross production value of the land per hectare per year is over 250 US$ /ha/yr. This estimate takes into account production losses due to the area rendered non-productive because of the presence of the SLM measures. Current inputs and prices are assumed.

Compared to the situation without conservation, percentage gross production value increase 10 years after implementing SLM is over 65% considering also the land occupied by conservation measures and assuming current input and prices.

Adoption and adaptation
Changes that have been made to the technology are stabilizing the natural and manmade waterways by grass and or paving with stone. About 45% of land users that have applied the SLM Technology have done it wholly voluntarily, without any incentives other than technical support

There is a growing trend towards spontaneous adoption of the technology. Waterways require high labor and material, and therefore a poor farmer will find it difficult to implement the technology without external support. There is not enough local skill and support to expand the SLM Technology. There are trained technical people in the government offices that provide technical support for land users and some farmers have skill to them but since this requires high labor land users should be subsidized.

The technology is of high durability and longevity as long as timely maintenance is made. The SLM Technology is set up in a manner it will be durable, or can be easily maintained and kept in good shape.

Maintenance
Land users are able to partially maintain and manage what has been implemented, lack of proper follow up, and low incentives are however, constraints for expanding the Technology.

Strength and advantages

Strength	Sustain and improve
Fodder production and soil formation rate is enhanced	Make frequent maintenance
Moisture and water harvesting enhanced	Plant useful trees
Effective soil erosion control and prevention of gully erosion made possible	Plant more fodder trees ant more fodder trees

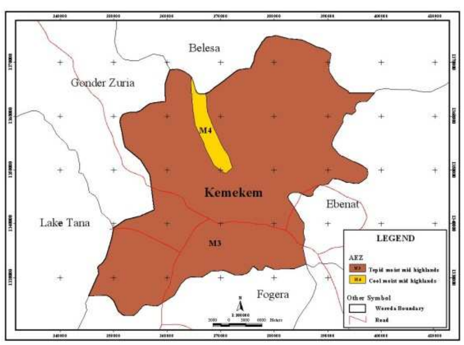
Supportive measures

Measure	Function
Area closure	Enhance natural regeneration
Cutoff drain	Reduce runoff inflow
Waterways	Dispose runoff safely
Fencing	Help in protecting assets created

Stone bund terraces on a severly degraded land, North Gonder (photo 2004)

25. Stone cum soil bund terraces (Gonder)

Common Name of SLM Technology: Stone terrace
Local name: Irken (Amharic)
Associated approach: Food for Work
Contributing SLM specialist: Mengistu Mergia, Libo Kemkem Agriculture and Rural Development Office, Amhara Region, South Gonder Zone, Libokemkem Woreda
Date: 18/10/2005 Updated: 2006
Area information
Total SLM Technology area: 120.51 Sqkm

	
Agroecology of Kemekem Woreda	Location of Kemekem Woreda

Definition
Stone terraces are developed from stone-faced bunds constructed on a cultivated land following the contour.

Description
Stone-faced bunds are laid out on a contour line of a zero gradient. First, a contour line is laid out using a line level. Trained land users known as contour markers lay out the contour. A small ditch is dug out following the contour line as a foundation for the stone bunds. The stone bunds have dimensions of 0.5 m – 1 m wide depending on the availability of stones or whether or not the stone

bund is supported by a soil embankment. The bunds have a minimum height of 0.50 m and can be as high as 0.75m. Excess water from the bunds is disposed by cutoff drains placed at intervals and most commonly placed above the bunds where slope changes occur and the water from the cutoff drains is disposed to natural waterways, which are protected by check dams and stabilized by vegetation. Earth bunds normally are planted with grass or trees.

When land slope is steeper the spacing between bunds becomes very narrow and to make it wider there will be a need to increase the bund height. Open grazing should be avoided on cultivated lands with stone bunds until the bunds become stable.

Technical functions

Main	**Secondary**
Reduce erosion, trap rainwater, increase infiltration, control concentrated runoff (retain/trap)	Reduction of slope length

Land use is mostly cropland with the dominant being annual cropping. Main crops: Teff, sorghum, millet. Agro-climatic regime: sub humid, semi-arid. Major land use constraints include land shortage, insufficient agricultural inputs, livestock and human diseases, shortage of clean water and lack of adequate public services.

Land degradation

Types of land degradation on the land surrounding the SLM area

Land use	**Type of degradation**	**Degree**	**%**	**Landform(s)**
Forest land	Water erosion	l		H
Grazing land		s	70	M
Cropland		s	80	F, M

Purpose and classification

Major land use problems in the area without SLM are overgrazing, land degradation, population pressure, low productivity and erosion. The technology combats land degradation through, control of concentrated runoff, reduction of slope length, control of dispersed runoff. The technology is intended to provide significant off-site benefits as well by protecting the downstream areas from flooding and sedimentation.

The technology is best described as a program implemented by the Woreda Department of Agriculture. The SLM Technology is new to the area (introduced in the last 20 years). The SLM technology comes from other regions, where the technology is implemented first. Indigenous SLM Technologies have not been used before the current SLM Technology was introduced. Contour tillage, traditional plough, planting bunds with sesbania and vetiver grass

Hedge rows of sesbania sesban on a cultivated land (photo 2005)

Vetiver strips along a contour on a cultivated land (photo 2005)

Layout of structural measures (m)

Structures	Material	Vertical interval	Spacing	Width	Length	Depth
Bund/bank	Earth/stone	0.5 -1	20	0.6-1	110	0.3-0.4

Specification of vegetative measures
Type and alignment of vegetative measures (m)

Strips/blocks	Material	Plants/ha	Vertical interval	Spacing	Interval	Width
contour	Vetiver	4500	1	5	0.2	0.7
contour	Sesbania	150	1.5	1	1	1

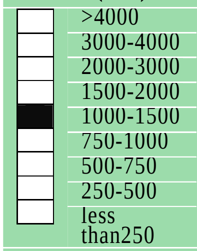
Construction and maintenance

I) Field activities for agronomic measures			
Activity	**Energy**	**Equipment**	**Timing**
Raise planting materials	Manual labor M	Hoe, shovel	Beginning of rainy season
Planting		Hoe	Rainy season
II) Establishment activities for vegetative measures			
Planting local grass	Manual labor		Rainy season
Maintenance activities for vegetative measures			
broadcast-local grass	Manual labor	Spade, hoe	After rains
III) Construction activities for structural measures			
Bund construction	Manual labor	Shovels, hoe	Dry season
Stone checkdam		Hoe	Dry season
IV) Maintenance activities for structural measures			
Repairing bunds	Manual labor	Hoe	After rains

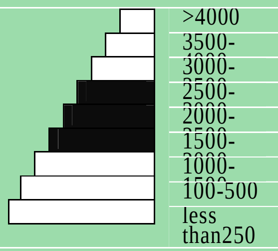
Constraints during construction and establishment: low quality structures, poor layout, open grazing, labor, hand tools and the use of small stones, which collapse immediately after construction. Farmers demand wider spacing and a short bund height. Possible improvements: promote awareness, organize farmers in groups and enforce legislations. Constraints during maintenance are open grazing, labor, hand tools.

Natural Environment

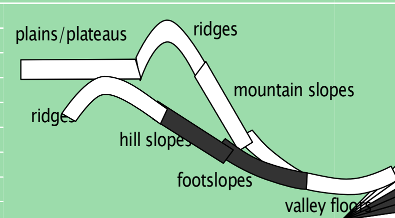
Average annual rainfall (mm)



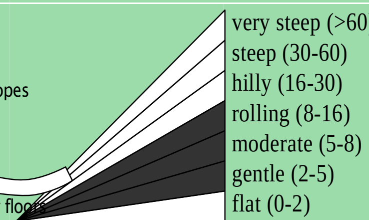
Altitude (m a.s.l.)



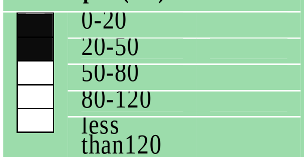
Landform



Slope (%)



Soil depth (cm)



Growing season:

Soil fertility:

Soil texture: medium (loam), coarse (sandy)

Surface stoniness: Some loose stone

Topsoil organic matter: medium (1-3%): flat lands, low (less than1%) on other lands

Soil drainage: Medium

Soil erodibility: high on steep slopes, medium on slopes, low on flat lands

Number of erosive water storms per year is 10-30. They mainly occur in the beginning and middle of the growing season. Rainfall in the growing season is usually sufficient but not well distributed. The number of growing season per year is 1.

Human environment and land use

Typical household size of the land users is 4.5 persons. Population density is 100-200 persons/km^2. The annual population growth is 2-3 %. The trend in land size per household shows a decreasing trend because of increase in population. Land ownership and land use rights affected SLM to a certain extent. Subdivision of land has not affected the implementation of the SLM Technology.

There is little difference between the better-off and poor in how they practice SLM. The poor participate in food for work and benefit from food incentives for participating in the implementation of the technology. Off-farm income is less than 10% of all income for the land users who apply the SLM technology. The level of technical knowledge required for implementation of the technology is high for field staff and moderate for land users. The use of the SLM Technology is hindered little when land users cannot read and write. 80 % of land users cannot read and write and are unable to access new information.

Crop and livestock production

Land cultivation is performed by animal traction. Cropping is rainfed and plowing is operated by oxen. Intercropping is practiced to a very limited extent.

Animal production

The current trend in herd types is more of large stock. There is no change in herd size

The number of livestock units per household is 1 small stock and 2 large stock. The size of livestock is decreasing because of shortage of land and feed. There are three forest areas in the woreda, which are state owned. They are protected by site guards.

A view of a state owned forest areas in the woreda (photo 2007)

Cultivated lands are expanding while forestland and grazing lands are decreasing.

Costs (US$)

Category	**Input**	**Unit**	**Quantity**	**US equivalent**	**% borne by land user**
Agricultural	Harvesting	Ha	20	16	100
	Animal traction	Oxen days	30	38	
	Weeding	PD	30	24	
	Fertilizer	KG	150	54	
	Seedlings	No	2000	23	
	Seeds	Kg	20	7	
	Tools	No	5	13	
Bund construction	Labor	PD	250	200	25
				375	

Note: PD = Person days,   KG = Kilogram and No = number

Most important factors affecting the costs are: availability of stone, slope, soil depth. Costs were calculated for a stone-faced soil bund construction. Daily wage cost of hired labor to implement SLM is 0.8 US$ per person per day

Cost recovery period of investment in land management technologies
Crop: sorghum

Cost (US$)

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1	28	12	24	54	13	132	200	125	-207
2	28	12	24	54	0	120	50	150	-20
3	28	12	24	54	13	120	50	163	-7
4	28	12	24	54	-	120	25	188	43
5	28	12	24	54	-	120	0	188	68
6	28	12	24	54	-	120	0	188	68
7	28	12	24	54	-	120	0	188	68
8	28	12	24	54	-	120	0	188	68
9	28	12	24	54	-	120	0	188	68
10	28	12	24	54	-	120	0	188	68
11	28	12	24	54	-	120	0	188	68
12	28	12	24	54	-	120	0	188	68
Total	336	144	288	648	26	1452	325	2130	353

Note: 1= tillage, 2 = seeds, 3= weeding, 4= fertilizers, 5= total input, 6 = cost of SLM technology, 7 = benefit, 8 = net benefit

Cost recovery period is 12 years. The cost recovery period can be reduced if other crops are used and bunds are vegetated with trees and good quality grass species

Benefits, advantages and disadvantages

Production and socio-economic benefits		**Socio-cultural benefits**	
Crop yield increase	High	Community institution strengthening	High
Fodder production/quality increase	Medium	Improved knowledge SLM/erosion	
Wood production increase			
Farm income increase	High		
Ecological benefits		**Off-site benefits**	
Soil cover improvement	Negligible	Reduced downstream flooding	High
Increase in soil moisture	High	Increased stream flow in dry season	
Increase in soil fertility	Negligible	Reduced downstream siltation	
Soil loss reduction	High		
Biodiversity enhancement	Negligible		
Production and socio-economic disadvantages		**Ecological disadvantages**	
Loss of land	Medium	Water logging	Negligible
Increased labor constraints	High		
Increased input constraints	Little		
Hindered farm operations	Negligible		

Economic analysis
No data is available on the economic returns resulting from conservation measures.
However, without SLM, the gross production value in US$ per hectare per year around the SLM Technology area is 150 US$/ ha / yr. With SLM Technology, the gross production value of the land per hectare per year is 260 / ha / yr. Compared to the situation without conservation, percentage gross production value increase 10 years after implementing SLM by considering the area occupied by conservation measures and assuming current input and prices is over 70%.

Adoption and adaptation
Farmers have increased the vertical interval (VI) and constructed quality bunds applying a spacing of 2 m VI. Land users are using oxen power for excavating foundation for structural measures. About 75 % of land users that have applied the SLM Technology have done it with incentives. This accounts to 60 % of the area. There is moderate trend towards growing adoption of the technology.

There is enough local skill and support to expand the SLM Technology. There are specialists in various fields (soil and water conservation, forestry as well as agronomy) to support land users. The SLM technology is durable. Standards of structural measures are well considered. To strengthen this: prevent cattle interference, increase soil moisture retention and use appropriate species tolerating tough conditions in order to increase durability. Since the inception of the introduced SLM (soil bunds, stone bund and terracing) practices, there is a sharp decline in the trend of land users' practicing traditional ditches.

Maintenance

Maintenance is done every year before getting engaged in new activities.

Strength/advantages	**Sustain/improve**
Reduced erosion and improved soil moisture	Continuous awareness creation and exposure visits
Promote cut and carry	Provision of suitable Species, collection and distribution of seeds
Weaknesses / disadvantages	Overcome
Space between bunds is narrow for oxen plough	proper spacing to be designed/adopted
Harbor pests	Proper management and use of pesticides
Loss of land due to land occupation	Increase/improve productivity of fodder trees on bunds

Supportive measures

Cutoff drain: reduce flooding of cropped lands at the foothills and valley floors. Waterways: Convey surplus rainwater safely to outlets.

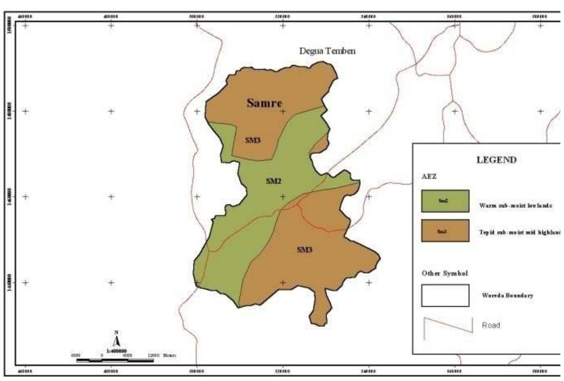
Gullies developed into ataerways to convey dischrge from cutoff drains (Photo 2007)

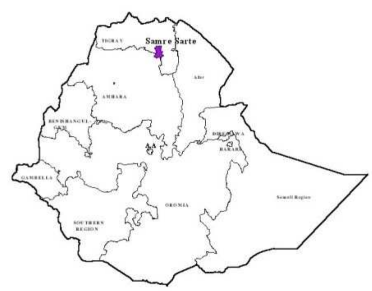
aces developed from stone faced bunds near Maychew, tigray (photo 2006)

Stone faced bunds, Samre, Tigray (photo, 2008)

26. Stone-faced soil bund (Tigray)

Common Name of SLM Technology: Stone-faced soil bund of Tigray
Local or other name: Emni Getsu hamed zala
Associated Approach: Mass Mobilization and Incentive Based Particicpatory Approach
Contributing SLM specialist: Woldegabriel G/Hawaria, Bureau of Agriculture and Natural Resources, Tigray
Area information





Agroecology of Samre Woreda

Location of Samre Woreda

Definition
Stone banks placed at the down slope side of soil bunds, in an inclined manner and laid out along the contour.

Description
Stone walls placed along a contour line in a ditch of 30 cm width and 42 cm depth. First, foundation is excavated and stones are placed upright to a height of 0.5-0.75 with 1 m width and 30 cm top width. On the upper side, embankment of soil is added and supported by stonewall. A basin having tie ridges is placed at an interval of 5-10 m to store runoff water.

The purpose of the Technology is to control soil erosion, shorten slope length and retain soil moisture. Structural measures are integrated with biological SLM activities. The combined measures help in enhancing vegetation growth, improve microclimate, and reverse the effects of land degradation. The technology is also intended to provide off-site benefits as well. There is a number of water harvesting structures downstream the SLM technology area, which include ponds, earth dams and water wells. The technology is also aimed at decreasing sediment flow to reservoirs downslope. The major purpose however is to retain moisture in crop fields. The long-term objective further goes to increase ground water recharge, increase river flow and enhance spring discharge. The technology is best described as program implemented. The SLM Technology is mainly new, based on previously introduced technologies. It is adapted from the experience of other countries and adapted to the technology area.

Picture of the technology
The SLM Technology is a modified version of the traditional knowledge. The traditional way of doing is forming an embankment that is supported by stone lines at the down slope side. The aim of the traditional technology is to control water erosion and to retain soil moisture.
Traditional SLM technologies are maintained well and are being modified with improved techniques that enable reduce runoff and erosion effectively. The SLM technology is designed by experts. The appearance of the applied technology has changed very much over time. It is improved from stonewalls to inclined, properly placed stones, inclined and strengthened by earth embankments. In some of the areas where the technology has been applied it is observed that bench terraces have developed well.

Land degradation
Types of land degradation on the land surrounding the SLM area

Land use	Type of degradation	Degree	% area affected	Land forms
Cultivated land	Water erosion	High	20	PH
		Medium	30	
		High	40	
Grazing land		Medium	10	

Soil erosion is very serious in the hilly areas where cultivation is done. Soils are sandy in texture and slopes are steep favoring erosion.

Purpose and classification

Major land use problems in the area without SLM: Soil erosion, deforestation, overgrazing, decline of fertility, low moisture holding capacity, low productivity, deforestation.

Technical functions

Main	Secondary
Increase infiltration Improve soil moisture Reduce erosion	Reduction of slope length Reduction of slope angle Control of concentrated runoff (retain/trap) control of dispersed runoff (impede/retard)

Characterization and purpose

The types of land degradation mainly addressed by the technology include: water erosion, gully erosion, riverbank erosion and loss of topsoil. The technology combats land degradation through, control of dispersed runoff by retaining it, control of concentrated runoff, and reduction of slope angle, reduction of slope length and increase of infiltration.

Specification of structural measures

Type and layout of structures (m)

Length of structure	Height	Material	Vertical interval	Embankment		Channel	
				Height	Width	Depth	Width
30-80	0.5-0.75	Earth /stone	1-1.5	0.5-0.6	0.75-1	0.50 - 0.35	0.50-1

Construction and maintenance

Activities	Energy	Equipment	Timing	Frequency
I) Field activities for agronomic measures				
Contour plowing	Manual labor	Hoe	April- May	3 times
Contour plowing	Animal traction	Plow	April-May	3 times
II) Establishment activities for vegetative measures				
Seedling production	Manual labor	Hoe, shovel, wheelbarrow,	Dec- Jan	Once
Pitting		Hoe, shovel, meter tape	May	**Once**
III) Maintenance activities for vegetative measures				
Enrichment planting	Manual labor	Hoe, shovel	August	**Annual**
Weeding and cultivating			September	
IV) Construction activities for structural measures				
Survey and layout	**Manual labor**	**Line level, nylon string, poles and pegs**	**January**	**Annual**
Foundation excavation		Digging hoe and spade	Feb.-April	
Stone collection		Crowbar, hammer,	Feb.-April	
Construction and placing of stones			Feb.-April	
Maintenance activities for structural measures				
Repair breached parts of a bund	Manual labor	Crowbar, hammer	February-April	

Specification of vegetative measures
Type and alignment vegetative measures (m)

Material	Plants/ha	Space between rows	Space within rows	Vertical interval (VI)	Horizontal spacing / interval	Width
Bund stabilizing vegetation	Varying for various crops	0.20-0.50	0.15 - 0.30	1-2	15-20	0.75-1.25

Constraints during establishment: Free grazing, low rainfall, low survival rate, pest, and illegal tree cutting. Constraints during maintenance include free grazing, erratic rains and mainly moisture stress. Possible improvements include practicing of closing the area uphill, which is degraded, construct water harvesting measures, application of pesticides, timely cultivation and weeding, practice timely and proper planting techniques.

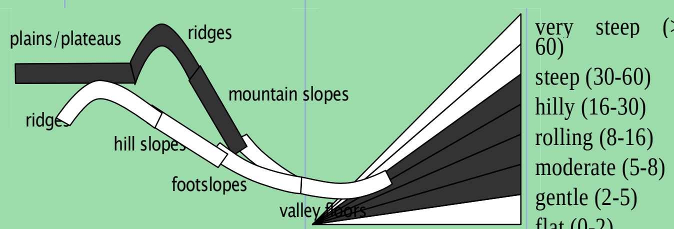
The technology is implemented by community mobilization. Groups are organized to undertake the construction but the maintenance is done by individual land users on their holdings. Constraints during construction and establishment include free grazing and low quality structures. Constraints during maintenance are free grazing, low survival rates of planted seedlings.

Natural Environment

Average annual rainfall (mm)
>4000
3000-4000
2000-3000
1500-2000
1000-1500
750-1000
500-750
250-500
less than250

Altitude (m a.s.l.)
>4000
3500-
3000-
2500-
2000-
1500-
1000-
100-
less than250

Landform **Slope (%)**



Soil depth (cm)
0-20
20-50
50-80
80-120
less than120

Growing season:
Soil fertility:
Soil texture: coarse (sandy), medium (loam) and fine (clay)
Surface stoniness: some loose stone and abundant loose stone
Topsoil organic matter: Low (less than1%)
Soil drainage: good, medium and poor
Soil erodibility: very high

Number of erosive water storms per year is less than 10 and these mainly occur in the middle of the growing season. Rainfall in growing season is usually insufficient and not well distributed. Number of growing season is 1.

Human environment and land use
Typical household size of the land users is 5 persons. Population density is 100-150 persons/km^2. Annual population growth including migration is 3%. Land size per household is decreasing as a

result of increasing population. Land ownership and land use rights have affected SLM in certain cases.

The rich and average land users have livestock and they apply manure to fertilize their land but the poor do not have livestock and could not apply manure on their land. Off-farm income is less than 10% for the land users who apply the SLM technology. This comes from employment as daily laborers or by getting engaged in petty trade.

The level of technical knowledge required for the implementation of the technology is high for field staff / extension worker and moderate for the land user. The use of the SLM Technology is hindered little, when land users cannot read and write. About 85% of land users cannot read and write.

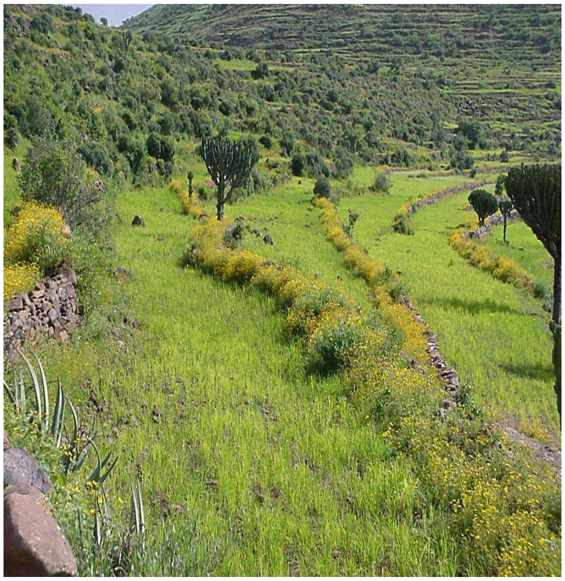
Crop and livestock production
Land cultivation is performed by manual labor and animal traction. Crops are grown rain fed and the major crops grown are Teff and sunflower. Teff is a soil depleting plant and sunflower is soil enriching. The former is the staple food and the later is an oil crop.

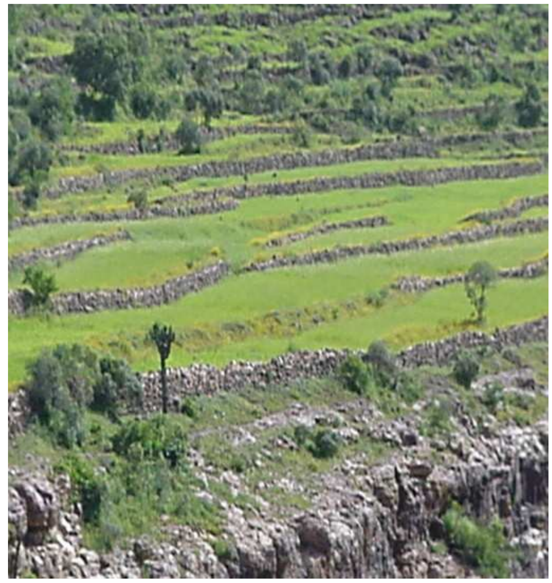
The current trend in herd types is more small stock. Number of livestock is decreasing owing to decreasing size of grazing lands. The number of livestock units per household is 3 small stock and 2 large stock. The current trend in livestock numbers shows slight reduction.

Costs
Establishment and recurrent costs (US$)

Categories	**Input**	**Quantity**	**Cost**	**% borne by land users**
Others	Person days	53.5	66.9	100
Agricultural	Fertilizer (kg)	100	33.75	
Agricultural	Seeds (kg)	25	9.4	
Equipment	Tools	10	20	
Labor	Person days	125	90	
Total			220.05	

Factors affecting costs are slopes, transport for construction materials (stone), dryness of land, and shallow soils. Daily wage cost of hired labor to implement SLM is 0.875 US $ per person per day.





Stone faced bunds in Adet Tigray (photo 2003)

Economic analysis

Without SLM percentage gross production value of the land per hectare per year is 150 US$ / ha / yr. the gross production value of the land per hectare per year is 312 US$ / ha / yr. Compared to the situation without conservation percentage gross production value increase 10 years after implementing SLM is 60% considering also the land occupied by conservation measures and in assuming current input and prices.

Adoption and adaptation

Changes have been made to the technology. Initially stone bunds were constructed simply to form stone embankments. As more experience is gained, the stones are placed in inclined position by interlocking stones and reinforce them with soil embankment from upslope. Further strengthening is made by planting trees and grass. Modifications have been made by watershed technicians in the field. Watersheds with the technology have stabilized and sediment load to downstream croplands has reduced and sustainability of water storing structures increased. Pictures on the right show that low sediment water is stored in a watershed with the technology.

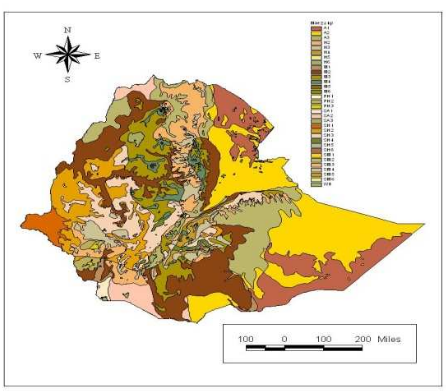
Land users, who have been involved, in the implementation of the technology have done it without any incentives except for material used in the water storage tanks seen in the pictures above. This accounts to 100 % of land users that have applied the SLM Technology. Land users, who have implemented the technology, have done it wholly voluntarily without any incentives other than technical guidance. Land users that have applied the SLM Technology are 98328. There is little growing spontaneous adoption but most land users maintain the structures established on their plots. There are production cadres and trained surveyors in the community, known as contour markers who make the layouts. These help in expanding the technology to new sites.

VI. Hillsides and gully rehabilitation measures

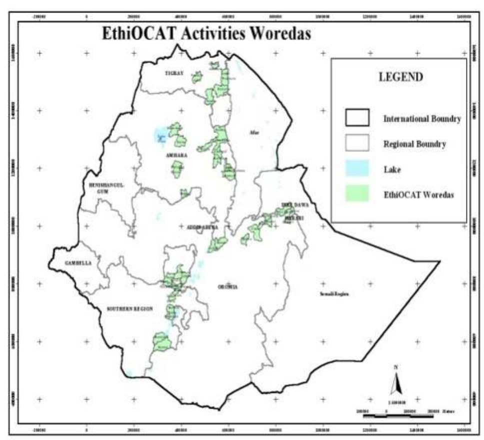
Hillside terrace in Diredawa (Photo 2004)

27. Hillside Terrace

Name of Technology: Hillside Terrace
Local or other names: Yegara Irken (Amharic). Kenetawi metrebawi zala (Tigrigna)
Contributing SLM specialist: Hans Hurni, Center for Development and Environment (CDE), Hallerstrasse 10, 3012 Bern, Switzerland
Email: hurni@giub.unibe.ch
Associated Approach: Social Infrastructure
Location: Harerge, Shewa, Wello, Tigray, Gonder
Date: 1995, updated 2007
Area information
Are applied in many regions
The Technology Area



Agro-ecological zones of Ethiopia



SLM activity areas where the technology is implemented

Definition
A hillside terrace is a structural measure laid out along the contour and a strip of leveled land is prepared for tree planting.

Description
Hillside terraces are up to 1 meter wide and constructed at about 2-5 m vertical interval. Hillside terraces should only be applied if there is a strong necessity of erosion control and/or water conservation justifying their construction. Hillside terraces are mainly used to enclose degraded hillsides and in the meantime prevent damage of flooding the area below steep slopes.

Hillside terraces help retain runoff and sediment on steep sloping land and support growth of tree seedlings planted on them. They are also effective on badlands and in areas with low rainfall to conserve water. Hillside terraces are usually combined with area closure. Few work tools are needed for their construction such as line level, digging instruments, stones, and other materials needed for combined measures. Activities for their maintenance include: weeding and cultivating the trees planted and repairing damages on the terrace.

Land degradation
Types of land degradation on the land surrounding the SLM area

Land use	**Type of degradation**	**Degree**	**%**	**Landform(s)**
c. g	Water erosion	v	50	F
g. c. m		v	80	H
g. c. f		v	100	M
g. c. m	Wind erosion	m	50	H, P
c. g	Chemical deterioration	s	90	H, R, M, F

Source of data: Experiments/ observation/ estimates.

Land without vegetative cover is the most degraded, North Wello (photo 2004)

Land degradation in Bilate River Basin, South Ethiopia (photo 2003)

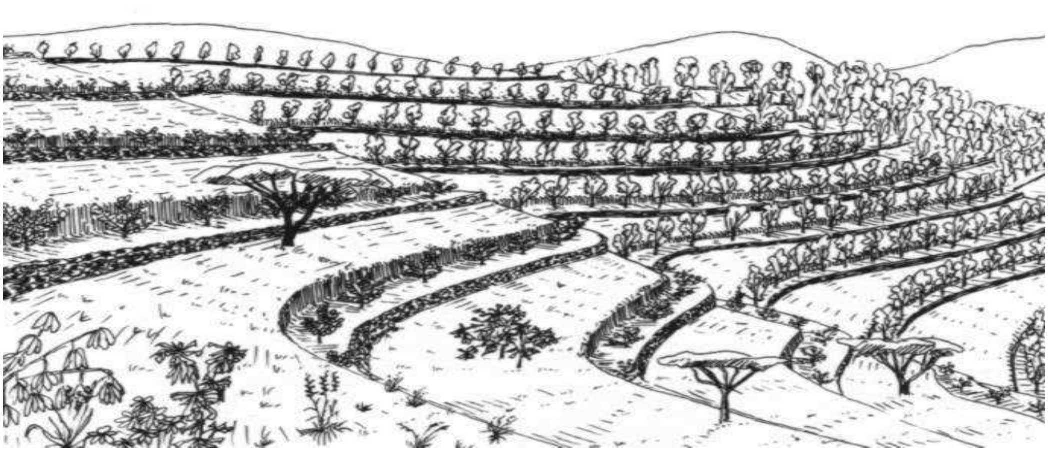
The SLM Technology is mainly new. The technology originated from engineering handbooks and the Indian experience adapted to Ethiopia. It is being implemented since 1978. The indigenous SLM technologies used before the current SLM technology were stone bunds and boundary bunds. The aim is to remove stones from cultivated land. Today, the indigenous SLM is continued and maintained owing to scarcity of arable land; there is a generally positive perception of its usefulness, and active promotion by extension services. The current SLM technology is designed following the initiation of international program with the support of incentives (Food-for-Work) from donor organizations.

The appearance of the applied technology has not changed over time. The vegetative measures taken on hillside terraces have some limitations because of ownership questions. This has limited the full involvement of the farmers in initiating the idea, planning for activities, and own development.

Stone bunds in area closures, Enderta, Tigray (photo 2007)

Closed area along Dessie –Kombolcha road (photo 2006)

Technical drawing



Land use problem

Sheet and rill erosion from slopes and the subsequent formation of gullies on cultivated land along foot slopes, lack of grass and woody biomass, lack of grazing for livestock, shortage of land for cultivation and, poor productivity are problems faced by land users.

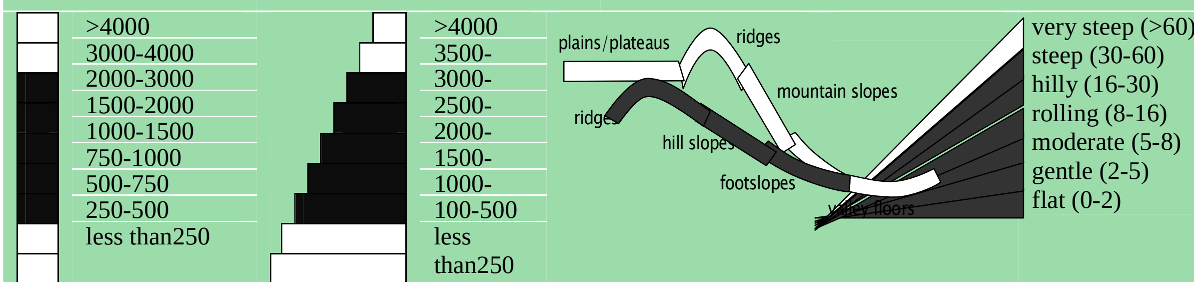
Technical functions

Functions	Degree
Increase of infiltration	High
Water harvesting	
Reduction of slope angle	Medium
Increase of surface roughness	
Increase/maintain soil water storage	
Improvement of ground cover	

The technology is intended to provide significant off-site benefits also by preventing major flooding below hillsides that cause gully erosion on croplands. Trees planted on hillside terraces also provide woody biomass after 5-10 years of establishment. Grass is cut and carried after 2-3 years.

Natural Environment

Average annual rainfall (mm)	Altitude (m a.s.l.)	Landform	Slope (%)



Soil depth (cm)	Growing season: Soil fertility: very poor **Soil texture:** all soils conducive to tree growth **Surface stoniness:** high level of stones and some stoniness **Topsoil organic matter:** very low- low (less than1%) Soil drainage: high Soil erodibility: high

Implementation

Establishment activities for vegetative measures				
Activity	**Energy**	**Equipment**	**Timing**	**Frequency**
Planting seedlings	Manual labor	Hoe, spade, bucket	Beginning of rainy season	Every planting season as need arises
Maintenance activities for vegetative measures				
Weeding	Manual labor	Hoe	Rainy season	Each cropping
Establishment activities for structural measures				
Lay out and construction	Manual labor	Hoe, pick axe, line level, string and poles	Dry season Beginning of rainy season	
Maintenance activities for structural measures				
Control of grazing	Manual labor Observation	Hoe	Always	All year round
Establishment activities for management measures				
Community guarding of closed areas	Observation		All year round	

Important constraints during establishment of vegetative measures: Occasional grazing may damage vegetative measures, scarcity of water during establishment, irregularity of rains and careless planting greatly reduces chances of survival for seedlings. Exclusion of livestock from the enclosed areas puts pressure on neighboring areas.

Important constraints during maintenance of vegetative measures: Grazing at a critical stage is most damaging. Possible improvements could include: proper timing, empowering farmers for planting and use of resource, proper use of grass and bush needs social organization that manages it. Allocation of closed areas to sections of communities is recommended for best and sustainable use of area closures.

Constraints during establishment: Availability of appropriate hand tools and improper layout along contour.

Crop and livestock production
Land cultivation is performed by animal traction and manual labor
Cost

Activities	**Cost (Birr)**	**Cost (US$)**
Construction cost per hectare	2585	235
Planting material production	385	35
Planting of seedlings	1210	110
Material / tools	220	20
Total	4400	400

Maintenance cost = 210 birr/year = 1050 Birr in 5 years. The most important factors affecting the costs are slope, soil condition, and length of terrace per hectare. Costs are calculated for the length of structure on an average slope. Daily wage cost of hired labor to implement SLM is 1 US $ per person per day.

Ownership and land use rights affect the practicing and sustainability of SLM measures strongly. User right of closed area needs to be clear from the outset (use of grass, trees, and the land). There is a difference between rich and poor in how they practice SLM. Better-off land users have more flexibility to test new technologies, but the poor see the necessity to reduce degradation more strongly. Off-farm income is less than 10% for the land users who apply the SLM technology. Level of technical knowledge required for implementation of the technology should be at least moderate for field staff / extension worker and low for land users.

Impacts of the technology

Benefits

Grass is cut every year = 5 x 200 = 1000 Birr/hectare. Trees planted are ready for use after 5-10 years (eucalyptus). After 5 years = 2000 trees x 5 birr/tree = 10,000 Birr

Estimate of production

Type of treatment	**Vegetation**	**Production (t/ha/yr)**
Without SLM	Grass and bush	7.5
With SLM	Grass, bush and trees	13

Adoption and adaptation

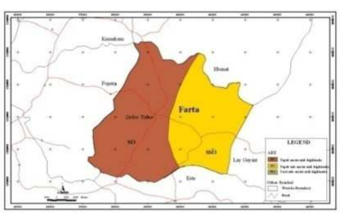
Trends towards growing spontaneous adoption of the technology were very little in the past. Recently, many communities have seen the value of hillside terracing and many have benefitted from the assets created. Changes that have been made to the technology: Local communities have acquired own user's rights and regulations, and as a result accepted the area closure technique together with hillside terracing if the latter was subsidized. The SLM Technology is moderately designed such that it allows changes by the land users. There is no enough local support and financial capacity to expand the SLM Technology. Durability is high, if livestock are totally excluded.

Gabion checkdams for reclaiming gullies (left)and and stabilizing gullies with vegetative measures GTZ project in South Gonder (photo 2007)

28. Gully rehabilitation (Farta, Gonder)

Common Name of SLM Technology**:** Gully Control
Local or other name: Kitir (Amharic)
Associated approach: Food for Work
Contributing SLM specialist: Wuletawu Mekuria Kebede, Woreda Agriculture and Rural Development Office, Amhara Region, Southern Gonder Zone, Farta Woreda
Date: 12/10/2005 Updated: 2007

Area information
Basin; Nile / Abay River Basin



Agroecology of Farta Woreda ***Location of Farta Woreda***

Definition

It is a barrier of stone/wood/earth placed across a gully to rehabilitate the gully by checking runoff and trapping the sediment passing through it.

Description

A checkdam is established from stone / rock fill, gabion, wood or branches of trees. It has an average height of 1m and is spaced at 0.5-1m vertical interval. The purpose is to reclaim gullies to productive lands by controlling the velocity of runoff and trapping the sediment carried by the runoff from cultivated and grazing lands. By plugging the gully, using different types of checkdams, the gully gradient is converted to a gentle slope and runoff and soil movement is regulated. Constructing checkdams in a gully starts with smaller checkdams which are maintained and upgraded by increasing the height and width regularly. Gully plugging by gabion, loose rock fill and vegetative material is suitable to all agro-climatic conditions but the choice of material for establishment depends on the availability of material in the nearby, the amount of flow, severity of gully, stage of development and cost of the investment. For high rate and volume of flows gabion checkdams and stone checkdams are preferred to wooden or brushwood checkdams.

Picture of the technology

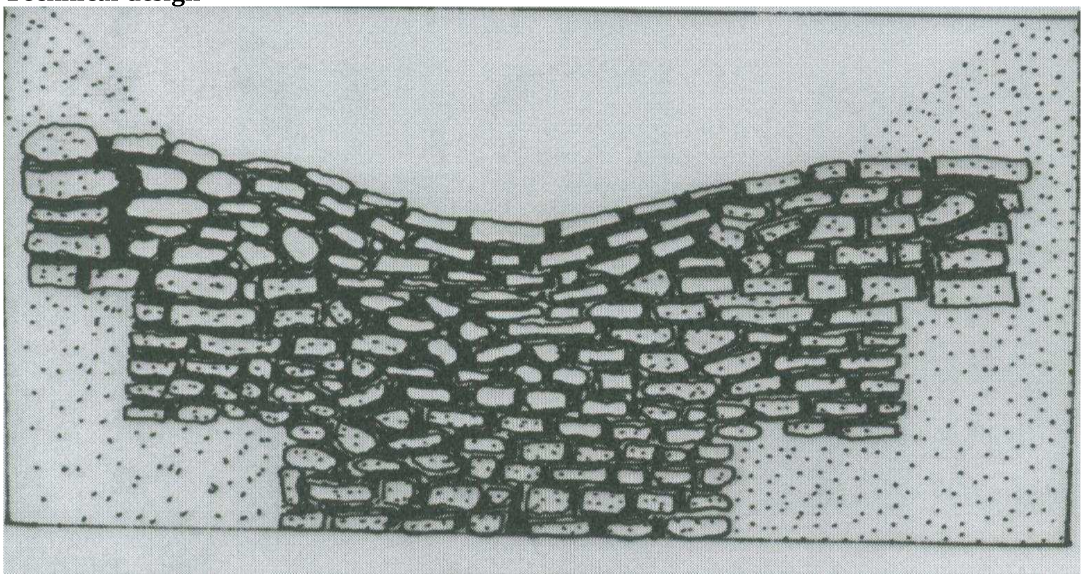
Gabion checkdam

Rock fill checkdam

Gullies under rehabilitation using gabion in Gonder (photo 2007)

Small gullies require low cost check dams such as loose stone and a bamboo mat (photo 2007)

Technical design



Purpose and classification

The major land use problems in the area without SLM

Expert opinion	**Open grazing, bare land, erosion**
Land user's point of view	**Land slide, erosion**

Land degradation

Types of land degradation on the land surrounding the SLM area

Land use	**Type of degradation**	**Degree**	**%**	**Landform (s)**
Mixed land	Water erosion	m	40	P,M,F
Forest		l	20	M
Grazingland		m	45	R,F
Cropland		**s**	80	M,H

Source of data: SLM Unit and Planning Team of Farta woreda

Characterization and purpose

The new technology is introduced in the country in the early 1980s from other countries. Traditional SLM Technologies have been used at a very small scale before the current SLM was introduced to the area.

Although the technology is not intentionally designed to provide off-site benefits, runoff flow to the bottomlands is regulated and hence there is very low sediment carried to cultivated lands at the lower reaches of the catchment. As a result, risk of flood and soil burial at the bottom lands is substantially reduced and losses of property as well is reduced.

The current status of the technology is best described as program implemented. The SLM Technology is mainly new, but has some indigenous practices in it such as planting on gullies with fast growing tree species such as eucalyptus which are often preferred by land users for the quality to grow fast and provide for household energy and construction poles requirements. Traditional gully control methods are used less because the traditional techniques used to rehabilitate gully are being replaced by improved techniques such as stone/wooden/brush checkdams**.**

The Woreda Agricultural office and the GTZ SUN project staff designed the current SLM technology. Site selection and determining the vertical interval is done by development agents in consultation with the land users. The layout is carried out by trained land users and the construction performed by land users. The appearance of the applied technology has moderately changed over time. Checkdams are now constructed from stones, gabions and other locally available materials and the land between the chekdams which is rich in fertile soils is used for planting crops, fruit trees and fodder species.

The gully after reclamation is planted by useful trees (fruit/fodder) and these trees are managed carefully. Moreover, activities such as cultivation and weeding, thinning and pruning are carried out to improve survival rate of planted trees and land productivity.

Constraints: Lack of proper choice on tree species, low quality structures, weak monitoring and supervision systems, open grazing and poor protection on assets created. Improvements for these constraints shall include proper follow up, monitoring of activities, organizing land users in user groups to protect assets created, fencing and area closure should be considered, use water harvesting structures.

Specification of vegetative measures
Type and alignment of vegetative measures (m)

Vegetative measures	Material	Plants/ha	Vertical interval	Spacing	Interval	Width
Scattered/dispersed	Trees/shrubs	400	1	5	1	5
Plantation	Fruit	2500	1	1	1	1

Implementation

Construction activities for structural measures			
Activity	**Energy**	**Equipment**	**Timing**
Stone collection	Manual labor	Spade	Before rains
Checkdam construction		Shovel, hoe	
Maintenance activities for structural measures			
Stone collection	Manual labor	Spade, hoe	Dry season
Repairing breaks		Hoe	

Establishment activities for structural measures			
Activity	**Energy**	**Equipment**	**Timing**
Stone collection	Manual labor	Hoe, shovel	Onset of rain
Gully reshaping		Spade, hoe	During rain
Maintenance activities for vegetative measures			
Replanting	Manual labor	Spade, hoe	Rainy season
Fencing		Hoe	Dry season

Establishment activities for vegetative measures			
Activity	**Energy**	**Equipment**	**Timing**
Raising seedlings	Manual labor	Hoe, shovel	Onset of rain
Planting		Spade, hoe	During rain
Maintenance activities for vegetative measures			
Replanting	Manual labor	Spade, hoe	Rainy season
Fencing		Hoe	Dry season
Establishment activities for management measures			
Fencing (live or wood)	Manual labor	Axe, hoe	Dry season
Maintenance activities for management measures			
Maintaining breaks in fence	Manual labor	Axe, hoe	Dry season

Proper selection of plant species for gully rehabilitation should be based on the amount of biomass that is produced and other values that attract land users. Encourage land users to actively engage in and widely adopt the technology.
Specification of structural measures

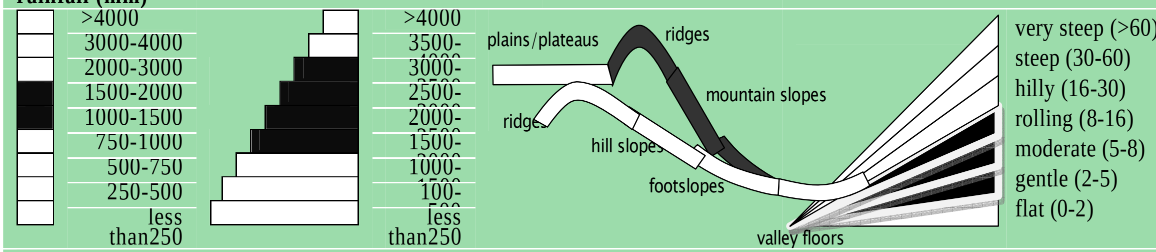
Type and alignment of structure (m)

Structures	Unit	Material	Vertical interval	Horizontal spacing	Height Increment /replacement	Width	Spill way height
Stone checkdam	Length	Loose stones	0.5 -1	10-20	0.5 -1 every year	Gully width	1st year
Gabion checkdam		Stone and gabion	1-1.5	15-30	0.5 -1 every year		1st year
Brushwood checkdam		Poles and brushwood	0.5	5-10	Replacement as needed		-

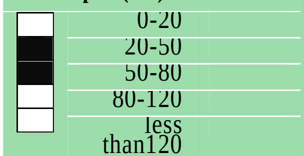
To control the expansion of gully towards cultivated lands, planting gully sides with trees will be necessary. The aim of the technology is to reduce loss of cultivated lands caused by gully widening and deepening and make the gully productive.

Natural Environment

Average annual rainfall (mm)	Altitude (m a.s.l.)	Landform	Slope (%)



Soil depth (cm)



Growing season:
Soil fertility: low, medium
Soil texture: loam, fine clay
Surface stoniness: no loose stone, some loose stone
Topsoil organic matter: low, medium
Soil drainage: good, low
Soil erodibility: high

Number of heavy erosive water storms per year is less than 20-30. They occur in the middle of growing season. Rainfall in growing seasons is usually sufficient but not well distributed. Number of growing seasons per year is 1 with 210 days from the month of May-November.

Human environment and land use

Typical household size of the land users is 5 persons. Population density is 300 persons/km^2. The annual population growth is 2.9%. Land size per household is showing a decreasing trend. Land ownership and land use rights affected SLM strongly. It is observed that when land users are titled for use they tend to provide care for the land they hold and are encouraged to plant trees. Subdivision of land affected the implementation of the SLM Technology more seriously because many land users are suspicious of losing their holdings if land subdivision continuous to take place.

Crop and livestock production

Land cultivation is performed by

Animal traction	Plowing using oxen, horses and cow
Manual labor	Digging by hoe

Type of cropping system and major crops

Water supply	Major crops	Type of cultivation
Rain fed Minor irrigation	Wheat Barley Teff Horse bean Peas Lentils	Continuous cropping no fallowing is practiced. Intercropping is practiced and crops intercropped include potato with beans, barley with hops

Types of animals

Large stock	Cattle
Small stock	Sheep, goat
Pack animals	Horse, mule, donkey

The current trend in herd types is more towards small stock. The number of livestock units per household is 2 small stock, 4 large stock and 1 or 2 pack animals. The current trend in livestock numbers shows slight reduction because of reduction in grazing land by size and quality but the number of livestock owners is increasing.

Forests and woodlands

Communities assign guards for community planted and managed forests, to protect them from illegal cutting and cultivation. Government and projects employ site guards for protecting the enclosure areas with trees planted at the initial stage.

The plantations with the enclosed area are handed over to the communities. The communities are trained and supported to establish byelaws for managing the community forests after the handing over. When the communities start getting benefits from enclosures and plantations, they are seen to assume responsibilities to manage the plantations themselves.

Enclosures managed by the communities in South Gonder (Photo 2007)

The technology is more applied to rehabilitate gullies caused by various factors among which improper road design and construction is the major. Stone checkdams help to restore productivity by improving and increasing infiltration of water and deposition of sediments behind structures.

Cost recovery

Measure: Stone Check dam on gully. The Crop is Teff

Cost (US$)

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1				0.04	0.5	1	0.1	23.64	0.4	15	15.4	-8.24
2		4	3	0.04	0.5	1	0.1	8.64	0.5	15	15.5	-6.86
3	7		3	0.04	0.5	1	0.1	11.64	0.6	15	15.6	+3.96
4			3	0.04	0.5	1	0.1	4.64	0.7	15	15.7	+11.04
5	6	2	3	0.04	0.5	1	0.1	12.64	0.8	15	15.8	+2.16
6			3	0.04	0.5	1	0.1	4.64	0.9	15	15.9	+10.26
7	5		3	0.04	0.5	1	0.1	9.64	1.0	15	16.0	+6.36
8			3	0.04	0.5	1	0.1	4.65	1.1	15	16.1	+11.46
9			3	0.04	0.5	1	0.1	4.65	1.2	15	16.2	+11.56
10	37	6	27	0.36	4.5	9	0.9	84.76	7.2	125	132.2	+47.44

Note*: *1= Establishment cost, 2= recurrent cost, 3 = land preparation, 4 = fertilizer, 5 = seed and seedlings, 6= herbicides 7 = harvest, 8= total cost, 9= production (yield) in q/ha, 10 = cost recovery period in years, 11= total benefit, and 12 = net profit

The table shows that the net benefit is negative for the initial two years and the most important factors affecting the costs are slope, labor, and time of cost recovery / payment period, width and length of the gully, availability of construction material. Daily wage cost of hired labor to implement SLM is 0.8 US $ per person per day

On-site and off-site benefits the technology

Production and socio-economic benefits		**Socio-cultural benefits**	
Crop yield increase	High	Community institution strengthening	High
Fodder production and quality increase		Improved knowledge SLM/erosion	
Wood production increase			
Farm income increase			
Ecological benefits		**off-site benefits**	
Soil cover improvement	Very high	Reduced downstream flooding	High
Increase in soil moisture	High	Increased stream flow in dry season	
Efficiency of drainage		Reduced Downstream siltation	
Increase in soil fertility			
Soil loss reduction			
Biodiversity enhancement			
Production and socio-economic disadvantages		**Ecological disadvantages**	
Loss of land	None	Water logging	Negligible
Increased labor constraints	High		
Increased input constraints	Little		
Hindered farm operations	Negligible		

The technology could be improved to achieve more benefits by: Carrying out regular maintenance, planting indigenous trees and grasses on structures, promote fruit trees and vegetables with proper design and monitoring

Economic analysis

Without SLM the gross production value in US dollars per hectare per year around the SLM Technology area is less than 100 / ha / yr. With SLM Technology, the gross production value of the land per hectare is 200 US$ / ha / yr. Compared to the situation without conservation, percentage gross production increased by over 100% after 10 years of implementing the technology.

Adoption and adaptation

Changes have been made to the technology. Physical structures are integrated with vegetative measures and the structures are stabilized and made productive. Fodder and woody trees are planted at the gully sides. More than 95% of land users that have applied the SLM Technology have done with incentives. Only 5% of the land users have implemented the technology without food support but they were given technical guidance. There is little trend towards growing spontaneous adoption of the technology

There is enough local skill and support to expand the SLM Technology. Farmers have gained skills that enable them replicate the technology with some material assistance and technical support. Is high and local materials can be used for constructing checkdams and obtain satisfactory results in terms of durability.

Maintenance

Land users have been partially involved in maintaining and managing what has been implemented

Strength	Solution
Fodder production and soil formation rate enhanced	Frequent maintenance
Moisture and water harvesting enhanced	Plant useful trees and nitrogen fixing trees
Soil erosion control and prevention of gully expansion.	
Sources of fodder	Plant more fodder trees
Weakness	Sustain
Rodents harbored	Apply mechanical rodents control

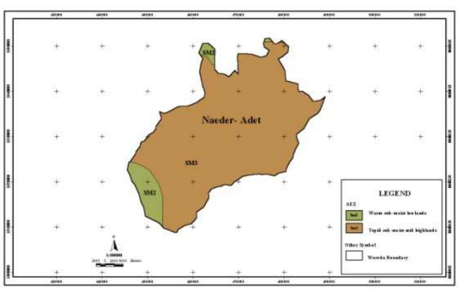
Supportive measures

Measures	Function
Area closure	Reduces runoff to down slopes
Cutoff drain	Reduce runoff inflow
Waterways	Safely dispose runoff strength
Fencing	Help in protecting assets created

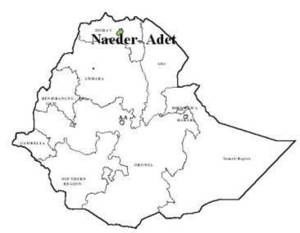
Hillside closures by means of physical and management measures (photo 2007)

29. Area closure combined with hillside terraces (Tigray)

Common Name of SLM Technology: Hillside terraces
Local or other name(s): Bota Klela (Tigrigna)
Associated Approach: 1. Mass Mobilization and 2. Food for Work
Contributing SLM specialist: G/Hawaria W/Gabriel and Tsegaye Mezgebe, Bureau of Agriculture and Natural Resources, Tigray Regional State
Date: 18/11/2003   Updated: 2007



Agroecology of Naider Adet



Location of Naider Adet

Definition

Closure of degraded land is practiced on land that has lost its vegetative cover, and has extremely low soil fertility to support production of any kind.

Description

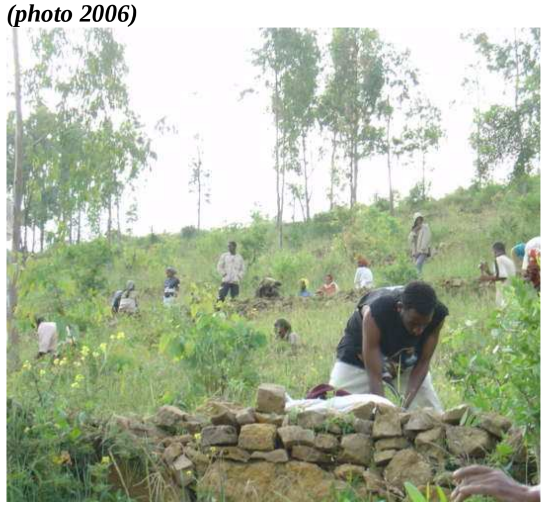
Degraded land is closed from human and animal interferences for at least 3-5 years in order to enhance rehabilitation of the degraded land. SLM activities, such as terracing, enrichment plantation and over sowing of grass are among activities undertaken along with closures. These practices enhance growth of natural vegetation and enrich biodiversity. The area to be closed is first demarcated. The local communities are given awareness promotion on the methods and benefits of area enclosures. Development agents in collaboration with community leaders call a general community meeting and discuss on the plan for closing a degraded area. The area to be closed from the interventions of human and livestock is fenced and guards assigned. Conservation measures which enhance water harvesting are also practiced in some cases. Area closures are mainly of two types depending on the type of measures taken. 1. Those involving only closing the area from interferences and human interventions (leaving it for nature for regeneration) and 2. Those which involve both closing the area and practicing additional SLM measures for speeding up the rehabilitation processes and get immediate benefits from the land.

The rate at which closed areas regenerate depends on the degree of degradation, climatic factors and the scale of management it receives. Experience shows that well managed and protected area enclosure rehabilitates very fast compared with areas which are not protected from external interferences. Physical measures which retain soil moisture are applied in integration with closures.

Picture of the technology

Women particicpation in area enclosures in Tigray (photo 2006)

Natural regeneration is observed in enclosures of steep slopes with very poor soils, Enderta, Tigray (photo 2006)



Area enclosure is applicable in all agro-ecological conditions but measures suitable to SM_3 agro ecological conditions are shown here. The measures include i) tree plantation (top leftt) ii) trenches (lower right)

Technical functions

Main	Secondary
Water harvesting (structural measures)	Increase /maintain water stored in soil
Improvement of ground cover (vegetative)	Control of concentrated runoff (retain/trap)
	Increase infiltration

Land degradation

Types of land degradation on the land surrounding the SLM area

Land uses	Type of degradation	Degree	%	landform (s)
c	Water erosion	Light	25	P
c, g, f		Moderate	30	P, H, F
g, f		Strong	20	H, M
g		Very strong	25	H

Soil burial caused by sediment deposit coming from up hills is among land degradation problems addressed by area enclosures, Tigray (photo 2007)

Purpose and classification

Major land use problems in the area without SLM are: Soil erosion, deforestation, degradation, loss of biodiversity, reduction in land productivity, low productivity and decline of soil fertility. The technology is applied in areas where land has lost its productive potentials and practically not being used or it has a very insignificant productivity level. The goal of the technology is to rehabilitate degraded hillsides and regenerate lost vegetation.

The technology combats land degradation through

Increase of surface roughness Increase of infiltration Increase water stored in soil Water harvesting Increase in organic matter Increase in soil fertility	Control of raindrop splash Control of dispersed runoff (retain/trap) Control of dispersed runoff (impede/retard) Reduction of slope length

The technology is best described as program implemented. The SLM Technology is mainly new but has aspects of traditional experience such as closing church premises from interferences. The technology is acquired from other countries and also takes aspects of the local experience of protecting natural resources in and around churches and some culturally protected and restricted areas. Indigenous SLM Technologies have been used before the current SLM. The traditional practices in area closures target at protecting and restrict the cutting of trees and preserve cultural heritages. Today, the traditional SLM practices are used more. More communities and individuals are practicing it widely across the country but pursuing varying methods and approaches.

The appearance of the applied technology is gradually changing over time. Currently, activities such as enrichment plantations, over sawing grasses and some physical structures are included. In the beginning the practice of area enclosure involved only closing the area from external interference by fencing and by letting natural regeneration to take place. In the course of this exercise additional measures were thought to enhance rehabilitation in applying physical measures which harvest rainwater and improving biomass by planting trees.

Establishment: Trees are planted at 2 x 2 m interval or 3 x 3 m or 4 x 4 m depending on the species and the area that is available for planting. On the average about 750 trees are planted on a hectare. Hillside terraces are spaced at 1 meter vertical interval in most cases and up to 2 meters in some cases. Microbasins of 0.5 m to 1 meter diameter are placed in between the terraces to enhance water harvesting. In some cases trenches with a dimension of 3 m long, 0.5 m wide and 0.5 m deep are constructed.

Important constraints during establishment include: Lack of land use policy, reluctance to observe the existing rules and regulations and low survival rate of planted trees. Constraints during maintenance include: improper handling of seedlings during transporting, planting and weeding, and livestock interference. Possible improvements include: implement appropriate land use policy, create awareness to the community, allow cut and carry from the area closures and apply water-harvesting structures.

Specification of structural measures
Type and alignment of structures (m)

Structures	**Material**	**Between structures**			**Dimensions of embankment**	
		Length	**Height**	**Width**	**Length**	**Width**
Terrace: bench level	Earth	2	5-8	0.5-0.75	1	300
	Stone	2	5-8	0.5-0.75	1	300

Construction and maintenance activities for structural measures
Structural measures are not implemented in all area closures but various SLM measures are applied wherever needed. Constraints during construction / establishment of structural measures include shortage of construction materials, hand tools and labor. In some places digging foundation for stone bunds and trenches is not possible because of the underlying rock.

Establishment activities for vegetative measures

Activity	Energy	Equipment	Timing
Seedling production	Manual labor	Hand tools	January-June
Pitting			May
Planting			July

Maintenance activities for vegetative measures

Activity:	Energy	Equipment	Timing	Frequency
Planting	Manual labor	Hand tools	July	Yearly
Weeding			End of August	Once

Construction activities for structural measures

Activity	Energy	Equipment	Timing
Layout and survey	Manual labor	Line level, string, poles, peg, hoe	**September**
Stone collection		Craw bar, hammer, hoe	December-May
Construction		Shovel, hoe, hammer and craw bar	

Maintenance activities for structural measures

Activity	Energy	Equipment	Timing	Frequency
Stone collection	Manual labor	Hoe, shovel	June - July	Annual
Construction		Hoe, shovel, hammer		

Establishment activities for management measures

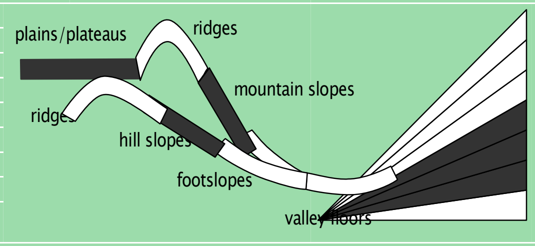
Activity	Equipment	Timing
Awareness creation and site selection	**-**	January
Fencing the area	Axe, sickle	
Site guard	**-**	Throughout the year

Maintenance activities for management measures

Activity	Equipment	Timing	Frequency
Enrichment plantation	Hand tools	July	Annual

Natural Environment

Average annual rainfall (mm)	Altitude (m a.s.l.)	Landform	Slope (%)
>4000	>4000		very steep (>60)
3000-4000	3500-4000		steep (30-60)
2000-3000	3000-3500		hilly (16-30)
1500-2000	2500-3000		rolling (8-16)
1000-1500	2000-2500		moderate (5-8)
750-1000	1500-2000		gentle (2-5)
500-750	1000-1500		flat (0-2)
250-500	100-1000		
less than250	less than250		



Soil depth (cm)
- 0-20
- 20-50
- 50-80
- 80-120
- less than120

Growing season:
Soil fertility: low, medium
Soil texture: medium (loam), coarse (sandy) and fine (clay)
Surface stoniness: Some loose stone
Topsoil organic matter: Low (1%)
Soil drainage: Medium and Good
Soil erodibility: low and medium

Number of erosive water storms per year is less than 10. Heavy storms are received in the middle of growing season. Rainfall in the growing season usually is sufficient but not well distributed. Number of growing seasons per year is 1.

Human environment and land use

Typical household size of the land users	5 persons
Population density	200-500 persons/km^2
Annual population growth (including migration)	3-4 %

Land ownership and land use rights affect SLM to a given extent. Similarly, Sub division of land affected the investment on SLM activities. There is a marked difference between the rich and poor in the way they practice SLM. The relatively better-off farmers manage their land properly, apply manure and perform farm operations timely where as the poor find it difficult. Off-farm income is significant for the land users who apply the SLM technology and it is about 20% of all income.

Level of technical knowledge required for implementation of the technology is high for field staff / extension worker and moderate for land user. The use of the SLM Technology is not hindered, because land users cannot read and write. About 85% of the land users cannot read and write.

Livestock production
The current trend in herd types is that the large stock as well as small stocks are declining in number because of feed shortages.

Costs (US$/ha)

Category	**Input**	**Quantity**	**US$**	**% borne by land users**
Agricultural	Seeds (kg)	2	15	100
	Person days (no)	28	20	
Equipment	Tools	6	10	
Labor	Person days	154		

Machinery/tools: Shovel craw bar, digging hoe, hammer, pole, line level, nylon string. Most important factors affecting the costs are labor, slope, and soil compaction. Costs are calculated on the basis of; length of structure, site guards per ha, number of seedlings planted. Costs are subsidized by the government and development partners. Daily wage cost of hired labor to implement SLM is 0.875 US $ per person per day.

Benefits

Production and socio-economic benefits		**Socio-cultural benefits**	
Crop yield increase	High	Community institution strengthening	High
Fodder production increase	Medium	Improved knowledge SLM/erosion	
Farm income increase	High		
Ecological benefits		off-site benefits	
Soil cover improvement	Negligible	Reduced downstream flooding	High
Increase in soil moisture	High	Increased stream flow in dry season	
Increase in soil fertility	Negligible	Reduced downstream siltation	
Soil loss reduction	High		
Biodiversity enhancement	Negligible		
Production and socio-economic disadvantages		Ecological disadvantages	
Loss of land	Medium	Water logging	Negligible
Increased labor constraints	High		
Increased input constraints	Little		

Offsite benefits

Clean water in the reservoirs just below closed areas (photo 2006)

Economic analysis

No data is available on the economic returns resulting from conservation measures. However, the gross production value is US$ per hectare per year around the SLM Technology area is 100 / ha / yr. With SLM Technology, the gross production value of the land per hectare per year is 160 US$ / ha / yr. Compared to the situation without conservation, percentage gross production value increase 10 years after implementing SLM is 60% also considering area occupied by conservation measures and in assuming current input and prices.

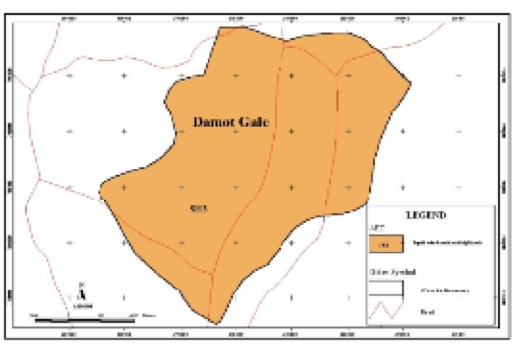
Adoption and adaptation

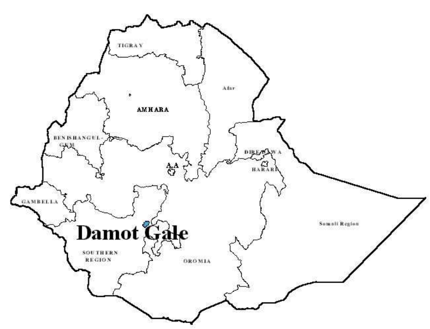
Previous area closure practices consider only natural regeneration to take place by preventing interference, but at present SLM activities, such as tree plantation and over sowing of grass species are included to speed up regeneration and enhance the reaping of the benefits at faster rates.


Earth checkdams in the rehabilitataion of severe gullies and reclamation activities in Damot Galle, SNNPR (photo 2005)

30. Earth-checkdams for gully reclamation (Damot Galle)

Common Name of SLM Technology: Earth structures for Gully reclamation
Associated approach: Food for Work
Contributing SLM specialists:
1. Daniel Danano Dale and
2. Hiywot Desta: Department of Agriculture and Rural Development, Damot Galle, SNNPR, Wollaita Zone
Area information
Basin/Watershed: The lake Basin and Bilate River Basin
Total SLM Technology area: 51.2 sq km





Agroecology of Damote Gale *Location of Damot Gale*

Definition
Earth-checks are established from earth embankment put across in a deep gully to trap sediment and runoff water passing through it.

Description
Earth check dams are small earthen structures constructed in severely degraded and active gullies to control further expansion of the gully, rehabilitate and make it productive. Active deep gullies are plugged by digging earth from the bottom as well as gully sides and embank it, forming a barrier to runoff passing through it. The embankment is reinforced by planting useful plants such as banana, sesbania, grevillea, gesho / rhamnus, etc.

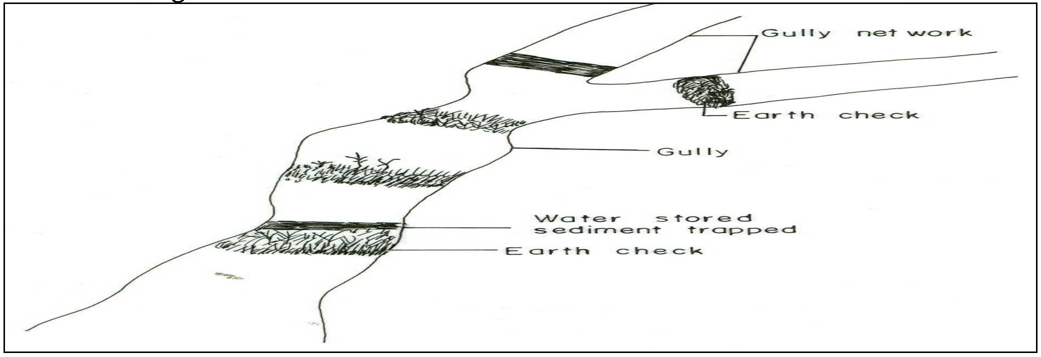
The purpose is to rehabilitate deep active gullies, which expand along sides and towards the head. By constructing earth checks the water is stored in the checks. The water percolates down the ground enriching the ground water. The soil is trapped in the checks and later raises the gully bed high by filling it with transported sediment. As a result, a cultivable strip is formed gradually and it is used to establish trees and other useful plants.

Weeding and cultivation is done regularly to better manage the planted woody and fruit trees. The gully is fenced to protect livestock and the structural measures upslope the gully are frequently repaired. The technology is practically suitable to humid highlands where loss of land by gully is a serious problem and land under cultivation is in growing pressure. In brief it is suitable in areas where land degradation problem is increasing with currently cultivated and grazed lands are seriously threatened by rill and gully erosion. Check dams are constructed in combination with various physical and biological measures such as bund stabilized by grass, legumes and tree species supplemented by cutoff drains placed in the catchment area.

Picture of the technology

Gullies being rehabilitated by earth structures (Photo Hanspeter Linniger, 2008)

Technical design



Degraded lands, severe gullies, low soil fertility, decline in productivity are the major constraints in the area for sustaining agricultural productivity. Before the current intervention, productivity has declined and high amount of inputs were required for crop production and to improve soil fertility. Cutoff drains and the diversion ditch placed at gully head protects the check-dams built successively in the downstream direction. They also reduce the movement of sediment from upper cultivated lands.

L**and degradation**

Types of land degradation on land surrounding the SLM area

Land use	Type of degradation	Percent land affected	Degree	Land form
Mixed/gully	Water erosion	60	VS	R
Grazing land	Water erosion	75	S	PR
	Physical deterioration	80	S	PR
Cultivated land	Water erosion	80	S	PR
	Chemical deterioration	90	S	PR

The woreda lies in the Bilate River basin, which is one of the severely degraded river basins in the country. Owning to vulnerability of soils, poor farming practices and lack of preventive measures substantially large area of the land in the basin is severely degraded. Soils are naturally deep and are inherently fertile. But due to continuous cultivation without measures for improving soil fertility, land productivity has been declining over the years.

Purpose and classification

The major land use problems in the area without SLM: Mono-cropping, soil erosion, fertility mining, overgrazing and improper runoff management. The technology consists of the following.

Measures	Type	Uses
Vegetative measures	Banana, sesbania, grevillea, elephant grass	Increase vegetation and improve production
Structural measures	Earth checks, cutoff drains, bunds, waterways	Water harvesting and silt trapping
Management measures	Fencing and site guarding	Protect from animals and humans
Agronomic measures	Mulches, composting	Fertility improvement

The technology combats land degradation through: control of concentrated runoff, water harvesting, sediment harvesting, slope length reduction and reduction of sediment load to the Bilate River. Erosion by water is the major form of land degradation in Damot Galle woreda and it is the result of inappropriate land use. Rains are seasonally intense and high in amount leading to excessive runoff and soils are susceptible to erosion.

Earth checkdams are planted with useful plants and a cutoff drain is placed above the gully head, to divert flow of runoff into the gullies until they are stabilized well. Once they are stabilized, runoff is let to pass through the gullies and they serve as waterways. Agronomic measures such as inter cropping; crop rotation and green manure are applied to improve land productivity in and around the gullies.

The technology is best described as program. The SLM Technology is mainly new, and is based on previously introduced technologies. The technology is introduced and is modified by adjusting design, layout and by increasing use of locally available materials for construction. Indigenous SLM Technologies have been used before the current SLM Technology was applied. This included: planting eucalyptus on gullies. The aim is to make the gully productive by planting eucalyptus. The technology area is highly populated and there is serious shortage of land. Farmers therefore are forced to rehabilitate the gullies and use them for planting.

Crop and livestock production: Compost is prepared and applied on crop lands that are prepared for planting. Wider oxen furrows are formed for storing rain water and prevent erosion. Compost is applied before sawing and planting. Constraints include: seasonal climatic changes, lack of knowledge, pests and diseases on crops such as sweet potato, maize etc. Possible improvements include: apply pesticides (subsidized), if land is bigger in size chemical fertilizers are feasible.

Tillage is performed several times in the technology area. Up to 4 -5 tillage operations are required for teff and wheat. In the homesteads, Enset and Coffee are planted and are fertilized by manure. Crops such as teff, sorghum, wheat and maize fields are fertilized using chemical fertilizers. Lack of agricultural inputs, shortage and uneven distribution of rains, pests and diseases are problems affecting crop production. Possible solutions for the problems include: awareness creation on land degradation, consequences of declining production and training land users on improved technologies to rehabilitate degraded lands. Vegetative measures are used for soil fertility improvement, firewood, fodder, fruit and additional income sources. Lack of planting materials, free grazing, and lack of proper management are also constraints.

Type and alignment of vegetative measures (m)

Vegetative measures	**Material**	**Plants per ha**	**Vertical interval**	**Spacing**	**Interval**	**Width**
Aligned strips	Sugar cane	3000	0.2	2-4 x 2-4	0.5-2	0.5-1
Dispersed	Leucaena	4000	0.2	1.5 x 1.15	1.5	1.5
Blocks	Grevillea	2500	0.5	2x2	2	2

Construction and maintenance

Activity	Energy	Equipment	Timing	Frequency
Land preparation	Annual traction	Oxen plough	September October	2 times
Land preparation	Annual traction	Spade, rake	September October	Each cropping
Sweet potato planting	Manual labor	Hoe	September	
Sweet potato cultivation	Manual labor	Hoe	October.	
Maize planting	Animal traction	Oxen plough	January or April	
Maize cultivation	Manual labor	Hoe/spade	June	
Teff sawing	Animal traction	Oxen plough		
Teff weeding	Manual labor			

Establishment activities for vegetative measures

Activity	Energy	Equipment	Timing
Land preparation	Manual labor	Hoe	Sep., Oct.
Sugar cane planting		Hoe	Nov.
Sugar cane cultivation		Hoe/spade	Jan./Aug.
Cassava planting		Hoe	April.
Cassava cultivation		Hoe/spade	June
Maize planting	Animal traction	Plough	January 1st plough, April 2nd plough
Maize cultivation	Manual labor	Hoe/spade	June
Sweet potato planting	Animal traction	Plough/hoe	September
Sweet potato cultivation	Manual labor	Spade	October
Fruit trees		Hoe	June

Maintenance activities for vegetative measures

Activity	Energy	Equipment	Timing	Frequency
Pruning	Manual labor	Machet, sickle	October	Annual
Mulching				
Thinning		Axe		
Fencing			Any time	

Specification of structural measures (m)

Structure	Material	Vertical interval	Spacing	Ditch		Bank		
				D	W	L	H	W
Diversion ditch	Earth/ stone	-	-	0.5	1	100	0.6	2-3
Retention/ infiltration ditch	Earth/ stone/ wood	0.5	1-2	0.7	3	50	0.75	2-3
Backward sloping terrace	Stone	1- 2.5	1-2	0.7	0.5	50	0.75	-
Level bund	Earth and stone	0.5	5-20	0.5	0.25	50-100	0.60	-
Reshaping gully wall	Earth	-	-	3-4	5-15	5-15	3-4	

Note: D = depth, W= width, L = length, H= height

Vegetation is used for stabilization of the structural measures. Structural measures stabilized with vegetative measures require very little maintenance. Land users who have better perception of the benefits make maintenance by themselves. To further enhance this: promote awareness creation, avoid or minimize free grazing by encouraging cut and carry, provision of different planting materials and introduce multipurpose tree species to increase land productivity.

Construction activities for structural measures

Activity	Energy	Equipment	Timing
Digging foundation	Manual labor	Spade, hoe	Nov.-Feb.
Forming embankment			
Side wall shaping			
Maintenance activities for structural measure			
Weeding	Manual labor	Spade, hoe	March each cropping season
Cultivation		Hoe	June each cropping season
Replanting		Hoe	Nov.-Feb. each cropping season
Repair on breaks		Spade	
Fence		Axe, Machete	Each cropping season

The management measures include closing the gully and severely degraded areas and undertake plantation. Important constraints during establishment include: interference by livestock, illegal cutting of trees and encroachment of unwanted bush and weeds. Possible improvements include: remove unwanted trees, plant useful species, reduce the number of eucalyptus trees and even exclude it from degraded areas, plant multipurpose trees that enrich soil fertility.

Establishment activities for management measures

Activity	Energy	Equipment	Timing	Frequency
Excluding animals by fencing and guarding	Manual labor	Axe	Dry season and early rains	Twice a year
Construct cutoff drain	Manual labor	Hoe	Early rains	Once a year
Establish buffer zone between area enclosure and cropland	-	-	June/July	
Construct earth checks and trenches in the gully	Manual labor	Hoe, spade		
Maintenance activities for management measures				
Repair breaches on cutoff drain and earth checks		Spade/hoe	Dry season	Once in two years
Pruning, weeding and cultivation	Manual labor	Spade/hoe	End of rains	When need arises

The technology is introduced through the Soil and Water Conservation National Program. Boundary plantations and hedgerows are planted along plots of different crops. Fencing around the technology area prevents livestock from entering to cropped fields and also controls soil erosion by obstructing runoff. Land users have developed the skills of establishing live fences, hedgerows and boundary plantations for a longer period. It includes improved practices such as planting leguminous trees on bunds, boundaries, etc. National specialists train and give advice on the introduced technology for woreda specialists and in turn woreda specialists train DAs and land users.

Natural Environment

Average annual rainfall (mm)	Altitude (m a.s.l.)	Landform	Slope (%)

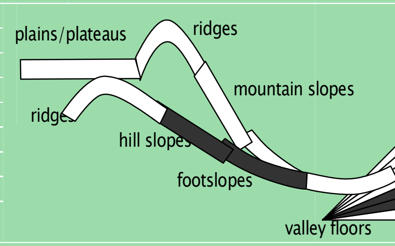
Average annual rainfall (mm)

- [ ] >4000
- [ ] 3000-4000
- [ ] 2000-3000
- [ ] 1500-2000
- [ ] 1000-1500
- [x] 750-1000
- [ ] 500-750
- [ ] 250-500
- [ ] less than250

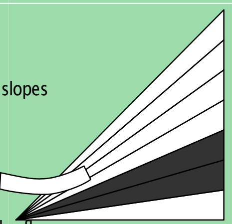
Altitude (m a.s.l.)

- [ ] >4000
- [ ] 3500-
- [ ] 3000-
- [ ] 2500-
- [x] 2000-
- [x] 1500-
- [ ] 1000-
- [ ] 100-500
- [ ] less than250

Landform



Slope (%)



Soil depth (cm)

- [ ] 0-20
- [ ] 20-50
- [x] 50-80
- [x] 80-120
- [ ] less than120

Growing season:
Soil fertility: low, medium
Soil texture: Medium (loam)
Surface stoniness: no loose stone
Topsoil organic matter: low, medium
Soil drainage: good, medium
Soil erodibility: Very high on gullies and crop lands and high in other land uses

Natural environment

Number of erosive water storms per year is over 15 and they mainly occur in the beginning of the growing season. Rainfall in the growing seasons is usually sufficient but not well distributed. The number of growing seasons per year is 2

Human environment and land use

Typical household size of the land users is 6 persons. Population density is greater than 500 persons/km^2. Annual population growth is 3 %. The trend in land size per household is decreasing. Land ownership and land use rights affect SLM. No land redistribution has however been made since the nationalization of land, which provided the opportunity for all farmers to have land, they till.

The vegetative measures practiced for stabilization of gullies and the structural measures constructed are established by planting seedlings raised in nurseries. Banana is propagated at the homesteads while sugar cane is multiplied by cuttings. Other tree based vegetative plants such as Grevillea, eucalyptus; cordia, etc. are raised in the nurseries.

Constraints during establishing are: Shortage of rains in some years, high fertilizer price is often too high, labor, and pests attacking crops such as sweet potato. Constraints during maintenance include: Labor, pests and weed. Possible improvements recommended are: market improvement, fertilizers provision, timely planting, weeding and cultivation and subsidy for pesticides.

There is a marked difference between the better-off and poor land users in how they practice SLM. The rich who are aware of land degradation and soil erosion problem are keen to invest on SLM better than the poor who are aware but no resources. Off-farm income is 10-50% of all income for the land users who apply the SLM technology. Farmers who have SLM measures on their land produce more and hence have better financial income, which allows them to be involved in petty trade and other activities.

The level of technical knowledge required for the implementation of the technology is high for extension workers and moderate for land users. The use of the SLM Technology is moderately hindered, when land users cannot read and write. 60% of land users cannot read and write in the area. Percent farmers who can read and write is increasing as a result of many young people who are school drop outs, ex –soldiers (demobilized soldiers) and jobless who settle in the villages after secondary school completion are land users.

In the past 2-3 years, decline in crop production has been a problem because of the increasing prices of fertilizers. Currently, however, most farmers are engaged in making compost and therefore an increase in crop production is being realized. Most farmers agree that production of maize and sweet potato has increased considerably by applying compost.

Some farmers herd their animals in a piece of land left un-cultivated in the field. The biggest proportion of livestock feed comes from crop residues, which is collected from crop fields. Maize stalk, teff straw and enset leaves are given to animals at home. The current trend in livestock numbers is observed to have shown great reduction owing to lack of fodder and decreasing grazing quality. The number of livestock is seriously decreasing because of lack of grazing land. The number of livestock units per household is 2 small stock and 2 large stock. Livestock such as cows, oxen, donkeys and horse are herded on a very small piece of land left in front of houses usually meant for social occasions.

Intensification of grazing areas with improved techniques is important activity undertaken along with the earth check dam technology. Live fences are also used for fodder production. Lack of follow up, shortage of planting materials, free grazing are constraints in the management of livestock. Suggested solutions include provision of high yielding livestock breeds, use of incentives, encourage cut and carry and controlled grazing.

Construction of bund is undertaken in dry season and plantation is carried out during rainy seasons. Erosion is a serious problem in the area and the technology is rapidly being adapted by land users. Due to high population pressure, land owned by a farmer is distributed among family members. Elephant grass, acacia albida, sesbania and leucaena seedlings planted in the gullies grew fast (picture right) and the rate of regeneration of local species is enhanced when the gully is fenced and rehabilitation measures implemented.

The better-off farmers have ability to implement the technology on their farms by hiring labor and they are aware of the benefits of the technology. Most of the people in the technology area are engaged in agricultural activities and only few are engaged in off-farm activities such as pottery, petty trade, weaving and etc. Most of the land users cannot read and write, which lead to low adoption rate of the technology. Individual implementation approach is the most appropriate for the land users to maintain the technology and reap benefit from the assets created.

Costs (US$)

Category	**Input**	**Quantity**	**Equivalent**
Agricultural	Seedlings	10000	118
Agricultural	Tools	200	270
Labor	Person days	400	282
Total			670

Factors affecting costs in the technology area are the depth and width of gully, steepness of slope, planting and replanting of vegetative materials. Costs were calculated on the basis of length and width of structure. Daily wage cost of hired labor to implement SLM is 0.75US $ per person per day.

Benefits, advantages and disadvantages

Production and socio-economic benefits		**Socio-cultural benefits**	
Crop yield increase	High	Community institution strengthening	High
Fodder production increase	Medium	Improved knowledge SLM/erosion	
Wood production increase	High		
Farm income increase			
Ecological benefits		**off-site benefits**	
Soil cover improvement	Negligible	Reduced downstream flooding	High
Increase in soil moisture	High	Increased stream flow in dry season	
Soil loss reduction			
Biodiversity enhancement			

Production and socio-economic disadvantages		**Ecological disadvantages**	
Loss of land	Medium	Water logging	negligible
Increased labor constraint	High		
Increased input constraints	Little		

Estimates of production

With or without SLM	Main plant	Production (t/ha/yr)
Without SLM	Maize	1
Without SLM	Sweet potato	1.5
With SLM	Maize	1.5
With SLM	Sweet potato	2.5

Economic Analysis

Without SLM, the gross production value in US$ per hectare per year around the SLM Technology area is 140 US$ / ha / yr. Compared to the situation without conservation the percentage gross production value increase 10 years after implementing SLM is 100% considering also the land occupied by conservation measures and assuming current input and prices.

Adoption and adaptation

The technology emanated on changes in the design, construction material and layout. Earth checks are established with earth as a construction material and are stabilized by planting vegetative material. No standards for design and layout have been applied and as a result the dimension of each check is made sufficient to accommodate the runoff coming in. Earth checks are very closely spaced compared to stone checks. The height of the checks varied from the smallest 0.5 m to 2 m and the spacing from 1-4 m. 100 % of land users that have applied the SLM Technology have done it with incentives.

Supportive measures

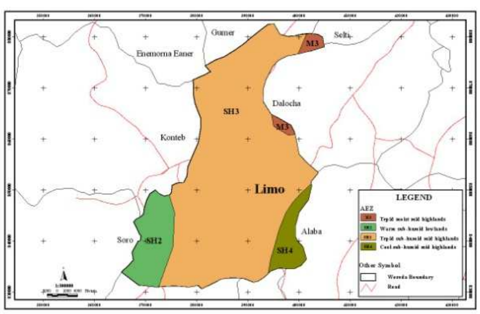
The gully catchment is partly grazing and partly cultivated land treated with physical conservation measures such as soil bunds, fanya juu and cutoff drains. Cutoff drain is constructed above the cultivated lands. It has a dimension of top width 1.5m, bottom width of 0.9m and depth of 0.50m and stabilized with grass. The cutoff drain is supported by small check dams placed at intervals. Natural waterway is used to convey excess water that comes from the cutoff drains and the bunds. Early planting helps to attain a good ground cover during the time of erosive rainfall.

Degraded land rehabilitation by enclosures and planataions (photo 2005)

Rehabilitated closures (photo 2006)

31. Microbasins with trenches for area enclosures, Lemo (Hadiya)

Common Name of SLM Technology: Area closure
Local or other names: Kutura (Hadiyisa)
Contributing SLM specialist: Solomon
Associated Approaches: Food for Work, Lemo Woreda Agriculture and Rural Development Office, SNNPR
Area information



Agroecological map of Limo Woreda

Location of Limo Woreda

Definition

Microbasins and trenches are small water retention measures usually constructed to retain rainwater in degraded areas that are closed for rehabilitation.

Description

Microbasins and trenches of various sizes are constructed to retain rainwater in closed areas. Management of closed areas comprises all processes that enable attain rapid rehabilitation of severely degraded lands. It starts with excluding human and animal interference and at the same constructing physical SLM measures and enrichment plantations. Microbasins are applied together with trenches and bunds of small sizes to trap maximum rain water in the closed areas. The objective of closing area is to allow natural regeneration and taking additional measures to improve the quality of soils and improve the survival rates of trees planted. Area closure is suitable for reclaiming degraded lands of all kinds. Degraded areas are excluded from animal and human contact and integrated with activities such as agronomic measures, structural, vegetative and management measures. Area closures improve the productivity of degraded lands, protect down slope fields from flooding and improve ground water recharge. Management and utilization plan is prepared by SLM specialists in consultation with the community members. Area closure is applicable in all areas that have lost vegetative cover and land productivity.

Area closures are the most successful conservation measures practiced in the technology area. Soil erosion substantially reduced from the closed area as well as on cultivated lands down the slope, when degraded hill slopes are closed.

Picture of the technology

Microbasins with planting pits in Lemo (photo 2004)

Area rehabilitataed with microbasins and other small structures in Lemo (photo 2005)

The practice of area enclosure and planting on gullies is not entirely a new technique. The picture shows some of such activities practiced by land users for years in the technology area. Moreover, land users have the practice of fallowing land for a given period with the aim of restoring its fertility through natural processes. In some cases letting animals to graze on fallow lands allows animals to drop their dung there. In practicing area enclosures, degraded and bare lands are converted to vegetated landscapes with further cut and carry practic employed to feed animals at home. The picture right shows a very good stand of eucalyptus trees planted on a gully.

Eucalyptus planted in a gully by a farmer (Ana Limu), Hossana, SNNPR

Useful trees , grasses and shrubs are raised in nurseries to be seeded and planted in closed areas. Some species are directly seeded on closed areas and establish there. Planted species have higher chances for establishing and survival while directly seeded species may face problems of low germination but once they germinate do establish well.

Major land use problems in the area without SLM are: overgrazing, lack of awareness among land users, lack of proper management practices, shortage of grazing lands and lack of common understanding on the management of common resources. The technology consists of vegetative, structural, management and agronomic measures. The goal of the technology is to restore productivity of land and improve income of land users. The types of land degradation mainly addressed by the technology are: loss of topsoil by water , gully erosion, fertility decline and reduced organic matter.

The technology combats land degradation through: increase of infiltration, improvement of ground covers, water harvesting, maintain water stored in the soil and increase in soil fertility. Microbasins and leguminous plants improve moisture retention and improving of soil fertility the two most important aspects. Similar traditional practices have been used in the past and are being used to a very less extent at the moment. Fallowing was largely practiced before but currently owing to high population growth every plot is continuously cultivated.

Field activity for vegetative measures

Activity	**Energy**	**Equipment**	**Timing**
Seedling production	Manual labor	Hoe, shovel	Throughout the year
Transportation	Vehicles		Beginning of rains
Planting	Manual labor	Hoe	Beginning of rains
Maintenance activities for vegetative measures			
Replanting	Manual	Hoe	During rains
Weeding and cultivation	Manual	Hoe	

Field activities for agronomic measures

Activity	**Energy**	**Equipment**	**Timing**
Land preparation	Oxen	Ox plough	Beginning of rains
Planting	Oxen	Ox plough	

In crop fields where there are no conservation measures the risk of erosion is high. Constraints: Shortage of farm lands, low awareness on agronomic measures. Possible improvements: Improved technologies introduced to the area have increased productivity per unit area of land.

Construction activities for structural measures

Activity	**Energy**	**Equipment**	**Timing**
Surveying	Manual	Line level	Dry season
Digging ditches and placing structural measures		Hoe, shovel	
Construction of structural measures		Spade, shovel	
Stabilization of terraces by planting grass and trees		Hoe	Rainy season
Maintenance activities for structural measures			
Replanting of terraces	Manual	Hoe	Rainy season

Specification of structural measures
Type and alignment of vegetative measures (m)

Structure	Material	Vertical interval	Spacing	Depth	Width	Length	Height
Microbasins	Earth	0.1-0.5	2--5	0.25-0.3	0.5-1	-	0.25
Trenches		0.4-1	5-7	0.3-0.5	03-0.5	3-5	0.30
Retention/ infiltration ditch		1	10	0.5	0.3	3	0.3
Forward sloping terrace		1.5	10	0.3	0.5	5	0.3
Terrace		2	10	0.3	0.5	5	0.3

Structural measures help increase moisture content of the soil. These include: water-harvesting structures such as micro basins, trench, eyebrow, micro ponds and half moon structures. To reduce the slope length, structures that control soil erosion such as hillside terrace, check dam and trenches are applied in combination.

Activities for establishment of management measures

Activity	**Energy**	**Equipment**	**Timing**
Delineating the degraded area and survey	manual	Surveying equipment	Dry season
Awareness creation for land users/meeting with land users		Meeting	Off-farm seasons
Planting			Off-farm seasons
Fencing and assigning site guards	Manual	Hoe, axe	Any time but specially before rains
Maintenance activities for management measures			
Repair fences	Manual	Hoe, axe	After rains

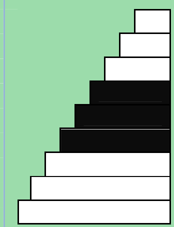
Close follow up, monitoring, periodical review and evaluation is needed to improve results. Constraints during establishment: Low awareness, shortage of technical staff. Constraints during maintenance: ownership questions. Possible improvements: Awareness creation, training, experience sharing and assuring user rights

Natural Environment

Average annual rainfall (mm)

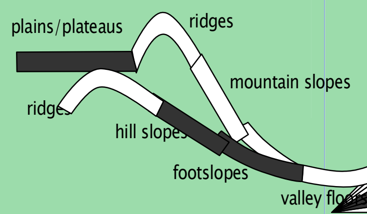
>4000
3000-4000
2000-3000
1500-2000
1000-1500
750-1000
500-750
250-500
less than250

Altitude (m a.s.l.)

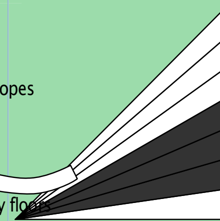


>4000
3500-
3000-
2500-
2000-
1500-
1000-
100-500
less than250

Landform



Slope (%)



very steep (>60)
steep (30-60)
hilly (16-30)
rolling (8-16)
moderate (5-8)
gentle (2-5)
flat (0-2)

Soil depth (cm)

0-20
20-50
50-80
80-120
less than120

Growing season:
Soil fertility:
Soil texture: fine (clay), medium (loam)
Surface stoniness: no loose stone
Topsoil organic matter: medium (1-3%), Low (less than1%)
Soil drainage: good, medium
Soil erodibility: high, very high
Soil water storage capacity: high, medium

Rainfall in the main growing season is sufficient but not well distributed. Number of growing seasons per year is 2 but the second season is less used for growing annual crops because it is of short duration and low in amount.

Human environment and land use

Typical household size of the land users is 6 persons. Population density is 200-400 persons/km^2. Annual population growth is 3%. The trend in land size is decreasing because of high population pressure. Land ownership and land use rights affected SLM strongly. Subdivision of land similarly affected the implementation of the SLM Technology strongly.

Off-farm income for the land users who apply the SLM technology is less than 30% of all income. Some land users are engaged in small trading and some are daily laborers in the off season. Level of technical knowledge required for implementation of the technology is moderate for field extension worker and moderate for land users.

Land cultivation

Energy	Tool used	% usage
Animal traction	Oxen plough	80
Manual labor	Hoe and Geso	20

Intercropping is practiced and the crops intercropped include: Maize – Haricot beans, Chat –and Cabbage. The cropping systems and sequence of crops: cereals – legumes –cereals. Croplands are used for growing cereals, which are used for consumption and market. The most commonly grown cereal crops are wheat, barley, horse bean and peas. These are largely for market and partly for consumption. Enset is the dominant food crop. It is a plant whose stem and the tuber are processed for Kotcho making. Kotcho is a staple food in the area.

Animal production

Large stock	**Cattle, mule, donkey, horse**
Small stock	Sheep, goat

There is substantial change in the current trend in herd types. The number of livestock units per household is 2 small stock and 2 large stock but this used to be over 4 small stock and 5 large stock some 30-40 years before. The current trend in livestock numbers is showing reduction because of shrinking grazing lands. In spite of decreasing grazing lands, farmers still want to own a given number of livestock. Grazing lands are increasingly being pressurized by expanding cultivated lands. Land users cut grass from area closures and carry home to feed the livestock. Land users who have plots for grazing close them to rest for a short period to let grass to grow. Land users cut the fresh green grass to feed animals at home or cut and make hay in the early period after the withdrawal of rains. Enset is used as fodder crop for animals especially during the dry season.

Natural forests do not exist. The community manages planted forests. In the SLM area, a large area has been planted some years back but at present the planted forests have been cleared for cultivation. This is the result of high population growth. Some of the planted forests have been sold or cleared for cultivation. Area enclosures and rehabilitating of degraded lands technology is appropriate to all areas that are degraded as a result of human activities. The most effective technology is area enclosure supported by rehabilitation enhancement measures (water harvesting and plantation). Areas that were severely degraded are seen to have recovered very fast owing to closures and additional measures exercised to speed up the rehabilitation process.

Important factors affecting the costs of construction, maintenance and management of the technology are slopes and depth of soil. Steep slopes and shallow soil depths increase the cost of construction. The cost is calculated for labor needed to construct SLM activities to rehabilitate a hectare of degraded land. Daily wage cost of hired labor to implement SLM is 0.7 US $ per person per day.

Benefits, advantages and disadvantages

Before land management practices were implemented, soil fertility of the land was low because of no measures taken to improve fertility and soil erosion. Today because of structural, vegetative, agronomic and management measures practiced, soil loss is controlled and in the mean time productivity of land is increasing.

On-site and off-site benefits the technology

I) Production and socio-economic benefits	Degree and explanation
Crop yield increase	High: soil depth and soil fertility improved
Fodder production/quality increase	Medium: biomass increased
Wood production increases	Medium: construction and fuel wood
Farm income increase	Medium: land productivity per unit area improved
Moisture retention	Medium: productivity is enhanced
II) Socio-cultural benefits	
Community institution strengthening	High
Improved knowledge SLM/erosion	High
Ecological benefit	
Soil cover improvement	High : vegetative cover is improved
Increase in soil moisture	Medium
Efficiency of excess water drainage	Medium
Increase in soil fertility	Medium
Biodiversity enhancement	High: disappearing species regenerated
Off-site benefits	
Reduced downstream flooding	High: runoff from the watershed reduced
Increased stream flow in dry season	High: ground water recharging is improved
Reduced downstream siltation	High: sediments deposited behind the bund

The technology could be improved to achieve more benefits by

Measures	Degree of improvement
Encouraging cut and carry system	High
Integrating with multipurpose tree plantation	High

Economic analysis

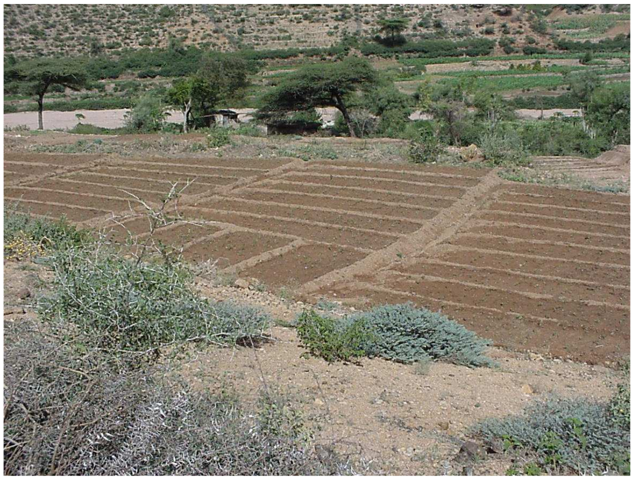
Without SLM the gross production value in US$ per hectare per year around the SLM Technology area is less than 200 / ha / yr. With SLM Technology, the gross production value of the land per hectare per year is over 400 / ha / yr. Compared to the situation without conservation, percentage gross production value increase 10 years after implementing SLM by considering the area occupied by conservation measures and assuming current input and prices is over 100%

Adoption and adaptation

Changes have been made to the technology from the previous activities that give more focus on physical SLM measures to more of planting and sowing trees and planting grass seedlings nowadays. About 97% of land users that have applied the SLM Technology have done it with incentives. About 3800 land user families have been involved and are beneficiaries. Only 3 % of land users that have applied the SLM Technology have done it without incentives. They are about 190 land user families

There is a growing trend towards spontaneous adoption of the technology. Farmers have made some improvements by making fences around enclosures, in order to increase the effectiveness of the technology. There is enough local skill and support to expand the SLM Technology. Land users have learned from their own experiences and continued to apply the technology by their own. The SLM technology is set up in a way that it will be durable, or can be easily maintained and kept in good shape. Area enclosures are suitable to all conditions. However, rapid regeneration is obtained in where the soils are relatively deep. The technology requires continuous maintenance and upgrading in order to improve the productivity per unit area of land. Maintenance is done by the farmers themselves by using their own resources.

VII. Runoff water harvesting practices

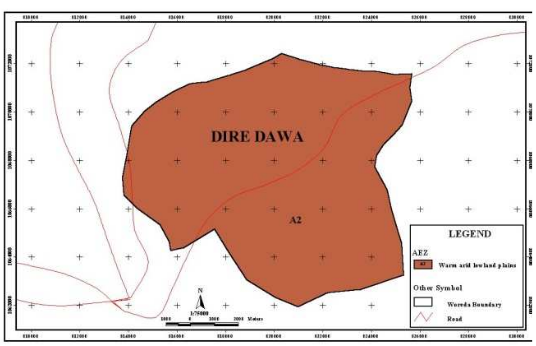


Runoff and flood water harvesting in DireDawa (Photo 2006)

Fruit trees grown by spate irrigation from the ephemeral river (Photo 2006)

32. Runoff and floodwater farming (DireDawa)

Common Name of SLM Technology: Runoff/floodwater farming
Local or other name (with language): Korbe (Oromifa)
Associated Approach: 1. Self Help 2. Food for Work
Contributing SLM specialist Daniel Danano Dale, Ministry of Agriculture and Rural Development, Addis Ababa
Email: ethiocat@ethionet.et / danieldanano@ethionet.et
Area information Technology area is greater than1000 sq km
Basin/Watershed- The Wabi Shebele and the Danakil Basins



Agroecology of Diredawa

Location of Diredawa

The main diversion ditch which starts at ephemeral river course is seen at the right side. Runoff or flood water diversion is a very common farming practice in Dire Dawa and the surrounding areas. Runoff and flood water from ephemeral rivers, road discharges and runoff from hillsides is diverted for supplemental irrigation as the one seen in the picture right.

Cultivated fields are prepared in rectangular blocks (Picture right), which are leveled and shaped to allow maximum retention and capturing the runoff water. Korbe is a local name for the technology (land preparation for irrigation by flood water). Korbe is very suitable for horticultural, fruit trees and high value crops. Cereal crops are irrigated in field size plots. The return from vegetables and fruit trees is higher than from cereals. Basins for storing runoff / flood water divereted from ephemeral streams, roadsides and hillsides, in DireDawa (photo 2005) is seen in the picture at the right.

Flood water directed to crop filed

Land prepared for runoff water cropping (photo 2006)

Flood water diverted through large canals from ephemeral river course

Land prepared for flood water irrigation and cropping

Land users cultivating in the valley floors depend largely on the runoff water received from the cathments on upslopes for growing crops. Land users know when they expect flood and prepare the land quite ahead. If they see there is rain on the hills at far distance they rush to the field to let the plots watered. This couyld happen even at night using torch light. The plot of each land user is irrigated on the time schedule prepared. The flood water users have bylaws by which they are governed.

A secondary canal conveying flood water to cultivated fields

Definition

Runoff or flood farming is a practice that involves diverting flood or runoff water from different sources to a field for growing vegetables, fruit trees and crops of high value.

Description

Flood and runoff is diverted by means of ditches and conveyed to cultivated fields by secondary and tertiary ditches. The land to be irrigated by spate irrigation is leveled and fine seed bed is prepared before the water is diverted to the field. Korbe is a system of farming where the land is prepared to an extent of storing maximum runoff with minimum erosion risk. The purpose of the technology is to make maximum use of runoff / flood water for growing economically useful crops such as chat, fruits and vegetable crops using water diverted from ephemeral rivers, roads and hillsides. Diversion canal is constructed during the dry season and is directed to the fields that are ready for planting. Maintenance on breaks along the canal and water conveying ditches is made every season before the onset of rains. The technology is suitable to semi arid, arid and dry areas where rain water is not enough for meeting the requirements of consumptive use.

The Technology is applicable in Semiarid to Arid agroclimatic zones

Land degradation

Types of land degradation on the land surrounding the SLM area

Land use(	**Type of degradation**	**% area**	**Degree**	**Land form**
Cultivated land	Water erosion	60	l	HP
Shrub and shrubs		30	m	
Grazing land		10	m	HP

Owning to topographic and soil conditions favoring erosion processes, the area around the SLM technology is extremely degraded. There are intensive cultivation practices involving tillage and cultivation of land several times. No ground cover or weed is left to exist in crop fields planted with sorghum and chat. Sorghum is clean tilled and hence the field under it is very susceptible to erosion. In the cultivated fields with the SLM Technology, erosion could have been more severe if basins and ridges have not been placed. Soils are very loose and highly susceptible to erosion on account of the texture of the soils which are dominantly sand.

Purpose and classification

Land use problems in the area without SLM are: Overgrazing on hill slopes, human and livestock interference in area enclosures, use of crop varieties of low production, low fertility of soils and the associated decline in production and erratic rains.

The technology consists of structural, vegetative and agronomic measures combined. It combats land degradation through reduction of slope angle, water harvesting, control of dispersed runoff, increase infiltration, water spreading and increase in soil fertility. Picture of the main diversion canal taken during the dry season is seen on the right. Rains are highly erratic in the technology area and sorghum planted can be seen to be wilting far right on the picture owing to shortage of rain in the highlands that contribute flood to the low lands.

The technology is best described as local. It is mainly indigenous, including new practices. The technology evolved locally to address moisture availabilty for crop production and reduce top soil movement by runoff. At present, improved techniques of constructing diversion ditches and efficient techniques for preparing Korbe are being practiced. Seed bed is prepared on a level or nearly level ground. Diversion ditches are constructed that direct water from seasonal rivers to the cropped land by means of primary, secondary and tertiary ditches.

The aim of the technology is to maximize the efficiency of runoff water use for crop production by leveling land bounded by ridges. Today, the indigenous SLM is used more. The technology area is characterized by erratic rains, erodible, loose and shallow soils and high consumptive use of rainwater owning to hot climatic conditions. Crop failure is a common phenomenon in the absence of supplemental irrigation. The land is leveled and partitioned into blocks for maximizing water use efficiency. The initial design is by land users and certain adaptations have been made by technical people. The layout of the diversion ditches have been improved so that the gradients are kept safe. Soil fertility improving measures such as compost and mulching are integrated.

The appearance of the applied technology has moderately changed over time. The land users were using the diverted water on sloping fields in the past but at present they level the land for better moisture conservation and erosion control. Fine seed bed preparation is required for better germination in case of seeding. Important constraints: Labor is the main constraint for most of the households. Land preparation, leveling and shaping by way of ridges and basins is a high labor demanding activity. Cost of establishment is high, vegetable seeds and seedlings are costly, work tools are expensive. Possible improvements include: use of animal traction for preparing the land and use improved scoop for leveling the land to the desired shape and direction.

Type and layout of vegetative measures (m)

Vegetative measure	Material	Plants /ha	Between rows		Within rows	
			Vertical interval	Spacing	Interval	
aligned: contour	Fruit trees	400-1000	0.30-0.50	1.80-3.80	3x3 – 6x6	
aligned: graded strips	Vegetables	10,000 – 40,000		0.5 x 0.5 – 1x 1		
in blocks	Fruit trees	400-1000	0.30	4x 4		
in blocks	perennial crops	1500-3000	0.10	2x4		

Type and alignment of structure (m)

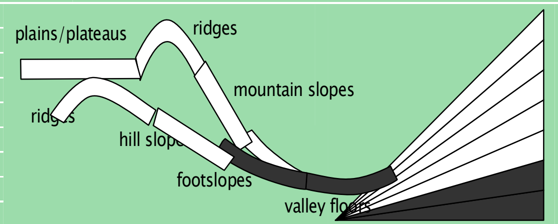
Structures	Material	Ditch			Embankment		
		Depth	**Width**	**Length**	**Width**	**Width**	**Height**
Diversion canal	Earth	0.3-0.5	1-3	200-2000	0.30	1-2	0.5
Diversion canal	Stone	0.3-0.5	1-3	200-2000	0.30	1-2	0.5
Reshaping surface	Earth	0.3-0.5	3-4	0.2-	0.3	0.25	0.3

The diversion canal particularly from ephemeral river course is a permanent structure and in some cases it could be a temporary one. The basin on where vegetables are planted is temporary while basins for trees planting are permanent. Every time preparation of land is performed, seedbeds are prepared again and again which means changes in size and orientation of bed is often done. Labor is the main constraint for constructing diversion ditches, preparation of blocks (ridges and basin) and also spreading the runoff water. Financial problem is also another problem. Constraints during maintenance include: labor, inputs (seed, agro-chemicals).

Possible improvements: Providing improved farm tools could improve efficiency of operation, credit provision solves financial problem and facilitating market would motivate land users to get more engaged in the business and organizing farmers in groups for sharing labor would mitigate labor problems. Irrigated land is prepared by leveling the land. The use is to increase water use efficiency, avoid water loss, and control soil erosion and fertility losses. Runoff diversion canals need to be maintained regularly. Parts that are damaged by scouring, sediment/ silt to be removed and breaks in the embankment must be repaired.

Natural Environment

Average annual rainfall (mm)	Altitude (m a.s.l.)	Landform	Slope (%)
>4000	>4000		very steep (>60)
3000-4000	3500-		steep (30-60)
2000-3000	3000-		hilly (16-30)
1500-2000	2500-		rolling (8-16)
1000-1500	2000-		moderate (5-8)
750-1000	1500-		gentle (2-5)
500-750	1000-		flat (0-2)
250-500	100-500		
less than250	less than250		



Soil depth (cm)	
0-20	**Growing season:**
20-50	**Soil fertility:** low, medium, very low
50-80	**Soil texture:** Coarse (sandy)
80-120	**Surface stoniness:** some loose stone, abundant loose stone
less than120	**Topsoil organic matter:**
	Soil drainage: Good
	Soil erodibility: very high, high
	Soil water storage capacity: low, very low

The number of erosive water storms per year is less than 10. Heavy storms occur in the beginning of the growing season. Rainfall in growing season is usually insufficient and not well distributed. The technology is most appropriate to semi-arid and arid conditions, where soil moisture for growing crops is a crucial problem. It is also suitable for vegetables, fruit trees and for growing cash crops such as Chat. There is a marked difference between the rich and poor in how they practice SLM. The better-off farmers practice the technology and also maintain it well compared to the poor who lack finance and labor.

Crop and livestock production

Land cultivation is performed by**:** 1. Animal traction: gentle slopes are cultivated by animal traction and 2. Manual labor: steep slopes and land between narrow terraces is cultivated. Major crop is sorghum followed by maize and sweet potato. Chat is the major cash crop, Cropping is predominantly rain fed with flood farming practiced as the most essential method for filling the gap of moisture limitation on the valley floors.

Water supply	Type of cultivation
Rain fed	Continuous cereal cropping
Post-flooding	Growing vegetables and fruit trees

Intercropping is practiced well. Crops intercropped include: Sorghum with chat; cereals with pulses. Sequence of crops: Sorghum - Sweet potato- Sorghum; Chat - Sorghum - Sweet potato. The most commonly grown crop in the technology area is sorghum. It is a local variety and very little research has been carried out to improve the local varieties. Farmers prefer local varieties because of the qualities to stand harsh conditions. Chat is mainly grown as a cash crop.

Cost per hectare (US$)

Activities / Item	Unit	Quantity	Cost
Diversion ditch	Km/ha	0.1	128
Seed bed preparation	Pd/ ha	24 oxen and 100 Pd	125
Seeds of vegetables	Gm/ ha	40	71
Seedlings of fruit trees	Fruit trees/ ha	1000	35
Weeding and cultivation	Pd/ha	50	43
Harvest	Pd/ha	75	64
Irrigating	Pd/ha	150	128
Total			594

Cost recovery

Year	Establishment Cost	Recurrent cost	Total cost	Benefit	Net benefit
1	594	30	624	850	226
2	431	32	463	920	457
3	431	34	465	950	485
4	431	34	465	1176	711
5	431	34	465	1176	711
6	431	34	465	1176	711
Total			2947	3896	3301

The most important factor affecting the cost is labor. Labor is required to construct diversion ditches, making blocks and seedbed preparation. Costs have been calculated on the basis of length of a diversion ditch and for a 0.5 ha of the land is planted by fruit trees and 0.5 ha planted with vegetables. Daily wage cost of hired labor to implement SLM is 0.85 US $ per person per day.

Benefits, advantages and disadvantages

Production and socio-economic benefits: Degree and explanation		**Socio-cultural benefits: Degree and explanation**	
Crop yield increase	High	Community institution strengthening	High
Fodder production/quality increase		Improved knowledge SLM/erosion	
Wood production increase			
Farm income increase			
Ecological benefits			
Soil cover improvement	High	Reduced downstream flooding	High
Increase in soil moisture		Increased stream flow in dry season	
Increase in soil fertility			
Soil loss reduction			
Offsite benefit		High	
Reduced downstream flooding	High		

Production and socio-economic disadvantages		**Ecological disadvantages**	
Loss of land	Medium	Water logging	Negligible
Increased labor constraints	High		
Increased input constraints	Little		
Hindered farm operations	Negligible		

The technology could be improved to achieve more benefits by

Placing permanent structures at the diversion head (concrete)	High
Making paved ditches- improves channel stability	Medium
Training on: time and amount of runoff water application	
Use of high value vegetables and fruit trees	

Economic analysis

Without SLM, the gross production value in US$ per hectare per year around the SLM Technology area is less than 200 / ha / yr. With SLM Technology, the gross production value of the land per hectare per year is about 500 US$ / ha / yr. Compared to the situation without conservation percentage gross production value increase or decrease 3 years after implementing SLM is 100%, taking into account production losses due to the area rendered non-productive because of the presence of the SLM measures and further assuming the current inputs and prices. Compared to the situation without conservation percentage gross production value increase or decrease 10 years after implementing SLM is 400% considering also the space occupied by conservation measures and further assuming current input and prices.

Adoption and adaptation

Changes that have been made to the technology include leveling the cropped area, laying out diversion ditches at safe gradients and methods of runoff water application involving efficient use of runoff water and surplus arrangements. The SLM Technology is designed in such a way that it allows changes by the land users to adapt to changing land use practices. These include orientation of beds for planting vegetables, the spacing between plants and rows, use of diverse crops and plant species. About 100% of land users that have applied the SLM Technology have done it wholly voluntarily, without any incentives except technical guidance.

Supporting measures

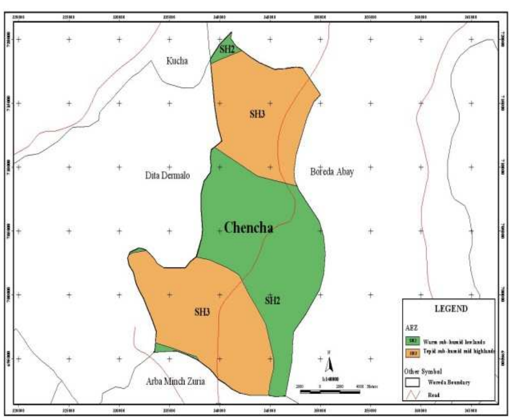
Supportive measures: stone bunds and soil bunds

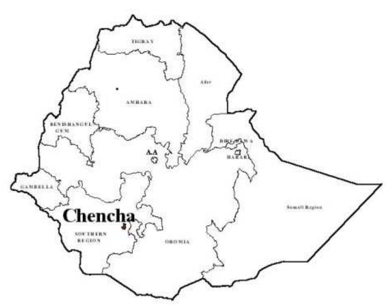
VIII. Grazing land management

Grazingland development with cut and carry in Chencha (photo 2003)

33. Grazingland improvement (Chencha)

Common Name of SLM Technology: Grass Land Improvement
Local or other name(s): Kaloa (Gamo)
Associated approach: Voluntary labor assistance and labor-share (Debo/Wenfel)
Contributing SLM specialist: Tesfaye Chumba, Office of Agriculture and Natural Resources, Chencha, SNNPR
Area information
Regional state: Southern Nation, Nationalities and Peoples Region
Basin: The lakes basin





Agro ecology of Chencha

Location of Chencha

Definition

It is a practice involving land preparation, sawing seeds and planting grass and shrub seedlings for fodder production and in the meantime improve land quality.

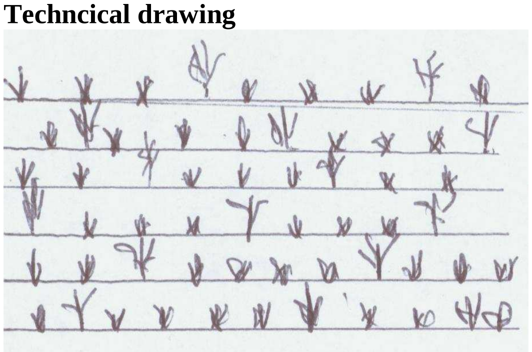
Description

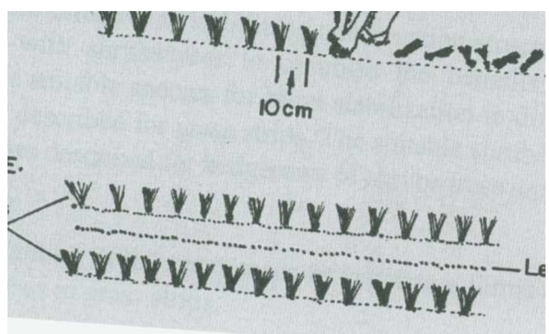
Grazing lands are excessively grazed resulting in shortage of animal feed and exposed the land to erosion. The Woreda Agricultural Department of Chencha assisted by MERET project has established a demonstration site for improving grazing lands. Individual land users were given plots in the site and technically assisted to plant seedlings of fodder trees and Desho grass. Improved grass and fodder species such as sesbania, leucanea and tree leucern were planted mixed with Desho grass. The purpose is to increase availability of feed for animals and reduce soil erosion that is taking place due to overgrazing. Establishment/maintenance activities include: land preparation by hoe, sowing, weeding and guarding. High quality grass of Desho is planted and is harvested 2-3 times a year for feeding animals.

Area under improved grazingland management with Desho grass and fodder trees such as sesbania and leucanea, Chencha (photo 2003)

Grass is cut and carried home to feed animals (photo 2003)

Techncical drawing





Technical functions

Main

Increase livestock feed availability and quality
Improvement of ground cover

Secondary

Increase soil fertility

Major land use problems in the area without SLM include shortage of land, population pressure, soil erosion, low soil fertility and reduced agricultural production.

Land degradation

Types of land degradation on the land surrounding the SLM area

Land use(s)	Type of degradation	Degree	%	Landform(s)
Cropland	Water erosion	s	70	PRHMF
Grazing land	Chemical deterioration	m	12	PRMF
Forestland	Chemical deterioration	m	10	RMH
Grazing land	Physical deterioration	m	8	P

Characterization and purpose

The technology consists of vegetative measures and management measures. The technology combats land degradation through improvement of ground cover and increasing soil fertility. The technology is not intended to provide off-site benefits. The technology is best described as a project activity promoted. The technology is not entirely new. Improvement techniques have been included to increase productivity of land and improve quality of grazing. Traditional SLM Technologies have been used before the current SLM practice was introduced.

Traditional practices existed long ago which consider exclusion of grazing animals from the area by fencing the area. This improves growth of grass, which after 3-4 months is cut and used for hay making or taken home immediately after cutting to stall-feed animals. Today the traditional SLM technology is continued and maintained. Some farmers prefer traditional grazing systems because they cannot establish the improved grazingland technology because it demands high labour. However, better-off farmers prefer the improved grazing land management because they have capacity to manage.

Construction and maintenance

Field activities for agronomic measures				
Activity	**Energy**	**Equipment**	**Timing**	**Frequency**
Plowing	Manual labor	Hoe , Tsoile (a local farming tool)	Dry season	3 times
Plowing	animal traction	oxen, farm implements		3 times
harrowing	Manual labor	Tsoile		once
Manure application		Tsoile, shovel	onset of rain	2 times
Establishment activities for vegetative measures				
Fencing	Manual labor	Hoe, wood	Dry season	Once
Plowing		Oxen plough	During rains	3-4
Plowing		Oxen plough		
Transplanting grass	Manual labor	Hoe		
Applying compost				
harvest			End of rains	

Maintenance activities for vegetative measures				
Fence maintenance	Manual labor	Hoe	Throughout the year	2-3 times/year
Replanting and fertilizing grass		Hoe	During rains	
Compost application		Wheelbarrow	Mid of rain season	
Establishment activities for management measures				
Fencing		Axe, hoe	Dry season	

Crop and livestock production

Land is cultivated manually by Tsoile (a local tool for digging) or ploughed by oxen. Manure application, weeding and cultivation are done to ensure proper survival and growth of the trees and grass planted. When the planted grass gets older it is removed and replaced by new grass. Constraints during establishment and maintenance include: Labor, inputs such as seeds and seedlings, lack of awareness of the community and low level of participation. Promoting awareness, improving production per unit area and use of locally available materials (animal dung, compost) and maximizing the use of inputs are measures for tackling the constraints. Better management measures such as good seed bed preparation, pulverizing the soil, sowing and splitting, transplanting, compost application help achieve better results. Main livestock management practices of land users is mostly free grazing (70%) out in the field and (30%) stall-fed. Importance of livestock: means of income, draught power, dairy milk and prestige for very few land users.

Current trend in herd types is more of small stock. There is slight change due to new knowledge gained from grazing land improvement interventions. The number of livestock units per household is 1 small stock and 4 large stock. The current trend in livestock number shows slight reduction. The management of grazing land and livestock production is difficult owing to: reduced grazing land, lack of feed and size of grazing land per household, which is extremely low.

Natural Environment

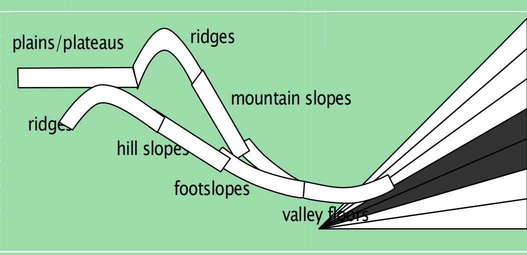
Average annual rainfall (mm)

- >4000
- 3000-4000
- 2000-3000
- 1500-2000
- 1000-1500 ■
- 750-1000
- 500-750
- 250-500
- less than250

Altitude (m a.s.l.)

- >4000
- 3500-
- 3000- ■
- 2500- ■
- 2000-
- 1500-
- 1000-
- 100-500
- less than250

Landform / **Slope (%)**



- very steep (>60)
- steep (30-60)
- hilly (16-30)
- rolling (8-16)
- moderate (5-8)
- gentle (2-5)
- flat (0-2)

Soil depth (cm)

- 0-20
- 20-50
- 50-80 ■
- 80-120 ■
- less than120

Growing season:

Soil fertility: low, medium

Soil texture: medium (loam), fine (clay

Surface stoniness: no loose stone

Topsoil organic matter: low (less than1 %), medium (1-3%)

Soil drainage: medium

Soil erodibility: very high, high

Human environment and land use
Typical household size of the land users is 7 persons. Population density is 200- 500 persons/km^2. Annual population growth is 3-4 %. The trend in household land size shows a decrease due to high population growth and the growing need for cultivated land specially by the young people and the landless. No trends towards privatization of land. All land belongs to the public and the government.

Land ownership and land use rights have not affected SLM. Land users did not feel that the land is not theirs. However, subdivision of land seriously affected the implementation of the SLM Technology as land size gets smaller. There is no marked difference between the better off and poor in how they practice SLM. Off-farm income provides 50% of all income for the land users who apply the SLM technology. Most land users are engaged in other income generating activities such as petty trade and weaving. Level of technical knowledge required for implementation of the technology is high for field staff / extension workers and moderate for land users.

Benefits, advantages and disadvantages
Estimates of production

With or without SLM	**Crop / plant**	**Production (t/ha/yr)**
Without SLM	Local grass	5
With SLM	Improved and local grass	30

On-site and off-site benefits of the technology

Production and socio-economic benefits	**Degree and explanation**
Fodder production/quality increase	Little
Sales of product	Negligible
Socio-cultural benefits	
Improved knowledge SLM/erosion	Medium
Ecological benefits	
Soil cover improvement	High
Increase in soil moisture	
Biodiversity enhancement	

The technology could be improved to achieve more benefits by promoting awareness, capacity building of technical staff, providing seed and seedlings to land users and expand the technology to other areas.   .

Economic analysis
No data is available on the economic returns resulting from conservation measures. Compared to the situation without conservation percentage gross production value increase 3 years after implementing SLM is 200%. Compared to the situation without conservation percentage gross production value increase 10 years after implementing SLM is 400%, considering also the land occupied by conservation measures.

Adoption and adaptation
The local practice of enclosing grazing land has been improved by integrating more techniques such as better land preparation, sodding or sowing grass, planting fodder trees, weeding and cultivation, introduction of high yielding grass. The SLM Technology is designed to allow changes by the land users to adapt to changing land use practices such as mechanization. However, mechanization is not appropriate in the area since land holdings are small and fragmented. About 2 % of land users that

have applied the SLM Technology have done it voluntarily, without any incentives and the number of land user families is 16. Trend towards spontaneous adoption of the technology is increasing. There is enough local skill and support to expand the SLM Technology. Mixing exotic and local grass species improves the productivity of the grazing land and the quality of feed

Maintenance

The technology is durable if frequent maintenance and upgrading is done. Land users have been able to partly maintain and manage what has been implemented. Low level of commitments as a result of other interests such as focusing on off farm activities resulted in low attention given for maintenance.

XI. Agroforestry systems

Multi-storey agroforestry systems (Maize, coffee and trees grown together) (Photo 2010)

Enset, fruit trees and trees agroforestry systems (Photo 2010)

34. Agroforestry systems for land management (Gedeo, Jima, ----)

Common Name of SLM Technology: agro forestry systems
Local or other name: Den Timir Ersha (Amharic)
Associated approach: Extension
Contributing SLM specialist: Daniel Danano Dale; Ministry of Agriculture and Rural Development
Area information
Gedeo zone, the Southern highlands of SNNPR and Jima zone Oromiya

Definition

Agricultural production systems involving the growing of various crops (perennial, trees and shrubs with annual crops) in a crop calendar and combination on the same plot.

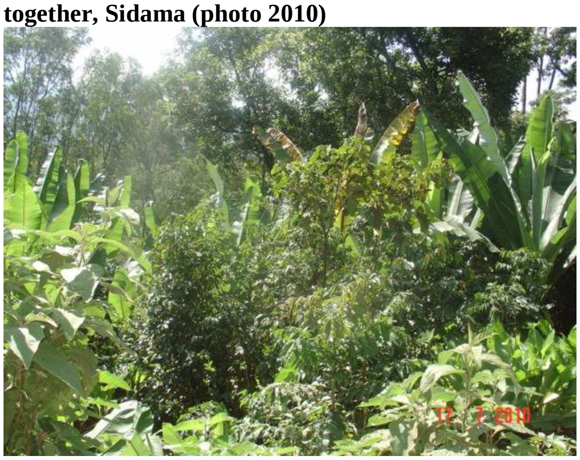
Description

The Gedeo agroforestry system has been practiced since the time land users inhabited the area. Varying agroforestry systems have at the same time been practiced in Sidama, Gedeo, Guji, Wolaita, Kembata and Tambaro, Hadia, Jima and Kefa zones. These systems mostly follow similar patterns and sequencing of crops but with variations in the number and species of vegetation planted. The crops grown largely depend on specific area and socio-cultural conditions. For instance the agroforestry practice of the Gedeo is among the best sustainable land management systems adopted also by communities in the South Eastern, South Central and South Western highlands of the SNNPR and Oromiya regions. Agroforestry based land management practice involves deliberate growing of different vegetation types and crops (annuals and perennials) together in a given plot of land. The purpose of adopting agroforestry based farming practice is to obtain maximum possible production from a fixed area the land possibly from each and every crop and tree planted. The type and composition of crop/vegetation varies depending on slope, soils and the amount of rainfall.

Picture of the technology

Agroforestry system (multi-storey) involving planting crops such as banana, fruit trees and woody biomass together, Sidama (photo 2010)

Various fruit trees species and woody biomass grown together, Gedeo (Photo 2010)



Enset is grown together with fruit and woody trees Gedio (photo 2010)

Cordia (Wanza) is the main woody tree species grown in the agaroforestry systems of altitudes ranging from 1700-2000 masl (Photo 2010)

Technical functions

Main	**Secondary**
Soil fertility enhancement	Soil moisture conservation
Crop diversity averts risk of failure	Increase income
Year round production	Agrobiodiversity
Food security	Crop failure risk aversion
	Resilience to climate change

Major land use problems in the technology area are shortage of land, population pressure, declining agricultural production.

Land degradation

Soil erosion by water is not a big problem in the Technology area as compared to other cultivated lands but there is a risk of reduced production and income which is mainly attributable to reduced size of land holdings

Characterization and purpose

The technology consists of agronomic, vegetative and management measures. The technology combats land degradation by practicing vegetative measures, improvement of ground cover and increasing soil fertility. The technology is best described as an indigenous practice that has evolved and has been adapted over a long period. Improvement techniques have been part and parcel of the system and aim at diversifing crops, increase productivity of land and engage in the best management methods for enhancing production.

Establishment and maintenance

Field activities for agronomic measures				
Activity	**Energy**	**Equipment**	**Timing**	**Frequency**
Planting Enset	Manual labor	Local hoe	Onset of rains	3-4 times
Weeding and cultivation			After rains	
Mulching	Manual labor	Sickle and stick		Twice
Manure and household garbage application		Shovel	Onset of rain	Twice
Establishment activities for vegetative measures				
Fencing	Manual labor	Hoe, wood	Dry season	Once
Planting fruit trees and woody trees	Manual labor	Hoe		
Applying mulch and manure				
Harvest			End of rains	
Maintenance activities for vegetative measures				
Fence maintenance	Manual labor	Hoe	Throughout the year	1-2 times/year
Replanting and fertilizing		Hoe	During rains	
Establishment activities for management measures				
Thinning and pollarding		Axe	Dry season	

Crop and livestock production

Land is cultivated manually using the local hoe and other farm tools. Applying manure, weeding and cultivation are performed to improve performance of crops, trees and shrubs planted. Crops grown include maize, sorghum, yam, enset (Enset ventricosum), coffee, banana, mango, guava, avocado, and etc. The commonly planted trees include Cordia (Cordia Africana), Millettia (Millettia ferruginea), Spathodea (Spathodea campanulata), Ficus, Croton, Podocarpus, Grevillea, Sesbania (Sesbania sesban), Vernonia (Vernonia, amygdalina) erythrina (Erythrina brucei) etc.

The land holding in the technology area is very small and as a result crop production is small owing to small land holdings. As a result crop cultivation and tree tending practice alone is not adequately supporting households with family size of five or more. Land users therefore engage in other income generating activities such as petty trade, hired labor and participate in the safety net program. However, only few members who are poor and very poor get the opportunity to be assisted by the productive safety net program of the government.

A farmer who has a plot on the hillslopes a few kilometers east of Dilla town is seen in the picture on the right side with his elder son who has recently married. According to him he gave part of the land to the son and he is left with a small piece of land (0.25 ha). He also said that other land users also divide the small piece of land under their possession to the male children who get married. The production from these plots is barely enough to feed the family on an average five to six months. It is the agro forestry practice in place that has allowed maximizing production from the very small holding. If this was a cereal based production none of the land users could have obtained the same production level even in applying the best intensification techniques.

The farmer grows a variety of annual and perennial crops on the very small holding he has. It can be seen from the picture that coffee, yam and enset are grown along with trees planted to provide for construction material, fuel wood and fodder. The production the land user gets from coffee is enough only for about three months while the production from Enset, is only for four months maximum. He has to buy food from the market for the rest of the months in the year.

Enset is propagated vegetative and the seedlings / saplings are raised under the shade of other plants as could be seen from the picture right. Soil erosion is highly reduced in agroforestry management systems because of adequate ground cover provided by small plants, weeded material and mulch from Enset leaves.

The combination of crops, fruit trees and woody biomass is largely determined by the elevation, soils and rainfall of the particular area. In mid altitudes (1600-1800 masl) the most commonly planted trees are cordia, croton (Croton macrostachys), albizia (Albizia schimperiana) and sesbania. In high altitudes (1900–2200 masl) the most commonly grown tree species include milletia, sesbania, The best crop and tree mix is cordia – fruit trees- enset: coffee – yam – maize/ sorghum or croton-enset-coffee-maize/sorghum in mid altitudes. In the high altitudes the most dominant crop is enset and is often grown with fruit trees, milletia, banana. On altitudes over 2000 masl enset is the main crop grown with hagenia, vernonia, millettia, prunus (Prunus africanus).

The main livestock management practice is cut and carry for stall-feeding. Grazing lands are very rare and only few communities have them along stream courses. The current trend in livestock number shows a considerably declining trend owing to practical absence of grazing lands. Small stocks dominate the livestock production and feed is relatively better available to them.

Agroforestry systems in other areas of Ethiopia

There are a variety of agro forestry systems practiced in the different farming systems in the various agroecological zones of Ethiopia, which range from multi-storey systems to scattered trees kept in the crop lands. Some of the commonly practiced systems include: creals – trees, coffee – trees, enset – trees, enset – cereals – trees, fruit trees - root crops- enset – cereals etc. The following pictures depict some of these combinations. The most suitable combination of trees and Coffee plants according to Jima research report are: Delinox-coffee, Milletia- coffee, Albizia- coffee, Acacia – coffee, Sesbania-coffee or the mix of two or more of these trees with coffee. The most suitable combination of trees and Enset plants are Cordia (Cordia Africana), Hagenia, Vernonia (Vernonia, amygdalina) erythrina (Erythrina brucei) and Croton.

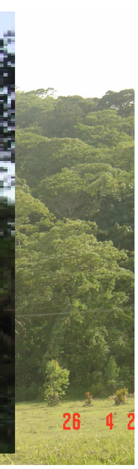
Dispersed trees on crop lands in Ormiya (photo 2008)

Enset with useful trees in Kembata-Tambaro highlands (photo 2008)

Agrobiodiversity (variety of annual and perennial crops) in wollaita (photo 2007)

Agroforestry practices Kuyera Shashemene (Ficus vasta, maize and wheat) (photo 2007)

Coffee and trees agroforestry, Jima (photo



Coffee and trees agroforestry, Agaro Ethiopia (photo 2010)

Coffee - trees agroforestry systems at Goma 2 Coffee Development Farm, Jima zone (photo 2010)

Vetiver-coffee-trees agroforestry systems (photo 2010)

***A*cacia-coffee agroforestry systems, Goma 2, Jima zone (photo 2010)**

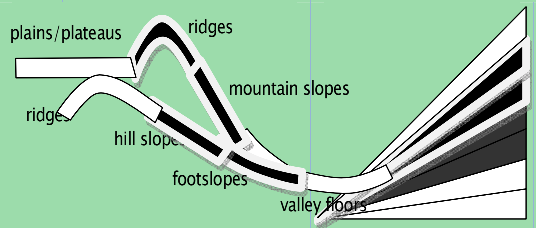
***C*roton - coffee agroforestry systems, Jima (photo 2010)**

In the South Central highlands of Ethiopia where cereal based farming system is dominant, there is a tradition of tending trees on cultivated lands. The most commonly maintained trees are acacia spp, juniperus, cordea, croton and olea. Land users tend these trees for the various uses they provide, which among others include construction, poles, farm implements; fodder etc. cultivated lands with scattered trees are more productive than the fields with no trees. The trees are managed so that crop grown under them is not affected.

Juniper - creal crops agroforestry systems, Gurage zone (photo 2008)

Natural Environment

Average annual rainfall (mm)	Altitude (m a.s.l.)	Landform	Slope (%)
>4000	>4000		very steep (>60)
3000-4000	3500-		steep (30-60)
2000-3000	3000-		hilly (16-30)
1500-2000	2500-		rolling (8-16)
1000-1500	2000-		moderate (5-8)
750-1000	1500-		gentle (2-5)
500-750	1000-		flat (0-2)
250-500	100-500		
less than250	less than250		



Soil depth (cm)
0-20
20-50
50-80
80-120
less than120

Growing season: 2
Soil fertility: medium' high
Soil texture: medium (loam), fine sandy loam
Surface stoniness: no
Topsoil organic matter: medium (1-3%)
Soil drainage: high
Soil erodibility: high

Human environment and land use

Typical household size of the land users is 5 persons. Population density is 300- 500 persons/km^2. Annual population growth is 2.8 %. The trend in household land size shows a decrease due to high population growth and the growing need for cropped land especially by the young people and the landless.

Subdivision of land has seriously affected the production system as land holdings have gone down to 0.25ha in the SNNPR. Land ownership and land use rights have not affected SLM. Land users have the perception that the land they hold is theirs. There is no significant difference between the better off and poor in how they practice SLM since all practice it but the only difference is the quality of management. Off-farm income provides over 50% of all income for the land users who apply the SLM technology. Most land users are engaged in other income generating activities such as petty trade and from being a laborer. Level of technical knowledge required for the implementation of the technology is moderate for land users. No known technical support is provided from the extension workers and development agents to improve the agro forestry system except the provision of seed and seedlings of fruit trees.

On-site and off-site benefits of the technology

Production and socio-economic benefits	**Degree and explanation**
Fodder production/quality increase	High
Social institutions strengthened	
Socio-cultural benefits	
Improved knowledge on the technology	Medium
Ecological benefits	
Soil cover improvement	High
Increase in soil moisture	
Biodiversity enhancement	

Adoption and adaptation

Trend towards spontaneous adoption of the technology is increasing very fast. There is enough local skill and support to expand the SLM Technology. Improving the productivity of the crops and fruit trees would enhance the increase in productivity of land per unit area. The population growth is very high and the chance for accommodating more land users households does not exist. The strategy for scaling up the technology will be organizing exposure visits for land users from the northern highlands to go to the technology area.

Maintenance

The technology is highly durable. Land users are able without any external support to maintain and manage what has been implemented.

X. Vetiver hedge for land management

Vetiver hedges that have formed terrace, Illubabor (Photo 2010)

35. Vetiver hedge for land management (Illubabor)

Common Name of SLM Technology: agro forestry systems
Associated approach: Extension
Contributing SLM specialist: Daniel Danano Dale; Ministry of Agriculture and Rural Development
Area information
Illubabor and West Ethiopia: Oromiya

Definition

Vegetative grass planted on contour or nearly a contour and developed to a strip of hedge.

Description

Vetiver grass is multiplied in nurseries but it can also be propagated in the field near to plantation sites as well. Slips separated from clumps are planted on a contour line or just following the natural boundary of a field. It naturally forms a clump of slips of varying numbers depending on the quality of soils, moisture availability and the management it receives. Vetiver is known for its high quality to perform under harsh conditions once it establishes well. The most common species is Vetiveria zizanioides and is best suited to form a contour strip on various land uses for protecting and or control soil erosion. It is also used as mulch to conserve soil moisture, regulate soil temperature and increase soil fertility by decomposing.

Lines of vetiver slips that form consecutive strips are spaced more or less in the same way physical measures are spaced (one meter vertical interval between two strips on gentle sloping lands and from 1.5 – 2.5 meter vertical interval on slopes greater than 10 %.). Plantation is normally undertaken at the early weeks of rains to ensure that the grass is established well. Although vetiver can be planted using single tiller it is better to plant two to three slips so that a thicker and wider hedge is established. The spacing between two consecutive lines is determined by the vertical spacing discussed above but its performance increases when the spacing between two slips is 10-15 cm for soil erosion control and 40-50 cm for other purposes. To form a well-established 50 cm wide strip it is recommended to have two to three lines of the slips planted in a staggered position.

Vetiver was first introduced in Ethiopia at the Agricultural Research Center of Jima. It was brought by two research scientists (Mesifin Amha and Ferni) from Tanzania according to a report of the Center. Then the Goma 2 Coffee Development farm expanded its application primarily as a mulching material to control weeds in the coffee plantation. It was found out later that vetiver was very effective in substantially controlling soil erosion, reducing evapotranspiration losses and regulating soil temperature. Land productivity and specially production of coffee increased considerably by integrating the use of vetiver along with other agronomic practices and management packages.

It is now being extensively used in the farm and also other Coffee development farms managed by the coffee development enterprise. During the past two decades (1990 - 2010) a number of agencies got involved in expanding the use of vetiver for land management especially in the Western Ethiopia (Illubabor, wellega). Vetiver, systems are being further expanded by the SLM program of the MOARD in its program areas in the country. Many NGOs and Civil Society organizations are vigorously being engaged in its scaling up.

Vetiver hedge at the Jima agricultural Research Center (photo 2010)

Photo of the technology

Well established vetiver hedge in Illubabaor (photo 2010)

Vetiver is fire tolerant and regenerates very fast in Illubabor (photo 2020

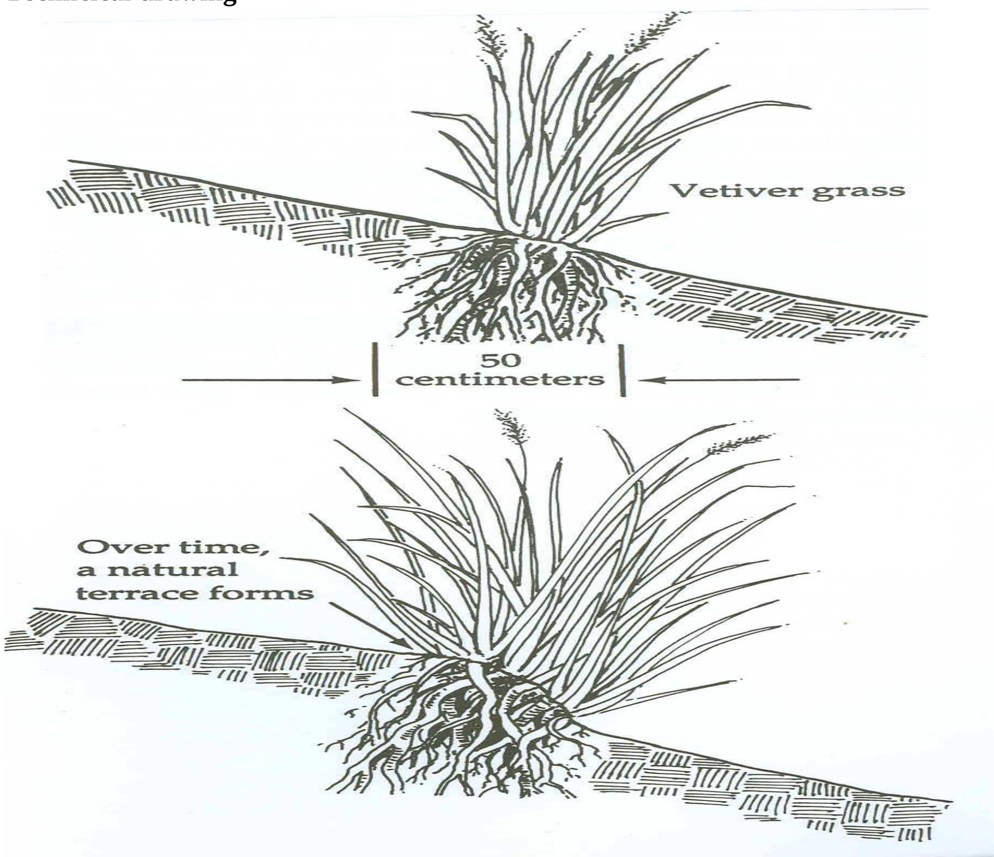
Small earth dam upstream side stabilization by vetiver in Goma 2 coffee farm (photo 2010)

Road side stabilization by vetiver

Grass root divisions, or slips are planted in a single plowed furrow. A 50 cm wide strip is the most commonly recommended strip width for providing effective root and surface protection.

Processes involved in the propagation of vetiver (clumps-slips – planting) in the field

Techncical drawing



Source: Vetiver Grass; The hedge Against Erosion book

Technical functions

Main	**Secondary**
Soil erosion control	Material for thatching
Soil moisture conservation	Mulching

Major land use problems in the technology area are depleting soil nutrient, acidic soils, termites, deforestation, increasing land degradation, population pressure, declining agricultural production.

Land degradation

Soil erosion due to water is a serious problem in the Ethiopian highlands, which receive relatively high amount of rain. Soil acidity is increasing at an alarming level and substantially large area in the country has been affected. Soil acidity tremendously leads to declining crop and livestock production. West Ethiopia receives high amount of rainfall and this coupled with lack of good agricultural practices that help restore soil nutrients that are taken up by crops have lead to high acidity level of the soils. The picture right shows one of the areas highly affected by acidity in Gimbi, Oromiya region.

Termites infested land is increasing and it is another serious land degradation problem faced by land users in the technology area. Substantially large tract of crop lands are abandoned because of termite infestation in West Wellega. Cultivated lands as well as non-cultivated lands abandoned due to intense termite infestation are seen (Picture right).

Characterization and purpose

The technology consists of vegetative and management measures of SLM. The technology combats land degradation through controlling concentration of runoff, trapping sediment and by easily forming terraces. The technology is best described as introduced by land management projects implemented by different actors.

A well managed vetiver nursery in Gobu Seyo wereda, Oromiya

Soil erosion caused by improper design and construction of roads is one of the serious environmental problems in Ethiopia. Considerably large number of gullies have been formed in Ethiopia as a result of improperly placed culverts, turnout ditches and roadside drains. Measures taken to curb the problem have been very minimal in the past but recently there are encouraging initiatives and actions taken to prevent road caused problems using vetiver.

The pictures right show some of the preventive and control measures taken on a newly constructed road on the Nekempt – Gimbi road (Photo 2009). The pictures also show that vetiver resisted bush fires that have burnt other vegetation nearby

Anno PLC in Gobu Seyo wereda is among the pioneers who initiated and extensively used vetiver for soil erosion control. The pictures right show a well developed vetiver hedge on the farm. The farm has reported an increase in maize production on plots with vetiver hedges compared to plots without the hedges. The report further showed that maize cropped plots with vetiver hedges were not affected by stalk borer, the major bottleneck in maize production compared with fields without vetiver hedges.

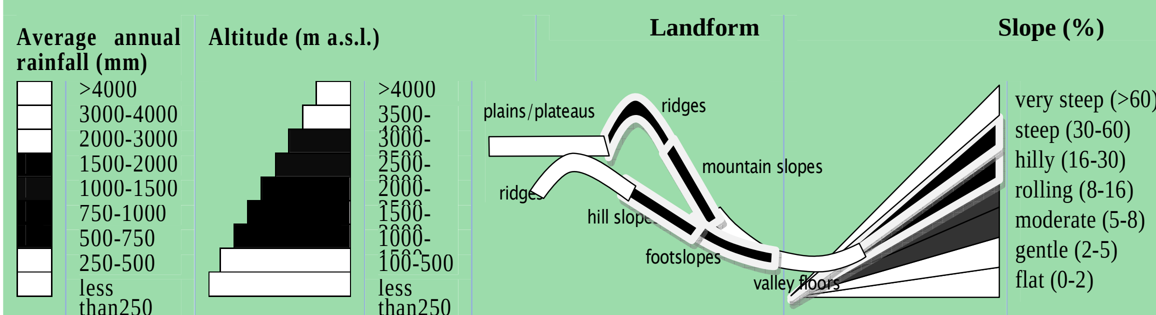
The dense hedges developed by vetiver as can be seen from the pictures right depict that erosion losses are minimum and runoff infiltration very high. The dense biomass obtained from the hedges could be used for various economic and social uses.

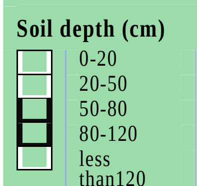
Establishment and maintenance

Establishment activities for vegetative measures				
Activity	**Energy**	**Equipment**	**Timing**	***Frequency***
Land preparation and leveling	Manual and animal traction,	Hoe, plow, scoop	Withdrawal of big rains	
Fencing	Manual labor	Axe sickle, wood	Withdrawal of rains	*Once*
Fine seedbed preparation	Manual labor	Hoe, spade, shovel, wheelbarrow	Withdrawal of big rains	*Once*
Fertilizing seedbed	Manual labor	Hoe, scoop	Early rains or by watering	
Planting vetiver slips				
Weeding and cultivation				
Nursery level slips management				

Maintenance activities for vegetative measures				
Fence maintenance	Manual labor	Hoe	Throughout the year	*1-2 times/year*
Replanting and fertilizing		*Hoe*	*During rains*	

Natural Environment





Growing season: 1
Soil fertility: medium, high
Soil texture: medium (loam)
Surface stoniness: no
Topsoil organic matter: medium (1-3%)
Soil drainage: high and low
Soil erodibility: high

Human environment and land use

Typical household size of the land users is 5 persons. Population density is 300- 500 persons/km^2. Annual population growth is 2.8 %. The trend in household land size shows a decrease due to high population growth and the growing need for cropped land especially by the young people and the landless.

On-site and off-site benefits of the technology

Production and socio-economic benefits	Degree and explanation
Fodder production/quality increase	High
Social institutions strengthened	
Socio-cultural benefits	
Improved knowledge on the technology	Medium
Ecological benefits	
Soil cover improvement	High
Increase in soil moisture	
Biodiversity enhancement	

Adoption and adaptation

Trend towards spontaneous adoption of the technology is increasing in the country as a whole. There is enough local skill and support to expand the SLM Technology. Improving the productivity of the crops and coffee forests would enhance the increase in productivity of land per unit area.

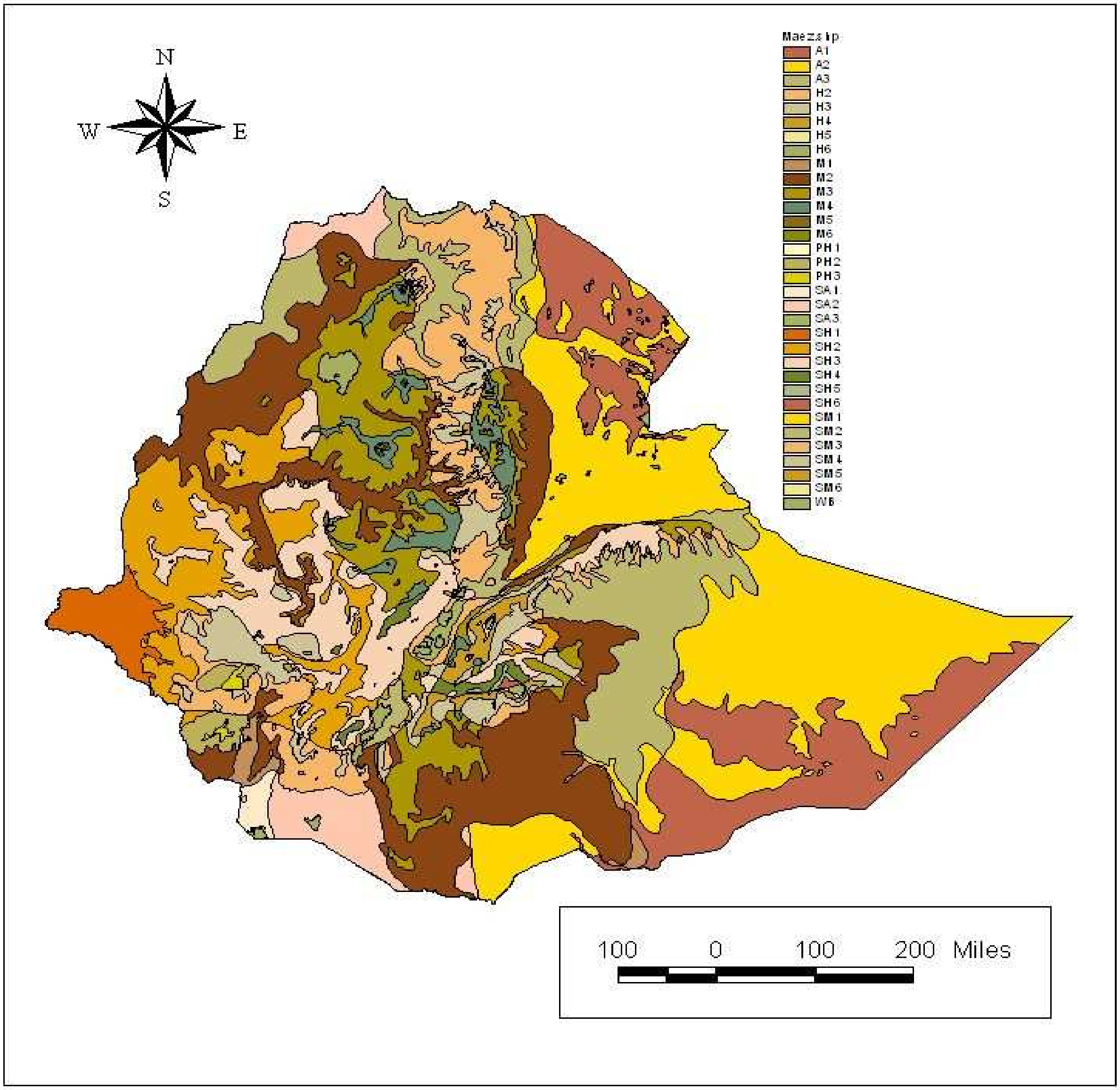
Maintenance

The technology is highly durable. Land users are able without any external support to maintain and manage what has been implemented.


Vetiver is used as a live fence Goma 2, Jima zone (photo 2010)

Annexes

Annex 1. Agro-ecological zones of Ethiopia



Source: Land use and Planning Department, MOARD (2002)

Legend

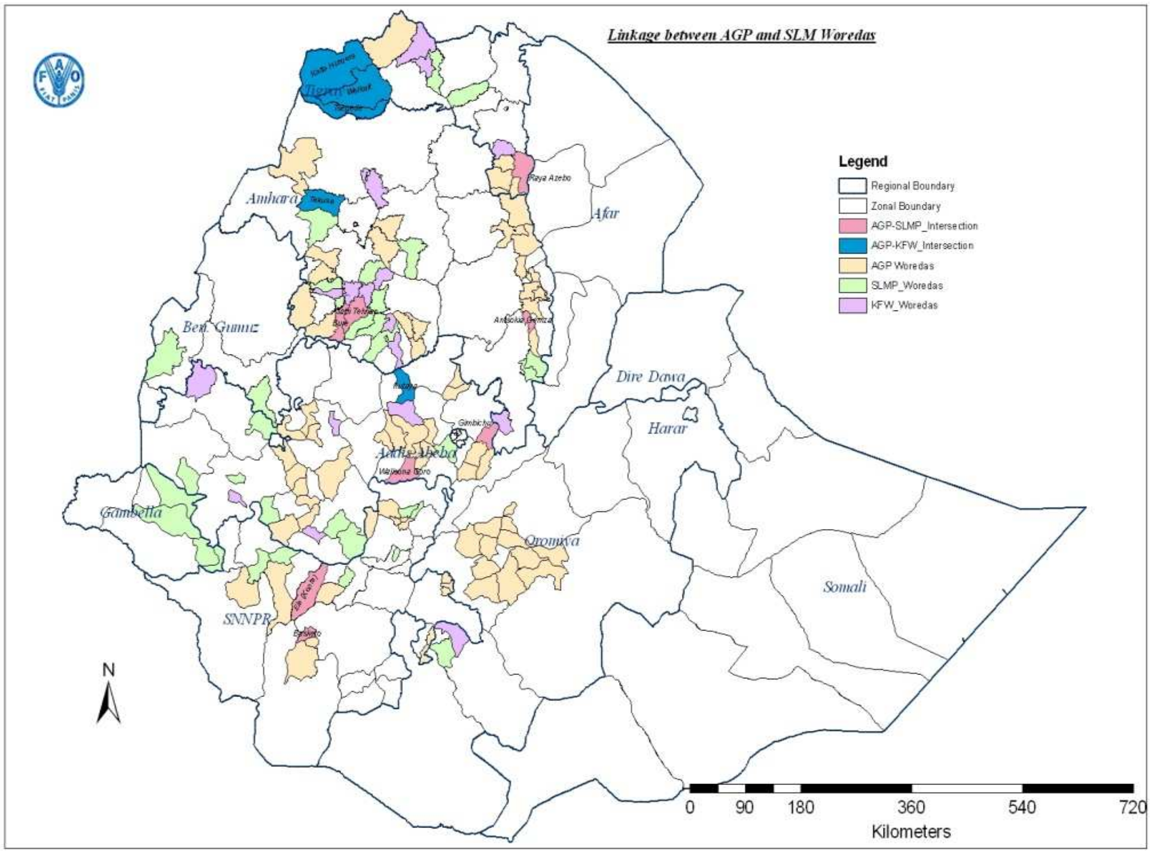
A1	Hot to warm arid lowland plains
A2	Tepid to cool arid mid highlands
SA1	Hot to warm semiarid lowlands
SA2	Tepid to cool semi-arid mid highlands
SM1	Hot to warm sub moist lowlands
SM2	Tepid to cool sub moist mid highlands
SM3	Cold to very cold sub-moist sub-afroalpine to afroalpine
M1	Hot to warm moist lowlands
M2	Tepid to cool moist mid highlands
M3	Col to very cold moist sub-afroalpine to afroalpine
SH1	Hot to warm sub-humid lowlands
SH2	Tepid to cool sub-humid mid highlands
SH3	Cold to very cold sub-humid sub-afroalpine to afroalpine
H1	Hot to warm humid lowlands
H2	Tepid to cool humid mid highlands
H3	Cold to very cold humid sub-afroalpine to afroalpine
Ph1	Hot to warm per-humid lowlands
Ph2	Tepid to cool per-humid mid highlands

Annex 2. Review workshops for quality assurance

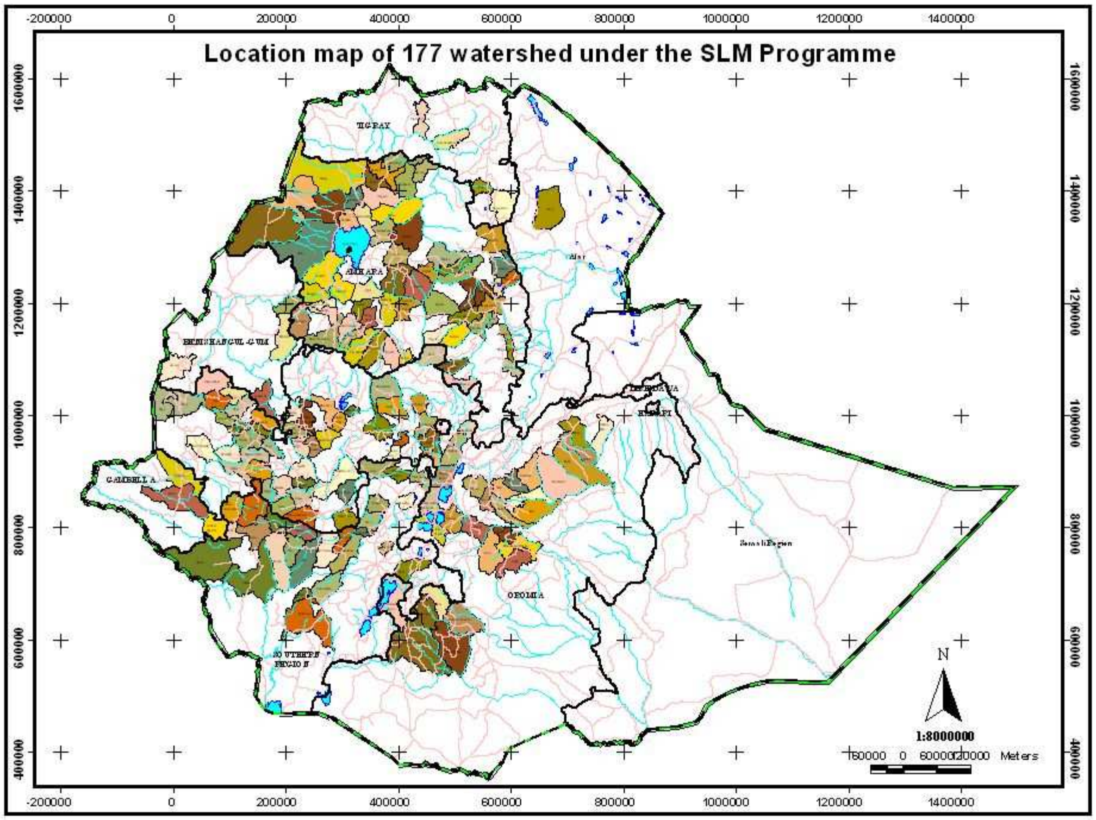
One of the review workshops conducted to review the documented technologies and approaches

EthiOCAT network members on information verification on the field

Annex 3. Current SLM project areas and future sites for scaling up



Source: FAO Sub regional Office Addis Ababa



Source: SLMP, MOARD

Community participation in land management activities on severely degraded land

Vetiver and agroforestry interventions combined in coffee plantation

Agroforestry systems provide maximum protection from soil erosion and improved land productivity

Rehabilitating degraded land: after land management interventions

Structural land management measures capture rainfall and retain it to enrich ground water

Coffee - trees- vetiver system land management offers considerable economic, environmental and social benefits