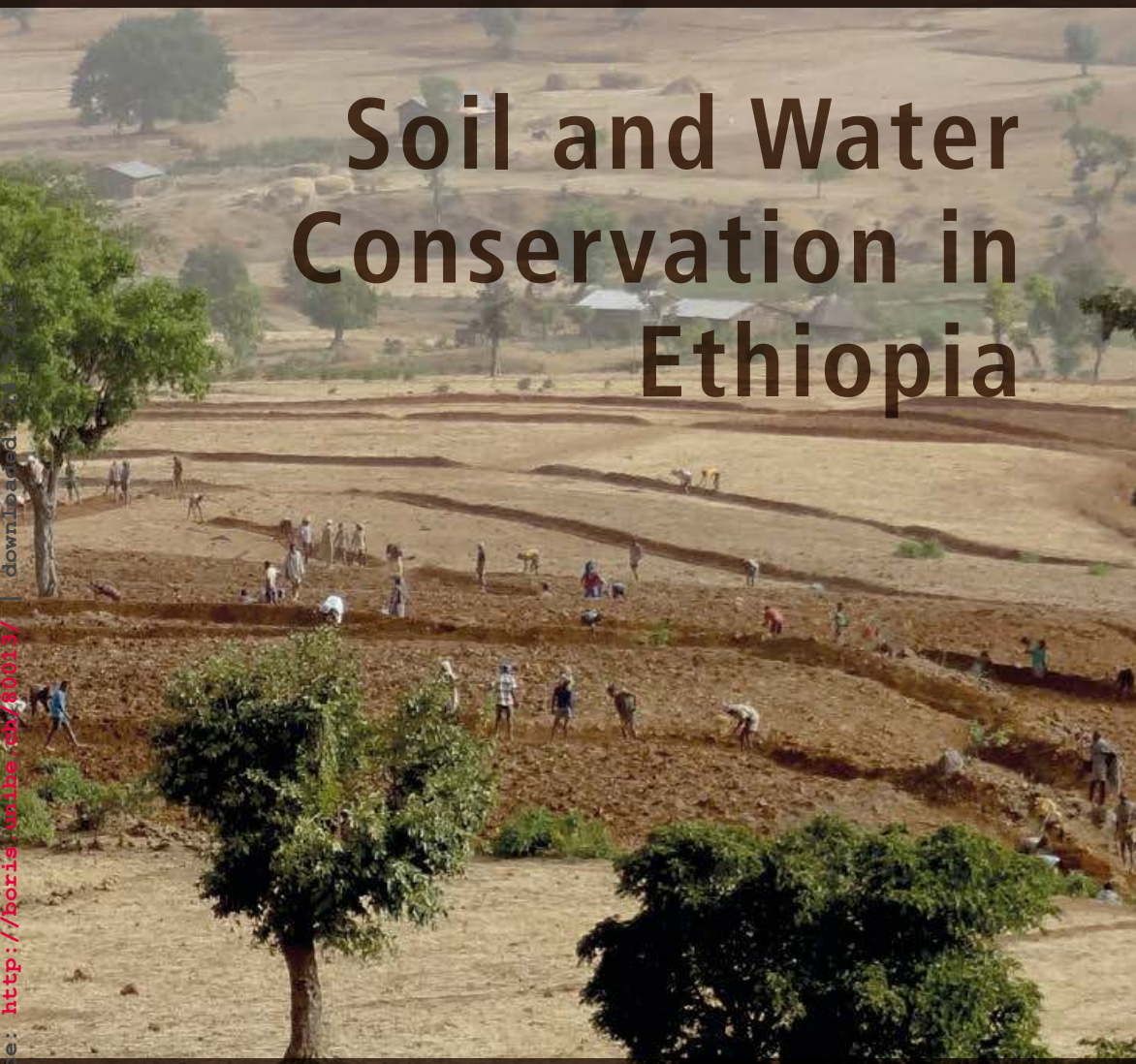
GUIDELINES FOR DEVELOPMENT AGENTS ON

Soil and Water Conservation in Ethiopia



Ministry of Agriculture (MoA)
Ethiopia
2016

GUIDELINES FOR DEVELOPMENT AGENTS ON

Soil and Water Conservation in Ethiopia

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GUIDELINES FOR DEVELOPMENT AGENTS ON

Soil and Water Conservation in Ethiopia

2nd Edition
2016

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Preface

The "Guidelines for development agents on soil conservation in Ethiopia" has been in use for 30 years; its translation into the Amharic language was published in 1987 and the book was reprinted in 1995. Thousands of copies were handed on to development agents, technicians and experts, some of whom sent comments and proposed more technologies based on their field experience. Since 2003, another reprinting was enthusiastically demanded by the regions, which organised region-wide campaigns in soil and water conservation that are still ongoing. At the federal level, the Ministry of Agriculture prepared a number of guidelines and policies for sustainable land management, to which this book is now added.

This 2nd edition has been revised in response to the above suggestions and requests. It is dedicated to the late Karlheinz Boehm (1928-2014), Dr h.c. mult., founder of Menschen für Menschen (MfM), with whom I collaborated closely from 1985 until he retired from active work. The revision was done in a collaborative effort of the Ministry of Agriculture, the Centre for Development and Environment (CDE) of the University of Bern, and the Water and Land Resource Centre (WLRC) in Addis Abeba, which has initiated sustainable land management activities in many 'learning watersheds' in the Eastern Nile Basin in recent years.

Today, soil and water conservation measures are not only socially accepted and integrated in most farming systems; they are also economically viable from a 30-year perspective, as a detailed study on the economics of land degradation in the Ethiopian Highlands has shown (Kaspar Hurni et al. 2015). Despite all the successes observed, however, only about 18% of the rainfed croplands have so far been treated with soil and water conservation measures. If we consider that 77% of the rainfed croplands have slopes steeper than 8%, there is a need to further apply measures on nearly 60% of all croplands, i.e. nearly 12 million hectares still have to be treated. It is for these activities that this book is being reprinted, enhanced by complementary information based on more recent experiences.

Hans Hurni

Dr phil.-nat. and Dr h.c., Initiator of the Soil Conservation Research Programme (1981-1998), Founding president of the Centre for Development and Environment, University of Bern, Switzerland, and Professor emeritus for Geography and Sustainable Development

Acknowledgements

The preparation of the 1st edition of this book was based on a series of workshops and numerous discussions in 1985 nd 1986 that brought together members of the following agencies:

- The Community Forests and Soil Conservation Development Department (CFSCDD) of the Natural Resources Conservation and Development Main Department (NRCDMD) of the Ministry of Agriculture (MoA)
- The State Forests Conservation and Development Department (SFCDD) of NRCDMD of the MoA
- The Soil Conservation Research Programme (SCRP) of the Swiss Agency for Development and Cooperation. SCRP was initiated in 1981 by the Institute of Geography, University of Bern, Switzerland, in association with the United Nations University, and implemented through CFSCDD
- The FAO ETH/81/003 'Assistance to Soil and Water Conservation Programme' implemented through CFSCDD
- Coordinators of the Swedish International Development Agency (SIDA) seconded to CFSCDD

Support for preparation and printing of the first edition of 1986, translation and printing of the Amaharic version of 1987, and a reprint of the English version in 1995 was provided by the Swiss Agency for Development and Cooperation.

The revised 2nd edition was made possible through occasional work inputs from 2007 to 2015 by assistants and financing of the Research Unit on Sustainable Land Management at the Istitute of Geography and the Centre for Development and Environment, the University of Bern.

The revision was carried out by Prof. Hans Hurni (main author of first and second editions), Dr Martin Grunder (contributor to first and second editions), Dr Punjab Chadhokar (contributor to first and second editions), Daniel Danano, Berhe W/Aregay, Dr Kassaye Goshu and Dr Gete Zeleke.

Preface to the 1st Edition of 1986

In the present day Ethiopia soil and water conservation occupies a very important place, if not the most important. It has been firmly established that in some parts of the country the problem of environmental degradation has gone beyond all limits of reversal and the problem is expanding very fast. Therefore, massive effort is required to reverse this trend and retain the disappearing natural resources. The Community Forests and Soil Conservation Development Department (CFSCDD) has been implementing soil and water conservation measures for the past few years. However, systematic approaches through local problem identification were missing and this has resulted in much lower impacts than expected.

The Soil Conservation Research Programme (SCRP) has been active in the collection of information on the processes and dynamics of soil erosion and ways to combat it. The massive information so far collected is now becoming available for field implementation. This document is therefore the beginning of a series of similar guidelines which will gradually emerge.

The book has a very original approach to soil and water conservation in Ethiopia. The main objective is to simplify conservation planning while at the same time providing sound scientific base on the measures to be applied. The book is basically meant for the Development Agents (DA) who operate at the farm level and who are the key link between the farmer and the Ministry of Agriculture.

Dr Hans Hurni who has been thoughtful and imaginative in the development of this approach needs special tribute. Mention should also be made of the staff of the SCRP, CFSCDD and FAO who have critically discussed and contributed to the improvement of the document.

It is hoped that the DA and field staff in general will improve the content and style of the book in due course.

Kebede Tato
Dr h.c., Head of Community Forests and Soil Conservation Development Department (1981 – 1991), Ministry of Agriculture, Ethiopia

Introduction and Guide to the Book

Guidelines for Development Agents on Soil and Water Conservation in Ethiopia

This introductory chapter describes the aim of this book and how it can be used in the field when you carry out soil and water conservation.

Soil erosion is the most dangerous ecological process observed in Ethiopia, degrading the precious soil resources which are the basis of agricultural production and food for the country's people and which provide numerous other ecosystem services. Soil erosion occurs mainly during the rainy season in the form of water erosion. Rills, gullies and brown rivers full of sediment show that a lot of soil is carried away and lost for agricultural production. Most soil erosion occurs on cultivated land in the form of sheet and rill erosion. However, it also occurs on grassland as gullies and even in forests if they are not properly managed.

Traditional conservation measures are well-known in some parts of Ethiopia. For example, the people of Konso applied terracing on their cultivated land long ago. Some terraces can also be seen in the northern regions and in lowland areas where water conservation is necessary. Other areas like Gojam have developed systems of ditches to drain surplus runoff. These measures, however, are not sufficient to control soil erosion.

Soil and water conservation activities have been carried out by the Ministry of Agriculture in the past forty years on a large scale on cultivated land with contour (level) bunds, on hillsides with afforestation terraces, and on degraded hills with hillside closures. However, much more will have to be done in the future. Sustainable development can be achieved in rural areas of Ethiopia if farmers are supported at all levels – from policy to programmes, from extension to NGOs, and from international cooperation to private partnerships – in their efforts to conserve nature, use natural resources with afforestation wisely, and engage in soil and water conservation.

Since Ethiopia has great climatic variety, from dry to wet, and also many different altitudes, from lowlands to highlands, the same conservation technologies cannot be applied everywhere. Therefore, it is necessary to know the characteristics of an area where soil and water conservation is to be implemented. Cultivated land requires conservation measures different from those required on grassland. Forests, in turn, require other measures.

This book tells you the measures that are considered best for the different local conditions in Ethiopia.

In order to make it easy for you to find the selection of measures in this book most suitable to your area, the book has been divided into three steps. Each step must be followed carefully until you have all information you need for your work.

In **Step 1**, the book helps you to determine the agroecological zone you are working in (pages 15 to 21). Such zonation is necessary because some conservation measures cannot be applied in all areas. Also, certain trees, forage grass and legumes needed for revegetation will not grow everywhere. Form 1 (pages 126–129) helps you to describe your area more clearly and, together with the farmers, assess the problems and challenges in your area.

In **Step 2**, recommendations for the different agroecological zones are given (pages 23 to 50). For you, only the zone in which you are working is important. Suitable conservation measures for the three major land use types are listed for this zone: For cultivated land, grassland, and forestland. In some cases, you have to make a selection from the list of measures proposed. Discuss with the farmers if they like the measures you propose before you include them in their Individual Farmland Plan. Also observe during the rainy season whether the applied measures really conserve the soil. Correct all places where erosion damage still occurs after the first conservation. Form 2 (page 130) helps you to make such a selection. You must justify on this form why you prefer some measures to others. Please memorize these preferred measures for your discussions and negotiations with individual farmers when you jointly develop the Individual Farmland Plan. See Form 3 on (pages 131 to 133), which you should fill out for your own records, with a second copy for the farmer.

In **Step 3**, the book provides a description for each recommended conservation measure with drawings, explanations and many useful details (pages 53 to 114). Here you must only look up those measures that were recommended for your agroecological zone (on the one page in Step 2).

When you intend to work on one of the steps, always read the guide given at the beginning of each step. The guide provides you with all the details needed to understand the step and how to apply it in your area.

Whenever you use this book, you must follow the three steps, one by one, proceeding from the first to the second and then to the third. Later, when you know your agroecological zone, you may start with the page in Step 2 where you have marked your agroecological zone. If you know all conservation measures described in Step 3, you only have to use your page of Step 2 (the agroecological zone), which will tell you what measures are ecologically most effective to apply in your area.

More useful information is given at the end of this book (pages 117 to 125). In particular, it is explained here how to make best use of the line level, the only instrument that you absolutely need together with the meter-band to design soil and water conservation measures. Look up the list of useful information given on page 117. Forms 1 to 3 are included in the last part of the book.

This book constitutes the «Guidelines for Development Agents on Soil and Water Conservation in Ethiopia». Since 1986 it has been a useful tool for very important fieldwork in soil and water conservation and in productive and sustainable land management. Remember that farmers have to integrate and apply proper land management on every part of their land. Within a few years, they have to use soil and water conservation everywhere and always have to take appropriate measures in the future.

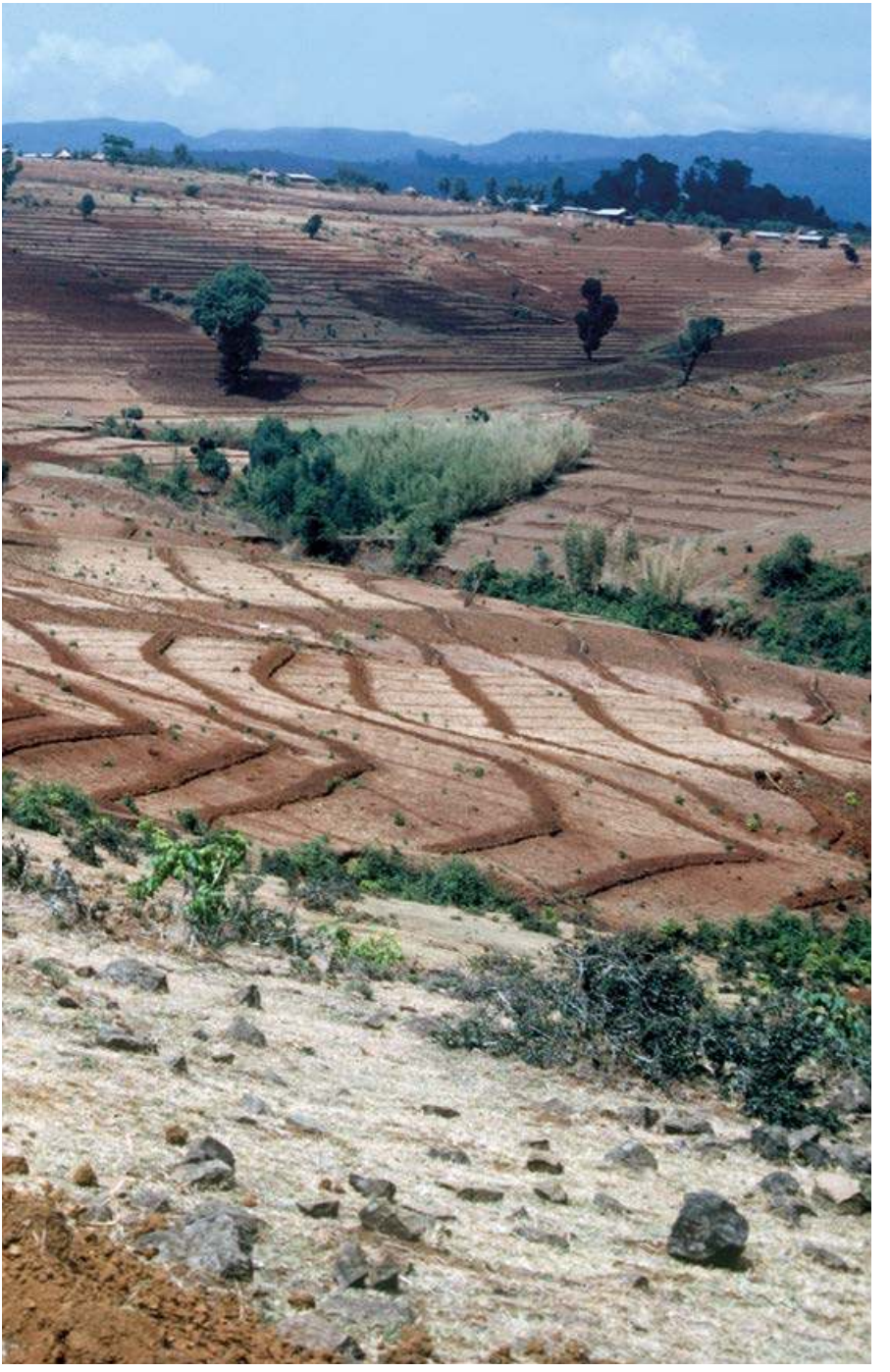
This is the only way to stabilize the catastrophic land degradation that has been taking place in Ethiopia for many centuries, and to improve the land, which is the basis for the production of more food and the provision of other ecosystem services.

Last and most important, farmers must be convinced of the measures you propose in their area. Discuss things with them, listen to their views and opinions in order to design the best option for their land, and then train and support them to implement it. In the years to follow, assist them in the maintenance of newly implemented measures, as these years are the most important and critical during the conservation process. A special effort is required during this time, on your part as well, for soil and water conservation and sustainable land management to become successful.

Step 1

In Which Agroecological Zone Do You Work?

Gobedin, Mekdela, Wello 1986



A fully conserved watershed in Anjeni, Gojam (1986)

Guide to Step 1

In Which Agrocecological Zone Do You Work?

The Ethiopian highlands have been divided for the purpose of this book into fifteen traditional agroecological zones. Along with three additional zones, two in the extreme highlands and one in the extreme lowlands, they are marked in the figure on page 8 to give a complete classification of Ethiopia. The extreme zones are not referred to afterwards for conservation recommendations because there is little conservation to carry out there.

Each zone in the figure is different for mainly two reasons: rainfall and temperature. The boundaries between two zones are generally also boundaries between agricultural crops. That is why the zones are called 'agroecological zones'.

Conservation measures are different for each zone. Therefore, it is important to know in which zone you are located when you carry out soil and water conservation. Your job in Step 1, therefore, is to find out in which zone your area is situated. We shall help you to find your zone in this chapter, especially with the figure on page 19:

Generally, 'dry' is defined as having less than 900 mm of annual rainfall. 'Moist' is between 900 mm to 1400 mm, and 'wet' is above 1400 mm of annual rainfall.

Only one zone is used for the extreme lowlands of the **Berha** belt (below 500 m), namely the moist zone in the western lowlands of Ethiopia.

Three zones are in the **Kolla** belt (500–1500 m), namely a dry, moist and a wet zone.

Three zones are also in the **Weyna Dega** belt (1500–2300 m).

The **Dega** belt (2300–3200 m), too, has a wet, moist, and a dry zone, the dry zone being located mainly in the north-eastern highlands.

The **High Dega** belt between 3200–3700 m is situated in the cold high mountain area and has a wet and moist zone.

The two extreme zones not used later on are the **Dry Berha** belt, a dry zone below 500 m which is desert area, and the **Wurch** belt, a moist or wet zone above 3700 m, which is mountain grassland and rocks, and not cultivated.

The twelve zones plus the three extreme ones are grouped in the figure on page 19 according to altitude and annual rainfall. Each box represents one agroecological zone. The main characteristics of each zone are listed in the boxes, including most important crops, traditional conservation, soils on slopes, and natural trees.

Your area is situated in one of these zones. You can find the box which best fits the local conditions of your area. Read the descriptions given in each box. Try to identify the zone in which your area is situated.

Try first to find the most suitable agricultural crops listed in the box. If there are still several possibilities, compare the other descriptions as well, and then make your selection.

Now, try to find the most suitable box from the figure on page 19.

Have you found a suitable box?

Make sure that the box selected for your area from the figure is the most suitable one. Compare especially the boxes to the left and the right of your selection, to check whether they do not fit better than the one you selected. In case of a big, long valley, you may have to select one box for the upper part, and one box for the lower part of the valley. It may well be that the valley is situated in two different agroecological zones. Therefore you have to apply different conservation measures in it.

Go now to Form 1 on page 126 and fill it in according to the instructions given there. Walk through the whole sub-catchment and measure its length and width in metres. Look at the land use and its proportions. Get more information on crops and major problems from the farmers and the Kebele. Look at the soil and soil erosion problems. Fill all information in on Form 1 as required. This work may take you several days before you continue further with this book.

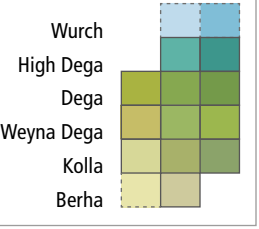
After having completely filled in Form 1 on page 126, are you still sure that you have selected the correct agroecological zone for your area?

If yes, read the page number that is given in your box in the figure on the opposite page (See page…). This number refers to the page where conservation measures are recommended in detail for your agroecological zone.

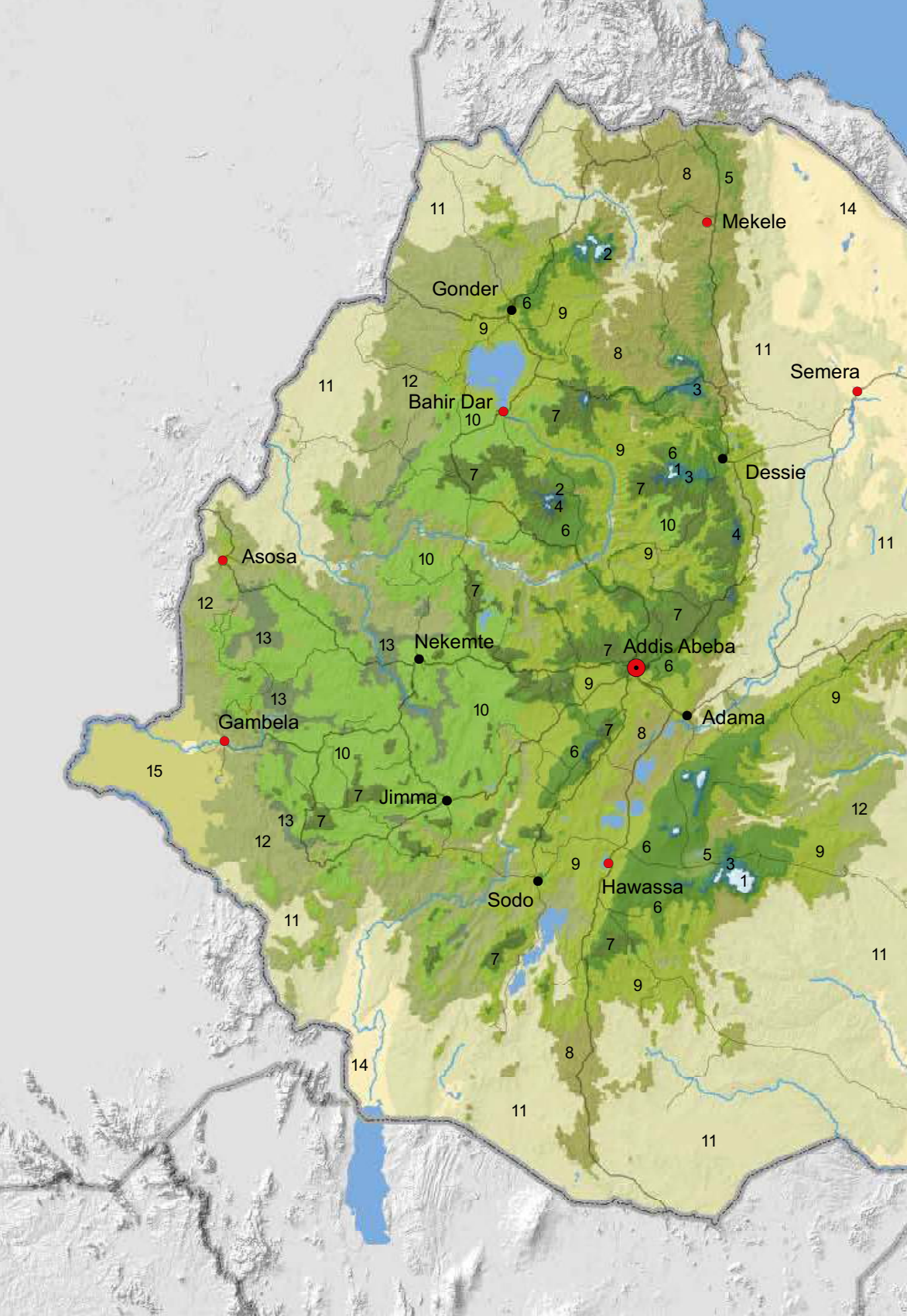
Before going directly to that page, read the **Guide to Step 2** given on page 25. It will give you information on how to use the recommendations for each agroecological zone.

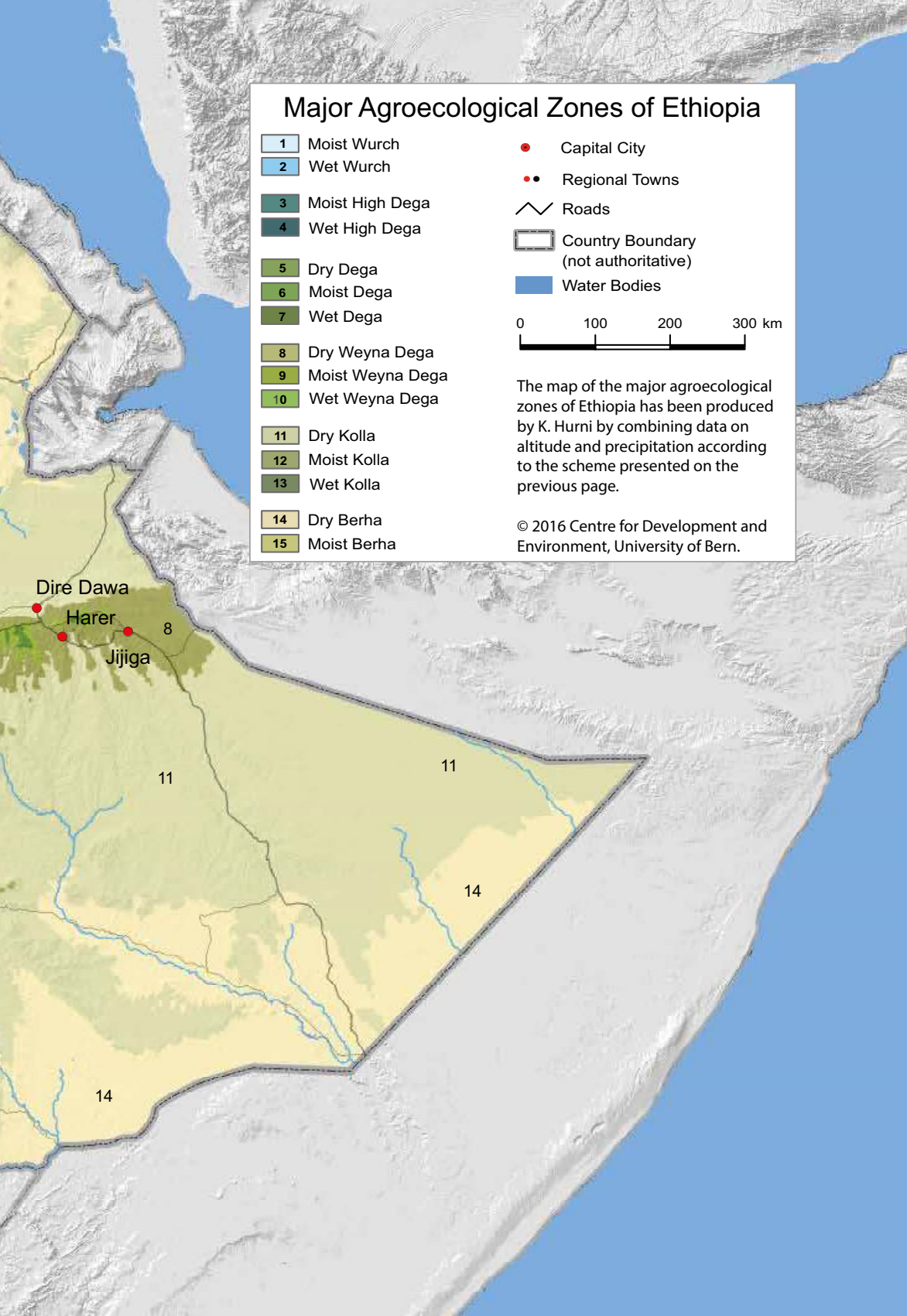
Opposite page: *Description of major agroecological zones in Ethiopia. The vertical scale shows the altitude, increasing upwards. The horizontal scale shows the annual rainfall, increasing towards the right. Each box represents one agroecological zone. Only the twelve boxes outlined in bold are used further in this book. Numbers 1–15 refer to the colours on the map on page 20–21. Page numbers refer to chapters for each agroecological zone.*

Note:
Later in the book this figure will be repeated in very small format, as follows:




Altitude in metres above sea level (m asl)
Above 3700
3700 to 3200
3200 to 2300
2300 to 1500
1500 to 500
Below 500
Moist Wurch 1
(No conservation)
A: None (frost limit)
C: None
S: Black, shallow
T: Few (mountain grassland)
Wet Wurch 2
(No conservation)
A: None (frost limit)
C: None
S: Black soils, little disturbed
T: Few (mountain grassland)
Moist High Dega 3
(See Page 128)
A: Only barley, 1 cropping season per year
C: Drainage rare
S: Black soils, degraded
T: Erica, Hypericum
Wet High Dega 4
(See Page 30)
A: Only barley, 2 cropping seasons per year
C: Widespread drainage ditches
S: Black soils, highly degraded
T: Erica, Hypericum
Dry Dega 5
See Page 32)
A: Barley, wheat, pulses
C: Traditional moisture conservation measures
S: Grey-brownish grey
T: Olea europaea, Maytenus undata, M. senegalensis
Moist Dega 6
(See Page 34)
A: Barley, wheat and pulses, 1 cropping season per year
C: Some traditional terracing
S: Brown clay soils
T: Juniperus, Hagenia, Podocarpus
Wet Dega 7
(See Page 36)
A: Barley, wheat, nug, pulses, 2 cropping seasons per year
C: Widespread drainage ditches
S: Dark brown clay soils
T: Juniperus, Hagenia, Podocarpus, Bamboo
Dry Weyna Dega 8
(See Page 38)
A: Wheat, tef, rarely maize
C: Terracing widespread
S: Light brown to yellow soils
T: Acacia trees
Moist Weyna Dega 9
(See Page 40)
A: Maize, sorghum, tef, inset rare, wheat, nug, dagussa, barley
C: Traditional terracing
S: Red-brown soils
T: Acacia, Cordia, Ficus
Wet Weyna Dega 10
(See Page 42)
A: Tef, maize, inset in W parts, nug, barley
C: Drainage widespread
S: Red clay soils, deeply weathered, gullies frequent
T: Many varieties, Ficus, Cordia, Acacia, Bamboo
Dry Kolla 11
(See Page 44)
A: Sorghum rare, tef
C: Water retention terraces
S: Yellow sandy soils
T: Acacia bushes and trees
Moist Kolla 12
(See Page 46)
A: Sorghum, rarely tef, nug, dagussa, groundnut
C: Terracing widespread
S: Yellow silty soils
T: Acacia, Erythrina, Cordia, Ficus
Wet Kolla 13
(See Page 48)
A: Mango, taro, sugarcane, maize, coffee, citrus
C: Ditches frequent
S: Red clay, highly oxidized
T: Calliandra
Dry Berha 14
(No conservation)
A: None (except irrigation areas)
C: None
S: Yellow sandy soils
T: Acacia bushes
Moist Berha 15
(See Page 50)
A: Seasonal rainfed agriculture possible
C: Burning grasses common: Silty and clayey, mainly black
T: Ziziphus, Calliandra calothyrsus
Less than 900
900 to 1400
More than 1400
Annual rainfall (millimetres)


Mekele
Gonder
Bahir Dar
Semera
Dessie
Asosa
Nekemte
Addis Abeba
Adama
Gambela
Jimma
Hawassa
Sodo


Major Agroecological Zones of Ethiopia
1 Moist Wurch
2 Wet Wurch
3 Moist High Dega
4 Wet High Dega
5 Dry Dega
6 Moist Dega
7 Wet Dega
8 Dry Weyna Dega
9 Moist Weyna Dega
10 Wet Weyna Dega
11 Dry Kolla
12 Moist Kolla
13 Wet Kolla
14 Dry Berha
15 Moist Berha
Capital City
Regional Towns
Roads
Country Boundary (not authoritative)
Water Bodies
0 100 200 300 km
The map of the major agroecological zones of Ethiopia has been produced by K. Hurni by combining data on altitude and precipitation according to the scheme presented on the previous page.
© 2016 Centre for Development and Environment, University of Bern.
Dire Dawa
Harer
Jijiga
8
11
11
14
14

Step 2

Which Consevation Measures Do You Apply?

Anjeni, Gojam 2014

List of Agroecological Zones Described

Moist and Wet Wurch (not described)

Moist High Dega 28
Wet High Dega 30

Dry Dega 32
Moist Dega 34
Wet Dega 36

Dry Weyna Dega 38
Moist Weyna Dega 40
Wet Weyna Dega 42

Dry Kolla 44
Moist Kolla 46
Wet Kolla 48

Moist Berha 50
Dry Berha (not described)

Guide to Step 2

Which Conservation Measures Do you Apply?

In Step 1, you selected the agroecological zone which best fits your area. In Step 2, recommendations for conservation measures that you can apply in your area are presented. In this chapter, two pages will be given to each agroecological zone. For each zone, you will find the following items:

– General information about the agroecological zone (on the left page), and
– Recommended conservation measures (on the right page).

The conservation measures are given in groups for three different land use types that you find in your area, namely for:

CULTIVATED LAND

This refers to all land under cultivation or under temporary fallow, or land that will be used for cultivation in the immediate future.

GRASSLAND

This refers to all land where the dominant vegetation cover consists of grass. Also included is cultivated land where cultivation was or will have to be abandoned and which will be changed into grassland or closed areas.

FORESTLAND

This refers to land where the dominant vegetation cover consists of trees as well as land that is designated for reforestation or area closure.

In your agroecological zone, read carefully which conservation measures are recommended for each of the three land use types. Even within one land use type, you have to select from the measures given according to the **slope gradient** (see page 122), **the soil texture** (see page 119), the **soil depth** (see page 123) and the **traditional measures** used by the farmers. After making your first selection of measures, fill them in on Form 2 (see page 130) in the order of your priorities. Once filled in by you, Form 2 will be the basis of your discussion with farmers when doing the 'Individual Farmland Plan' (IFLP) for each farm in your focal area (subcatchment).

The recommended conservation measures are listed in **bold letters**. If you do not know a measure, Step 3 (pages 53 to 115) gives instructions for each measure. A list of such measures written in **bold letters** is given on page 54.

Now proceed to the page of the agroecological zone that you have selected from Step 1. See also the list on the opposite page 24. Carefully read the recommendations given for your agroecological zone. Now you are ready to discuss with each farmer the best option for his/ her land management plan and fill in Form 3 (see page 131), the 'Individual Farmland Plan', together with the farmer. Discuss all proposed measures with the farmers and get their consent, because they will have to maintain and develop them in the future. Only what is accepted locally has a chance to remain on the land.

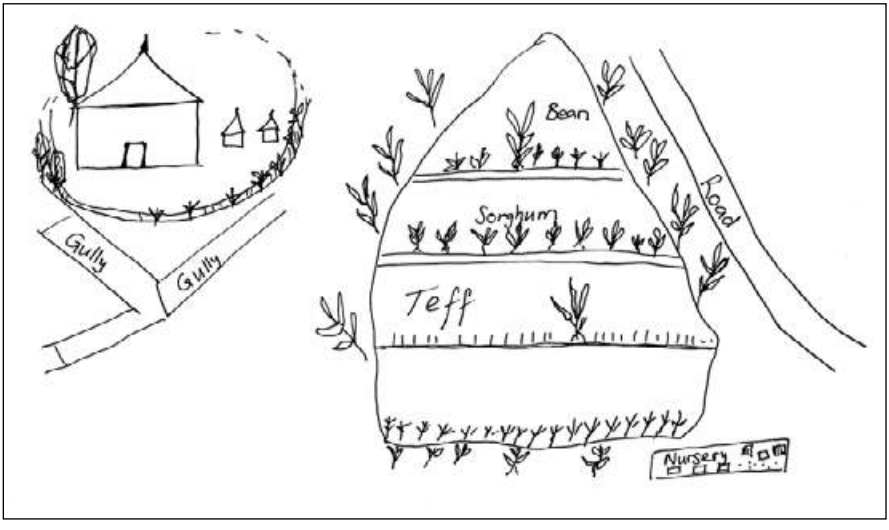
For all measures that go beyond an individual farm, an overall watershed management plan will have to be developed. This is particularly important for surplus water management or area closure, etc. Please consult the guideline "Community-based Participatory Watershed Development" (2005), see page 125.

How Do You Assist a Farmer?

Assisting a farmer in making an individual farmland plan puts the farmer and his/her farm at the centre of land management. This is an essential first step. In addition, it will be necessary to integrate all Individual farmland plans at the catchment/watershed level, for example when planning safe runoff devices from the farms to the rivers.

With the farmer at the centre of land management planning and therefore with his/her consent for the activities planned, there is a better guarantee of success, since the farmer him/ herself is the implementer and beneficiary of the agreed plan.

Individual farmland planning is a tool to assist the farmer in optimal and sustainable use of his/her land, while at the same time ensuring comprehensive land management planning for the area as a whole: a so-called 'sub-catchment plan' and eventually a 'catchment plan'. The latter will result in a composite of the individual farmland plans and can be considered as an important step towards community-based participatory watershed development, as was proposed by the Ministry of Agriculture and Rural Development in 2005.



The above drawing is a sketch of an Individal farmland plans, which was done together with the farmer.

As the name implies, a plan will be drawn up for each individual farm, together with the farmer. You, the Development Agent, will prepare together with the farmer a sketch map of his/her land and note what the farmer is doing on each spot, and what challenges he/she is facing. The Individual farmland plan encompasses all farm activities, not only soil and water conservation measures. It assists the farmer with farm

management as a whole, including livestock, which is often sidelined although it is an important part of every farm. Thereafter, still on-site, discuss with him/her the best options for the respective piece of land in view of the overall farming enterprise. If the need arises, call upon the specialist from the Wereda Office to assist.

In all cases it will be important to look carefully at runon water from land above, and runoff water towards lower-lying farmland, and to discuss with the concerned neighbouring farmers how best to manage it.

Note all activities planned on the individual farmland plan, including a time frame, showing when each activity is to be done and when it is to be completed. Leave a copy of the farmland plan with the farmer; it will remind him/her of what has to be done (the sketch will always be readable, even if he/she is illiterate). Keep the original of the complete individual farmland plan in a ringbinder in your office. Thus even your successor will know what has been agreed on each farm, and what remains to be done in case you are transferred to a different work place.

With this farmland plan you assure the consent of the farmer for the activities proposed. Proper land management, including soil and water conservation, will automatically be taken care of, and its implementation will be assured since the farmer has agreed to a beneficial package for his/her farm.

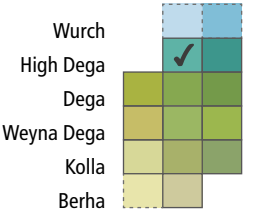
You need to be equipped with forms for the Individual Farmland Plan (see Form 3, pp. 131–133), a writing pad, a carbon paper, and a ball pen. In your office you need to keep a ring binder (boxfile) for proper safekeeping of all the plans.

It is of utmost importance to keep track of the timely implementation of all the activities you have agreed upon. Please discuss carefully upcoming problems with the farmer and always be available for him/her when advice is needed. Thus you will build up a good, lasting relationship based on mutual understanding.

Agroecological zone

Moist High Dega

Altitudinal Range: 3200–3700 m
Annual Rainfall: 900–1400 mm
Average Temperature: 7–12°C



In the photo, you can see an area in the Simen Mountains that is typical of the Moist High Dega agroecological zone. Houses usually have big compounds with some Eucalyptus trees and gardens. All the remaining area is cultivated. Except for some small bunding, almost no traditional conservation is visible.

DESCRIPTION AND PROBLEMS

Barley is the only cultivated crop. Sometimes there are also potatoes. One cropping season per year. Heavy runoff problem. Medium deep black clay soil on slopes with more recent cultivation. Highly degraded shallow soil of brown to grey colours widespread. High current soil loss rates. Gullying not widespread. Some traditional terracing on steep slopes which must be improved. Temporary drainage ditches rarely used on cultivated land. Grassland is generally well established, but overgrazed. Tree growth is slow due to high altitude with low temperature.

Have you filled in Form 1 on pages 126–129?

Conservation Measures Recommended for Moist High Dega

See also list of measures on page 54

CULTIVATED LAND

As a first step, look at the soil on your slope. If it is sticky clay, generally apply graded structures but look for a **Waterway** to be constructed in the first year. If the soil is sandy to silty and has good infiltration, you can generally apply level structures and you do not need waterways. However, with level structures, a **Cutoff Drain** is needed to remove excess runoff during heavy storms.

As a 2nd step, measure the slope gradient on the cultivated land that you want to treat.

For slopes with gradients less than 15%, you can suggest **Conservation Tillage** or apply **Grass Strip** if the soil has good infiltration. Combine with **Cutoff Drain** and stop grazing all year. Otherwise, apply **Level Bund** or **Level Fanya Juu** on such soil. The vertical interval is 1 m for all measures with such slope gradients. On clay soil, recommend the **Broadbed and Furrow** system or establish graded structures, but construct only the **Waterway** in the first year. Apply **Graded Bund** or **Graded Fanya Juu** in the second year. Here, careful construction and permanent maintenance is necessary, especially during heavy storms. All soil depths of more than 50 cm are possible. Otherwise, apply **Area Closure**.

For slopes between 15 and 50%, you can recommend **Conservation Tillage** but combined with contour structures. Measure the average reworkable soil depth first. On soil with good infiltration (sandy to silty texture), apply **Level Bund** or **Level Fanya Juu** combined with **Cutoff Drain** between every 10 to 15 structures. The vertical interval between two bunds is two-and-a-half times the depth of the soil. For clay soil, construct a **Waterway** in the first year, then **Graded Bund** or **Graded Fanya Juu** in the second year. All structures require careful maintenance by the farmer and continuous building up until **Bench Terrace** is developed after several years. Before construction by the farmers, outline structures on the slope. If the spacing is too narrow for them, change the land into grassland or forestland in consultation with them and with their agreement.

On all structures, apply **Revegetation**. In addition to this, construct **Checkdams** in gullies. On degraded cultivated land with shallow soil, apply **Area Closure**. Cultivated land with a slope gradient above 50% must be changed into grassland or forestland.

GRASSLAND

Normally, **Controlled Grazing** is sufficient. On degraded grassland with shallow soil, **Area Closure** is needed. Here, **Cut and Carry** can be used. Above gullies, construct a **Cutoff Drain** and in gullies, apply **Gully Rehabilitation** combined with **Revegetation** and **Checkdam**.

FORESTLAND

Normally, **Area Closure** is sufficient for **Tree Planting**. Use tree species suitable for high altitude **Cut and Carry** can be applied for grass management. On steeper slopes, make a **Microbasin**. Below and within degraded forestland, construct a **Cutoff Drain**.

Have you filled in Form 2 on page 130?

Agroecological zone

Wet High Dega

Altitudinal Range: 3200–3700 m
Annual Rainfall: Over 1400 mm
Average Temperature: 7–12°C

An area in Northern Shewa that is typical of the Wet High Dega agroecological zone. Graded structures have been constructed. A waterway leading from top right to bottom left collects surplus runoff. Some of the cultivated land had to be changed into grassland. On the top of the hill, a house and some Eucalyptus trees are visible.

DESCRIPTION AND PROBLEMS

Barely is the only cultivated crop. Sometimes there are also potatoes. One cropping season every two years. Heavy runoff problem. Medium deep black clay soil on slopes with more recent cultivation. Degraded shallow soil of brown to grey colour widespread. Soil erosion damage frequent due to high erosivity of rainfall. Very high current soil loss rates. Gullying not widespread. Some traditional terracing on steep slopes which must be improved. Temporary drainage ditches used on cultivated land. Grassland is generally well established. Tree growth is slow due to high altitude with low temperature.

Have you filled in Form 1 on pages 126–129?

Conservation Measures Recommended for Wet High Dega

See also list of measures on page 54

CULTIVATED LAND

Because of heavy rainfall it is generally recommended to apply graded structures, in order to drain excess surface water. As a first step, look for traditional waterways which you can improve. If the traditional waterways are too far apart, construct a new **Waterway** in between. Develop and stabilize the waterways in the first year before you construct graded structures in the second year.

As a 2nd step, measure the slope gradient on the cultivated land that you want to treat.

For slopes with gradients of less than 15%, you can suggest **Conservation Tillage** or apply **Grass Strip** if the soil has good infiltration (sand or silt texture). For excessive storms, combine these with a **Cutoff Drain** towards the next **Waterway**. However, grazing can no longer be allowed because the **Grass Strip** needs to have tall grass which can be regularly cut. For soil with low infiltration (clay texture), apply **Graded Bund** or **Graded Fanya Juu** at a vertical interval of 1 metre. Here again, cattle must be excluded from the land all year and the structures need very careful maintenance during storms, especially after construction. All land with soil depths greater than 50 cm can be treated. For shallow soil, apply **Area Closure**. For heavy black cotton soil (Vertisol) suggest the **Broadbed and Furrow** system.

For slopes between 15 and 50%, you can recommend **Conservation Tillage** but combined with structures. Measure the average reworkable soil depth of the slope first. After waterway stabilisation in the first year, apply **Graded Bund** or **Graded Fanya Juu** in the second year, which will develop into **Bench Terrace** with maintenance and improvement for several years. The vertical interval between two bunds must be two and a half times the average soil depth of the slope. Care for maintenance. Line out where the bunds will be situated on the land. Discuss with farmers if the spacing between bunds is acceptable. If the spacing is too narrow for them, change the land into grassland or forestland in consultation and with their agreement.

On all structures, apply **Revegetation**. For **Gully Rehabilitation** combine with **Checkdam**. On degraded cultivated land with very shallow soil, apply **Area Closure**. Land with a slope gradient greater than 50% must be changed into grassland or forestland.

GRASSLAND

Normally, **Controlled Grazing** is sufficient on slopes. On degraded grassland with shallow soil, Area Closure is needed. There, **Cut and Carry** can be used. Above gullys, construct a **Cutoff Drain**, and in gullies, use **Gully Rehabilitation** combined with **Revegetation**.

FORESTLAND

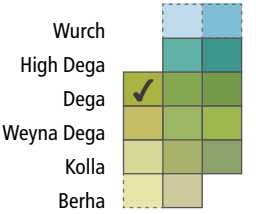
Normally, **Area Closure** is sufficient for **Tree Planting**. Use tree species suitable for high altitude. **Cut and Carry** can be used for grass management. Below and on degraded forestland, construct a **Cutoff Drain** to protect cultivated land.

Have you filled in Form 2 on page 130?

Agroecological zone

Dry Dega

Altitudinal Range: 2300–3200 m
Annual Rainfall: 300–900 mm
Average Temperature: 12–18°C



An area in Tigray near Idaga Hamus that is typical for the Dry Dega agroecological zone. In order to minimize runoff and maximize infiltration, farmers have constructed high barriers on the edge of their farmland terraces. This allows both water and soil to be conserved and production enhanced.

DESCRIPTION AND PROBLEMS

Very short rainy season with low but mostly intense rainfall. Problem of recurring drought. One cropping season only. Main crop is barley. Wheat and pulses are limited. Long history of land use with severe erosion damage. Soil is variable, on slopes it is brown coloured loam, and many places are badlands. Need for water conservation. Some gullying in deep accumulation. Problems for revegetation due to grazing (sheep), and low moisture availability. Grassland heavily overgrazed. Forests are almost completely lacking, and most dung is used as fuel for cooking.

Have you filled in Form 1 on pages 126–129?

Conservation Measures Recommended for Dry Dega

See also list of measures on page 54

CULTIVATED LAND

As a first step, look at traditional soil and water conservation measures existing in your area. Are there terraces? Do you feel they need improvement? Is your soil very shallow? If traditional terraces exist, you can improve them by increasing their height so that they become **Bench Terraces**. If they are discontinuous, close the gaps between them. If they are too far apart, make one more **Bench Terrace** in between.

To overcome water shortage, **Water Harvesting** can be applied.

If there is no traditional terracing, measure the slope gradient on the cultivated land you want to treat.

For slopes with gradients less than 15%, recommend **Mulch** for moisture conservation or apply **Level Bund** for maximum water conservation. In higher rainfall areas in your zone, apply **Level Fanya Juu** if cattle are excluded all year. Look for continuous maintenance during rainy season. The vertical interval is 1 metre for all measures on this slope. All soil depths of more than 50 cm are possible. You may also recommend **Trash Line** or **Conservation Tillage**. Otherwise, apply **Area Closure**. Above the cultivated land, make a **Cutoff Drain** to next river or gully.

For slopes between 15 and 50%, if not too steep, recommend **Mulch**. For structures, measure the average reworkable soil depth first. Apply **Level Bund** or **Level Fanya Juu** if cattle are excluded. Use a vertical interval which is two and a half times the soil depth you have measured. Add **Cutoff Drain** above the cultivated land. All structures need careful maintenance and continuous building up by the farmers until a **Bench Terrace** is developed after several years. Before construction by the farmers, outline structures on the slope. If the spacing is too narrow for them, apply **Area Closure** in consultation and with their agreement. In extremely low rainfall areas, make a **Bench Terrace** in the valleys.

All structures can be made of stones because grass establishment is difficult. **Revegetation**, with grass and shrubs suitable for arid areas, requires complete exclusion of cattle all year long. In gullies, make a **Checkdam**. On degraded cultivated land with shallow soil, apply **Area Closure**. Land above 50% slope gradient must be changed into grassland or forestland.

GRASSLAND

On all grassland, **Controlled Grazing** is necessary. On slopes with shallow soil, **Area Closure** is needed. **Cut and Carry** must be used here. Above gullies, make a **Cutoff Drain** and in gullies a **Checkdam** when doing Gully Rehabilitation. Exclude cattle from all gullies.

FORESTLAND

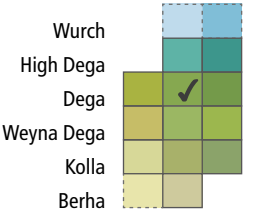
On medium slopes, combine Area Closure with **Microbasin** or **Trench** for **Tree Planting**. Use **Cut and Carry** for grass management. On steep slopes, make **Hillside Terrace**. Combine all measures.

Have you filled in Form 2 on page 130?

Agroecological zone

Moist Dega

Altitudinal Range: 2300–3200 m
Annual Rainfall: 900–1400 mm
Average Temperature: 12–18°C



An area in the Simen Mountains that is typical for the Moist Dega agroecological zone. The cultivated area below the village of Gich has been eroded and bare weathered rock appears in bright colours. Lack of natural trees is compensated by planting Eucalyptus around the houses.

DESCRIPTION AND PROBLEMS

This is a zone of high agricultural activity with barley, wheat and pulses as main crops. One cropping season only. Degradation widespread, gullying frequent. Long history of land use with high erosion damage. Soil is variable, on slopes brown coloured loams and many places are without soil. High current rates of soil erosion. Possibility of soil crusting on gentle slopes with high runoff rates and extreme gullying. Grassland is heavily overgrazed, forests are almost completely lacking, and most dung is used as fuel for cooking.

Have you filled in Form 1 on pages 126–129?

Conservation Measures Recommended for Moist Dega

See also list of measures on page 54

CULTIVATED LAND

As a first step, look at the soil on your slope. If it is sticky clay, generally apply graded structures, and look for a **Waterway** to be constructed in the first year. If the soil is sandy to silty and has good infiltration, you can generally apply level structures and you do not need waterways. However, with level structures, a **Cutoff Drain** is needed to remove excess runoff during heavy storms. To overcome water shortage, **Water Harvesting** can be applied. As a 2nd step, measure the slope gradient.

For slopes with gradients of less than 15%, you can suggest **Conservation Tillage** or **Mulch** and/or select **Grass Strip**, eventually with Vetiver, or **Alley Cropping** with **Trash Line** for soils with good infiltration (sandy to silty texture), combined with a **Cutoff Drain** if grazing can be stopped all year. Otherwise, apply **Level Bund** or **Level Fanya Juu**. Here, careful construction and permanent maintenance is necessary, especially during heavy storms. All soil depths of more than 50 cm are possible. Both bunds and **Fanya Juu** can be enforced with Vetiver. Otherwise, apply **Alley Cropping**. For heavy, sticky soils apply the **Broadbed and Furrow** system to avoid waterlogging.

For slopes between 15 and 50%, you can recommend **Conservation Tillage**, but combined with contour structures. Measure the average reworkable soil depth first. On soils with good infiltration, apply **Level Bund** or L**evel Fanya Juu**, combined with **Cutoff Drain** in between for heavy storms. The vertical interval between two bunds is two-and-a-half times the depth of soil. For clay soils, construct a **Waterway** in the first and a **Graded Bund** in the second year; or if cattle is excluded all year, **Graded Fanya Juu** for faster terrace development. All structures need development into a **Bench Terrace** after several years. Both bunds and Fanya Juu can be enforced with **Vetiver**. If the spacing between structures is too narrow for the farmers, change the land to grassland or forestland in consultation with them and only with their agreement.

On all structures, apply **Revegetation** or **Alley Cropping**. In gullies, make a **Checkdam** when doing **Gully Rehabilitation**. On degraded cultivated land with shallow soil, apply **Area Closure**. Land with a slope gradient above 50% must be changed into grassland or forestland.

GRASSLAND

Normally, **Controlled Grazing** is sufficient. Apply **Grassland Improvement** where necessary. On degraded grassland with shallow soil, **Area Closure** is needed. **Cut and Carry** can be used here. Above gullies, make a **Cutoff Drain** and in gullies, use **Gully Rehabilitation** with **Revegetation** and **Checkdam**.

FORESTLAND

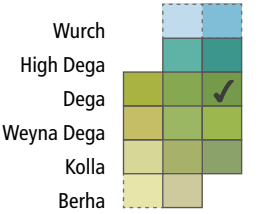
Normally, **Area Closure** is sufficient for **Tree Planting**. **Cut and Carry** can be used for grass management. On steeper slopes, make a **Microbasin**, and on very steep slopes, a **Hillside Terrace**. Below and on degraded forestland, construct a **Cutoff Drain**.

Have you filled in Form 2 on page 130?

Agroecological zone

Wet Dega

Altitudinal Range: 2300–3200 m
Annual Rainfall: Over 1400 mm
Average Temperature: 12–18°C



An area in Northern Shewa that is typical of the Wet Dega agroecological zone. Soil erosion damage is widespread on the slope in the background, even though numerous terraces were introduced since the early 1980s.

DESCRIPTION AND PROBLEMS

This is a zone of high agricultural activity with barley, wheat and pulses as main crops. High rainfall reliability. Two cropping seasons. Due to long history of land use, degradation is widespread and gullying frequent. Soils are variable, with mainly brown clay loams on slopes. High current rates of soil erosion. Gullying occurs mainly in deeper accumulations on valley floors. Traditional terracing exists, but is not sufficiently applied. Problem of surplus runoff from cultivated land and grassland. Grassland is overgrazed and soil on slopes is very shallow. Forest cover is almost completely lacking, but trees around homesteads are common.

Have you filled in Form 1 on pages 126–129?

Conservation Measures Recommended for Wet Dega

See also list of measures on page 54

CULTIVATED LAND

Because of heavy rainfall it is generally recommended to apply graded structures in order to drain excess surface water. As a first step, look for traditional waterways which you can improve. If traditional waterways are too far apart, place a new **Waterway** in between. Develop **Waterway** in the first year before constructing graded structures on the land in the second year. As a 2nd step, measure the slope gradient.

For slopes with gradients of less than 15%, you can suggest **Conservation Tillage** or **Mulch** and/or apply **Grass Strip**, eventually with Vetiver, or **Alley Cropping** with **Trash Line** if the soil has good infiltration (sandy to silty texture). For excessive storms, combine with **Cutoff Drain** towards the next Waterway. However, grazing can no longer be allowed because **Grass Strip** needs to have high grass, which can be regularly cut. For sticky clay soil, recommend the **Broadbed and Furrow** system or apply **Graded Fanya Juu** at a vertical interval of 1 metre. Here again, cattle must be excluded from the land all year and structures need careful maintenance during storms, especially after construction. Otherwise, apply **Graded Bund**. All soil depths greater than 50 cm are possible. Both bunds and Fanya Juu can be enforced with **Vetiver.**

For slopes between 15 and 50%, you can recommend **Conservation Tillage** but combined with contour structures. Measure the average reworkable soil depth on the slope first. After **Waterway** construction or improvement in the first year, apply **Graded Bund** in the second year, which will develop into **Bench Terrace**. The vertical interval between two bunds must be two-and-a-half times the average soil depth of the slope. If cattle can be excluded from the cultivated land all year long, apply **Graded Fanya Juu** because this will develop faster into **Bench Terrace**. Take care for maintenance. Both bunds and Fanya Juu can be enforced with Vetiver. Outline where the bunds will be situated on the land and discuss it with farmers. If it is too narrow for them, change the land into forestland or grassland, but in consultation with the farmers and only with their agreement.

On all structures, apply **Revegetation** or **Alley Cropping**. In addition to this, construct a Checkdam when doing **Gully Rehabilitation**. On degraded cultivated land with very shallow soil, apply **Area Closure**. Change land with slope gradients above 50%, into forestland or grassland in consultation with the farmers and only with their agreement.

GRASSLAND

Normally, **Controlled Grazing** is sufficient. Make **Grassland Improvement** where necessary. On degraded grassland with shallow soil, **Area Closure** is needed. **Cut and Carry** can be used here. Above gullies, make a **Cutoff Drain** and in gullies, use **Gully Rehabilitation** with **Revegetation** and **Checkdam**.

FORESTLAND

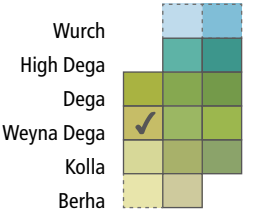
Normally, **Area Closure** is sufficient for **Tree Planting**. **Cut and Carry** can be used for grass management. Below degraded forestland, make a **Cutoff Drain**.

Have you filled in Form 2 on page 130?

Agroecological zone

Dry Weyna Dega

Altitudinal Range: 1500–2300 m
Annual Rainfall: 300–900 mm
Average Temperature: 18–25°C



An area in the Awash Basin that is typical of the Dry Weyna Dega agroecological zone. Traditional terracing of cultivated land is widespread here, as in this area around Sekawacho Village. In order to make it more effective for water conservation, the terraces have to be further developed.

DESCRIPTION AND PROBLEMS

Very short rainy season with low but intense rainfall. Problem of recurring drought. Main crops are wheat and barley. Pulses, sorghum and maize are limited. Severe degradation due to long history of land use. Almost no soil on slopes, but heavy accumulation in valleys. Soil erosion variable according to rain. Soil is sandy to silty with brown-yellow colours. Need for water conservation. Some gullying in deep accumulation. Problems for revegetation due to cattle grazing (goats), and low moisture availability. Grassland heavily overgrazed. Forests non-existent except for few remaining trees.

Have you filled in Form 1 on pages 126–129?

Conservation Measures Recommended for Dry Weyna Dega

See also list of measures on page 54

CULTIVATED LAND

As a first step, look at traditional soil and water conservation measures existing in your area. Are there terraces? Do you feel they need improvement? Is your soil very shallow? If traditional terraces exist, you can improve them by increasing their height so that they become **Bench Terraces**. If they are discontinuous, close the gaps between them. If they are too far apart, make one more **Bench Terrace** in between. To overcome water-shortage, **Water Harvesting** can be applied. If there is no traditional terracing, measure the slope gradient on the cultivated land you want to treat.

For slopes with gradients of less than 15%, you can suggest **Conservation Tillage** or **Mulch** for moisture conservation and apply **Trash Line**. For maximum water conservation, apply Level Bund. In higher rainfall areas of your zone, apply **Level Fanya Juu** if cattle is excluded all year. The vertical interval is 1 metre for all measures on this slope. All soil depths of more than 50 cm are possible. Otherwise, apply **Area Closure** in agreement with the farmers. Above the cultivated land, construct a **Cutoff Drain** to use for **Water Harvesting** or safely drain it to next river or gully.

For slopes between 15 and 50%, measure the average reworkable soil depth first. Apply **Level Bund** or **Level Fanya Juu** if cattle are excluded. Use a vertical interval which is two-and-a-half times the soil depth you have measured. Add **Cutoff Drain** above the cultivated land. All structures need careful maintenance and continuous building up by the farmers until **Bench Terrace** is developed after several years. Structures can be stabilized with **Vetiver**. Before construction by the farmers, outline structures on the slope. If the spacing is too narrow for them, apply **Area Closure** in consultation with the farmers and with their agreement. In extremely low rainfall areas, make a **Bench Terrace** in the valleys and use **Water Harvesting** wherever possible.

All structures can be made of stones because grass establishment is difficult. However, **Vetiver** is sturdy and may be used to stabilize the structures. **Revegetation**, with grass and shrubs suitable for arid areas, requires complete exclusion of cattle all year long. In gullies, construct a **Checkdam**. On degraded cultivated land with shallow soil, apply **Area Closure**. Land with a slope gradient above 50% must be changed with the farmer's agreement into forestland or grassland.

GRASSLAND

On all grassland, **Controlled Grazing** is necessary. On slopes with shallow soil, **Area Closure**, if possible with **Revegetation**, is needed. **Cut and Carry** must be used here. Above gullies, make a **Cutoff Drain** and in gullies, use **Gully Rehabilitation** with a **Checkdam**. Exclude cattle from all gullies.

FORESTLAND

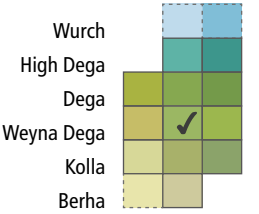
On medium slopes, combine **Area Closure** with **Microbasin** or Trench for **Tree Planting**. Use **Cut and Carry** for grass management. On steep slopes, make a **Hillside Terrace**.

Have you filled in Form 2 on page 130?

Agroecological zone

Moist Weyna Dega

Altitudinal Range: 1500–2300 m
Annual Rainfall: 900–1400 mm
Average Temperature: 18–25°C



An area in Harerge that is typical of the Moist Weyna Dega agroecological zone. Maize and sorghum are grown, sometimes intercropped with beans. Bush vegetation is a remnant of dense forests.

DESCRIPTION AND PROBLEMS

Good zone of agricultural activity with tef, maize, wheat and pulses as main crops. Sorghum in drier areas. Inset and Nug in the western highlands, and Khat in the eastern highlands. One cropping season. Degradation widespread, gullying frequent. Long history of land use with high erosion damage, especially on slopes. Shallow brown loams on slopes, sometimes degraded to greyish silts. Black heavy clays in flat areas. High current rates of soil erosion. Grassland overgrazed with bushy vegetation and low undercover. Forests heavily reduced to few areas. Trees common but not numerous.

Have you filled in Form 1 on pages 126–129?

Conservation Measures Recommended for Moist Weyna Dega

See also list of measures on page 54

CULTIVATED LAND

As a first step, look at the soil on your slope. If the soil has good infiltration (sandy, silty), you can apply **Level** structures. However, a **Cutoff Drain** may be needed in between to remove excess runoff during heavy storms. If there are clay soils, apply **Graded** structures, but look for a **Waterway** to be constructed in the first year. To overcome water-shortage, **Water Harvesting** can be applied. As a 2nd step, measure the slope gradient.

For slopes with gradients of less than 15%, you can suggest **Conservation Tillage** or **Mulch** and/or select **Grass Strip** with **Vetiver** or **Alley Cropping** with a **Trash Line** for soil with good infiltration, combined with a **Cutoff Drain**. Grazing must be stopped all year. Otherwise, apply a **Level Bund** or **Level Fanya Juu**. On clay soils, install graded structures but make a **Waterway** in the first year. Here, careful construction and continuous maintenance is necessary, especially during heavy storms. The vertical interval is 1 m for all measures on this slope. All soil depths of more than 50 cm are possible. Both bunds and Fanya Juu can be enforced with **Vetiver**. On shallow soil, again apply **Alley Cropping** with **Trash Line**. For heavy, sticky soils apply the **Broadbed and Furrow** system with **Waterway** to avoid waterlogging.

For slopes between 15 and 50%, measure the average reworkable soil depth first. On soil with good infiltration (sandy, silty), apply **Level Bund** or **Level Fanya Juu**, combined with a **Cutoff Drain** in between for heavy storms. The vertical interval between two bunds is two and a half times the depth of the soil. If you find clay soil, make a **Waterway** in the first year, then **Graded Bund** or, if cattle is excluded all year, **Graded Fanya Juu** for faster terrace development. All structures require careful maintenance by the farmer and continuous building up until **Bench Terrace** is developed after several years. Before construction by the farmers, line out structures on the slope. If the spacing is too narrow, apply **Alley Cropping**.

On all structures, apply **Revegetation**, preferably with **Vetiver** or **Alley Cropping**. In gullies, apply **Gully Rehabilitation** with a **Checkdam**. On degraded cultivated land with very shallow soil, apply **Area Closure**. Change land with a slope gradient greater than 50% into grassland or forestland with the agreement of the farmers.

GRASSLAND

Normally, **Controlled Grazing** is sufficient. Combine with **Grassland Improvement**. On degraded grassland with shallow soil, **Area Closure** is required with **Revegetation**. **Cut and Carry** can be used here. Above gullies and above cultivated land, make a **Cutoff Drain** and in gullies, use **Gully Rehabilitation** with a **Checkdam**.

FORESTLAND

Normally, Area Closure is sufficient for **Tree Planting**. **Cut and Carry** can be used for grass management. On steeper slopes, make **Microbasin** or **Trench**, and on very steep slopes, **Hillside Terrace**. Below and on degraded forest land, make a **Cutoff Drain**.

Have you filled in Form 2 on page 130?

Agroecological zone

Wet Weyna Dega

Altitudinal Range: 1500–2300 m
Annual Rainfall: Over 1400 mm
Average Temperature: 18–25°C

An area in northwestern Sidamo that is typical of the Wet Weyna Dega agroecological zone. Numerous gullies dissect the flat area in the foreground, while many crops and trees are grown on the slope, including Inset around the houses.

DESCRIPTION AND PROBLEMS

Best zone of agricultural activity with tef, maize, wheat and pulses as main crops. Inset in the West. High rainfall reliability. One to two cropping seasons. Land use history rather recent. Soil is deeply weathered. On slopes, red-brown clay loams or red clays are common. Severe erosion damage and degradation due to gullying. Red-brown clay loam has good infiltration, while red clay has high acidity and slow infiltration. On flat areas, black clays are widespread with difficult management and sometimes bad drainage. Grassland is relatively well established but has gully problem. Forestland exists, and trees are frequent.

Have you filled in Form 1 on pages 126–129?

Conservation Measures Recommended for Wet Weyna Dega

See also list of measures on page 54

CULTIVATED LAND

Because of heavy rainfall it is generally recommended to apply graded structures, in order to drain excess surface water. As a first step, look for traditional waterways you can improve. If traditional waterways are too far apart, place a new **Waterway** in between. Develop the waterways in the first year before constructing any graded structures on the land in the second year.

As a 2nd step, measure the slope gradient on the cultivated land that you want to treat.

For slopes with gradients of less than 15%, you can suggest **Conservation Tillage** or **Mulch** and/or select **Grass Strip** with **Vetiver** or **Alley Cropping** with a **Trash Line** if the soil has good infiltration (sandy, silty). For excessive storms, combine with **Cutoff Drain** leading to next **Waterway**. For heavy clay soils, recommend the **Broadbed and Furrow** system with **Waterway** or install graded structures, but make only a Waterway in the first year; apply **Graded Fanya Juu** at a vertical interval of 1 metre. Careful maintenance is needed here. Otherwise, apply **Graded Bund** at the same vertical interval (1 m). All soil depths of more than 50 cm are possible. On shallow soil, try **Alley Cropping**.

For slopes between 15 and 50%, measure the average reworkable soil depth of the slope first. Apply **Graded Bund**, which will develop into **Bench Terrace** after several years with maintenance and improvement. The vertical interval between two bunds must be two and a half times the average depth of fertile soil on the slope. If cattle can be excluded from the cultivated land all year long, apply **Graded Fanya Juu** because this will develop faster into **Bench Terrace**. Take care for maintenance. Outline where bunds will be situated on the land. Discuss with farmers if the spacing between bunds is acceptable. Use **Revegetation** on the bunds and **Alley Cropping** on steep slopes where the spacing for terrace development is too narrow.

On all structures, apply **Revegetation** or **Alley Cropping**. In gullies, make a **Checkdam**. On degraded cultivated land with very shallow soil, apply **Area Closure**. Land above 50% slope gradient must be changed into grassland or forestland.

GRASSLAND

Normally, **Controlled Grazing** is sufficient. Combine with **Grassland Improvement**. On degraded grassland with shallow soil, **Area Closure** is needed combined with **Revegetation**. **Cut and Carry** can be used here. The gully problem is very serious and needs careful treatment. Above gullies, make a **Cutoff Drain** and in gullies, **Gully Rehabilitation** including a **Checkdam**.

FORESTLAND

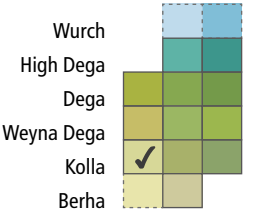
Normally, **Area Closure** is sufficient for **Tree Planting**. **Cut and Carry** can be used for grass management. Below and on degraded forestland, make a **Cutoff Drain** to protect cultivated land.

Have you filled in Form 2 on page 130?

Agroecological zone

Dry Kolla

Altitudinal Range: 500–1500 m
Annual Rainfall: 300–900 mm
Average Temperature: Over 25°C



An area in the lower Awash Basin that is typical of the Dry Kolla agroecological zone. In this bird's eye view, you can see that a small valley is used for cultivation. Terraces are built into this valley so that no runoff can escape. The hillside has some bushy vegetation.

DESCRIPTION AND PROBLEMS

In this zone, tef is grown during a short rainy season, as well as sorghum in years of sufficient rainfall. Drought is a recurring problem. Overgrazing, wind erosion and the destruction of trees and bushes for charcoal-making are serious. The soil is sandy to silty with yellowish colours. Soil erosion is variable according to rainfall and also serious on grassland. Numerous terraces are used in valleys constructed mainly for water conservation. Grassland is highly degraded, sometimes almost non-existent. Herds of camels and goats feed mainly on Acacia bushes and trees.

Have you filled in Form 1 on pages 126–129?

Conservation Measures Recommended for Dry Kolla

See also list of measures on page 54

CULTIVATED LAND

As a first step, look at the traditional Soil and water conservation measures existing in your area. Are there terraces? Do you feel they need improvement? If traditional terraces exist, increase their height so that they become a **Bench Terrace**. If they are discontinuous, close the gaps between bits of terraces. If they are too far apart, make one more **Bench Terrace** in between. To overcome water shortage, **Water Harvesting** can be applied. If there is no traditional terracing, measure the slope gradient on the cultivated land that you want to treat.

For slopes with gradients of less than 15%, you can propose **Conservation Tillage** or **Mulch** for moisture conservation. Apply **Level Bund** for maximum water conservation. In parts of your zone with higher rainfall, apply **Level Fanya Juu** if cattle are excluded all year. Look for continuous maintenance during the rainy season. The vertical interval is 1 m for all measures on this slope. All soil depths of more than 50 cm are possible. Otherwise, apply **Area Closure** in agreement with the farmer. If water from slopes creates gullies on the cultivated land, make a **Cutoff Drain** above the cultivated land and apply **Gully Rehabilitation** and use the water from the **Cutoff Drain** for **Water Harvesting**.

For slopes between 15 and 50%, measure the average reworkable soil depth first. Apply **Level Bund** or Level **Fanya Juu** if cattle are excluded. Here, the vertical interval must be two-and-a-half times the soil depth you have measured. If necessary, add a **Cutoff Drain** above the cultivated land. All structures require careful maintenance by the farmer, and continuous building up until **Bench Terrace** is developed. Before farmers undertake construction, outline structures on the slope. If the spacing is too narrow for them, apply **Area Closure** in consultation with them and with their agreement.

All structures can be made of stones because grass establishment will be difficult; however, **Vetiver** is sturdy and may be used to stabilize the structures. If structures are made of soil, apply **Revegetation** by all means, using grass and shrubs suitable for arid areas. In any case, completely exclude grazing animals all year long. In gullies, introduce **Gully Rehabilitation** and make a **Checkdam**. On degraded cultivated land with shallow soil, apply **Area Closure**. Change land with slope gradients above 50% to grassland or forestland in agreement with the farmers.

GRASSLAND

On all grassland, **Controlled Grazing** is necessary. On slopes with shallow soil, **Area Closure** is needed. **Cut and Carry** must be used here. Above gullies, make a **Cutoff Drain** and in gullies, **Gully Rehabilitation** with **Revegetation** and a **Checkdam**. Exclude grazing.

FORESTLAND

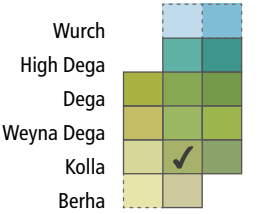
On gentle to medium slopes, combine **Area Closure** with large **Microbasin** or **Trench** for the planting of Acacia trees. Use **Cut and Carry** for grass management. On steep slopes, make a **Hillside Terrace** to control runoff but only if needed for land below.

Have you filled in Form 2 on page 130?

Agroecological zone

Moist Kolla

Altitudinal Range: 500–1500 m
Annual Rainfall: 900–1400 mm
Average Temperature: Over 25°C



An area in Wellega that is typical of the Moist Kolla agroecological zone. Long grass as in the foreground is widespread in valleys where annual burning commonly takes place. Cultivated land is on gentle to steep slopes. Hills as in the background are covered with trees.

DESCRIPTION AND PROBLEMS

This zone is mostly situated in the western parts of Ethiopia. It is suitable for sorghum, tef, cotton and dagussa. The soil is deeply weathered red clay loam to red clay and on flat areas, black heavy clay. The red soil is leaching and has thin topsoil humus. Nutrients are fixed more in the natural vegetation than in the soil so that there is a fertility problem, especially when associated with soil erosion on slopes. Insects and pests on agricultural crops are frequent. Fire, set purposely to control the long grass, can be an incidence in this zone, but is beneficial for grazing land. In the eastern lowlands of Ethiopia terracing is widespread to conserve water. Drought is a recurring problem.

Have you filled in Form 1 on pages 126–129?

Conservation Measures Recommended for Moist Kolla

See also list of measures on page 54

CULTIVATED LAND

As a first step, look at the soil on your slope. If it has good infiltration (sandy, silty), you can apply **level** structures. However, a **Cutoff Drain** may be needed to remove excess runoff during heavy storms. If there is clay soil, apply **graded** structures, but develop a **Waterway** in the first year. To overcome water shortage, **Water Harvesting** can be applied. As a 2nd step, measure the slope gradient.

For slopes with gradients of less than 15%, you can propose **Conservation Tillage** or **Mulch** or select **Grass Strip** with **Vetiver** or **Alley Cropping** with **Trash Line** for soil with good infiltration if grazing can be stopped all year. Combine with **Cutoff Drain**. Otherwise, apply **Level Bund** or **Level Fanya Juu**. On clay soil, make **Waterway** in the first year, then apply **Graded Bund** or **Graded Fanya Juu** in the second year. Here, careful construction and permanent maintenance is necessary, especially during heavy storms. The vertical interval is 1 metre for all measures on this slope. All soil depths greater than 50 cm are possible. Otherwise, again apply **Alley Cropping**. Mix trees and crops to provide good ground cover. For heavy, sticky soils apply the **Broadbed and Furrow** system with **Waterway** to avoid waterlogging.

For slopes between 15 and 50%, measure the average reworkable soil depth first. On red-brown clay loam soil with good infiltration, apply **Level Bund** or **Level Fanya Juu**. Combine with **Cutoff Drain** in between for heavy storms. The vertical interval between two bunds is two and a half times the soil depth. If you have red clay soils, make a **Waterway** in the first year, then **Graded Bund** in the second year; if cattle are excluded all year, use **Graded Fanya Juu** for faster terrace development. All structures require careful maintenance and continuous building up by the farmer, until **Bench Terrace** is developed. Before construction by the farmers, line out the structures on the slope. If the spacing is too narrow for them, apply **Alley Cropping**.

On all structures, apply **Revegetation** preferably with **Vetiver** or **Alley Cropping**. In gullies, apply **Gully Rehabilitation** with **Checkdam**. On degraded cultivated land with shallow soil, apply **Area Closure**. Change land above 50% slope gradient to forest land or grassland with the agreement of the farmers.

GRASSLAND

In the Western parts of Ethiopia, **Controlled Grazing** is needed on slopes only. In the eastern parts, apply **Controlled Grazing** everywhere. Combine with **Grassland Improvement**. On degraded grassland with shallow soil, **Area Closure** is needed. **Cut and Carry** must be used here. Above gullies, make a **Cutoff Drain** and apply **Gully Rehabilitation**.

FORESTLAND

Normally, **Area Closure** is sufficient for **Tree Planting**. **Cut and Carry** can be used for grass management. On steeper slopes, make a **Microbasin** and on very steep slopes or in drier parts, **Trench** or **Hillside Terrace**. Below forestland, make a **Cutoff Drain**.

Have you filled in Form 2 on page 130?

Agroecological zone

Wet Kolla

Altitudinal Range: 500–1500 m
Annual Rainfall: Over 1400 mm
Average Temperature: Over 25°C

View of an area in Dizi, Illubabor that is typical for the Wet Kolla agroecological zone. Because this zone is malaria-prone, it has been settled more recently, and thus there are still a lot of trees. Great care has to be taken to protect natural resources well, including soils, even if land use is changed.

DESCRIPTION AND PROBLEMS

This zone is situated largely in the western parts of Ethiopia. It is suitable for maize, taro, citrus and cotton. Two cropping seasons. The soil is deeply weathered red clay loam to red clay, and on flat areas, black heavy clay. The former is leaching and has thin topsoil humus. Nutrients are fixed more in the natural vegetation than in the soil, so that there is a fertility problem, especially when associated with soil erosion on slopes. Insects and pests on agricultural crops are frequent. Fire, set purposely to control the long grass, can be an incidence in this zone, but is beneficial for grazing land.

Have you filled in Form 1 on pages 126–129?

Conservation Measures Recommended for Wet Kolla

See also list of measures on page 54

CULTIVATED LAND

Because of heavy rainfall it is generally recommended to apply graded structures, in order to drain excess surface water. As a first step, look for traditional waterways you can improve. If traditional waterways are too far apart, place a new **Waterway** in between. Develop the waterways in the first year before constructing any graded structures on the land in the second year.

As a 2nd step, measure the slope gradient on the cultivated land that you want to treat.

For slopes with gradients of less than 15%, you can suggest **Conservation Tillage** or **Mulch** and/or apply **Grass Strip** with **Vetiver** or **Alley Cropping** with **Trash Line** if the soil has good infiltration (sandy, silty). For excessive storms, combine with a **Cutoff Drain** leading to the next Waterway. For sticky clay soils, recommend the **Broadbed and Furrow** system with **Waterway** or install graded structures: apply **Graded Fanya Juu** at a vertical interval of 1 metre. Careful maintenance is needed here. Otherwise, apply **Graded Bund** at the same vertical interval (1 m). All soil depths of more than 50 cm are possible. On shallow soil, again try **Alley Cropping** with **Trash Line**.

For slopes between 15 and 50%, measure the average reworkable soil depth of the slope first. Apply **Graded Bund**, which will develop into **Bench Terrace** with maintenance and improvement. The vertical interval between two bunds must be two-and-a-half times the average depth of fertile soil on the slope. If cattle can be excluded from the cultivated land all year long, apply **Graded Fanya Juu** because this will develop faster into **Bench Terrace**. Take care for maintenance. Outline where bunds will be situated on the land. Discuss with farmers if the spacing between bunds is acceptable. Use **Vetiver** or Revegetation on the bunds, and **Alley Cropping** with **Grass Strip** in between on steep slopes where the spacing for terrace development is too narrow.

On all structures, apply **Revegetation** or **Alley Cropping**. In gullies, build a **Checkdam**. On degraded cultivated land with very shallow soil, apply **Area Closure**. Land with slope gradients above 50% must be changed with the farmer's agreement into grassland or forestland.

GRASSLAND

Normally, **Controlled Grazing** is sufficient. Combine with **Grassland Improvement**. On degraded grassland with shallow soil, **Area Closure** is needed. **Cut and Carry** can be used here. The gully problem is very serious and requires careful treatment. Above gullies, make a **Cutoff Drain**, and in gullies, use **Gully Rehabilitation** with **Checkdam** and **Revegetation**.

FORESTLAND

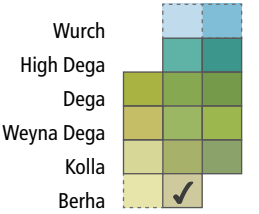
Normally, **Area Closure** is sufficient for **Tree Planting**. **Cut and Carry** can be used for grass management. Below and on degraded forestland, install a **Cutoff Drain** to protect cultivated land.

Have you filled in Form 2 on page 130?

Agroecological zone

Moist Berha

Altitudinal Range: Below 500 m
Annual Rainfall: 900–1400 mm
Average Temperature: Over 30°C



Abbay River in the far western lowlands of Ethiopia that is typical of the Moist Berha agroecological zone at about 500 m. Although the term '*Berha*' is traditionally used for desert-like areas, this area is still very hot but with high rainfall, so that maize can be grown.

DESCRIPTION AND PROBLEMS

This zone is situated in the south-western part of Ethiopia, actually only in Gambella. On the slightly undulating relief, soils are variable; on the plains there are black clay soils and on the slopes brown coloured loams. Some gullying with deep accumulation. Savannah with tall grass and still numerous trees. The area is mainly used for cattle grazing, with grass burning common. There is localised rainfed cropping, depending on the ethnic group. However, insects as well as crop and livestock pests are frequent.

Have you filled in Form 1 on pages 126–129?

Conservation Measures Recommended for Moist Berha

See also list of measures on page 54

CULTIVATED LAND

As a first step, look at traditional soil and water conservation measures existing in your area. Are there drainage ditches or cut-off drains? Are mulching or trash lines common? If yes, think about how to improve the conservation systems, and discuss your ideas with the farmers.

For slopes with gradients of less than 15% on sticky clay soils, which are very common here, recommend **Broadbed and Furrow** system, combined with **Waterway**. On the loamy-silty soils on gentle slopes you may recommend **Conservation Tillage**. Recommend **Mulch** or **Trash Line** for moisture and nutrient conservation, or apply **Level Bund** for maximum water conservation. In areas with higher rainfall in your zone, apply **Level Fanya Juu** if cattle are excluded all year. Look for continuous maintenance during rainy season. The vertical interval is 1 metre for all measures on these gentle slopes. All soil depths greater than 50 cm are possible. Otherwise, apply **Area Closure**. Above the cultivated land, make a **Cutoff Drain** to next river or gully.

For slopes between 15 and 50%, if not too steep, recommend **Mulch**, and for structures, measure the average reworkable soil depth first. Apply **Level Bund** or **Level Fanya Juu** if cattle are excluded. Use a vertical interval two-and-a-half times the soil depth you have measured. Add a **Cutoff Drain** above the cultivated land. All structures need careful maintenance and continuous building up by the farmers until **Bench Terrace** is developed after several years. Before construction by the farmers, outline structures on the slope. If the spacing is too narrow for them, apply **Area Closure** in consultation with farmers and with their agreement.

On all structures apply **Revegetation**, preferably with **Vetiver**. Complete exclusion of grazing animals all year long is recommended. In gullies, apply **Gully Rehabilitation** with **Checkdam**. On degraded cultivated land with shallow soil, apply **Area Closure**. Land with slope gradients above 50% must be changed with the farmer's agreement into grassland or forestland.

In case of water shortage, **Water Harvesting** can be applied, e.g. for vegetable production.

GRASSLAND

On degraded slopes with shallow soil, **Area Closure** is needed. **Cut and Carry** must be used here. Above gullies, install a **Cutoff Drain**, and in gullies, a **Checkdam** together with **Gully Rehabilitation**. Exclude grazing animals from all gullies.

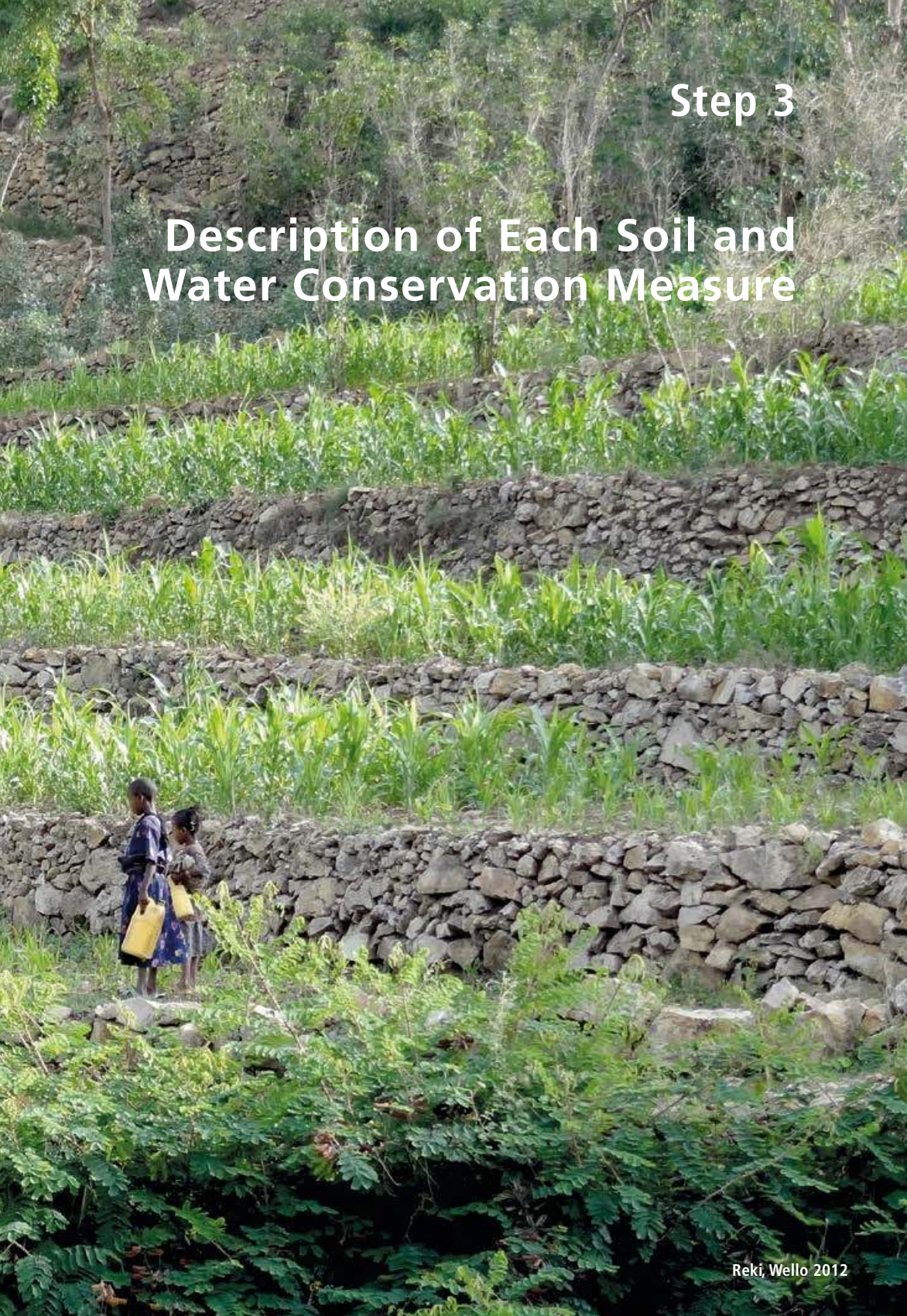
FORESTLAND

Normally **Area Closure** is sufficient to allow wildlings to grow. **Tree Planting** is only necessary when specific trees are desired. In this case use **Cut and Carry** for grass management until the trees are well-established.

Have you filled in Form 2 on page 130?

Step 3

Description of Each Soil and Water Conservation Measure



Reki, Wello 2012

List of Soil and Water Conservation Measures

1. CONSERVATION MEASURES ON CULTIVATED LAND

Alley Cropping	58
Bench Terrace	60
Broadbed and Furrow	62
Conservation Tillage	64
Graded Bund	66
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Grass Strip	70
Level Bund	72
Level Fanya Juu	74
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2. CONSERVATION MEASURES ON GRASSLAND

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3. CONSERVATION MEASURES ON FORESTLAND

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Cutoff Drain	106
Gully Rehabilitation	108
Revegetation	110
Water Harvesting	112
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Guide to Step 3

Description of Each Soil and Water Conservation Measure

Step 1 of this book helped you to find the agroecological zone in which you work. In Step 2, soil and water conservation recommendations were given for each agroecological zone. For cultivated land, they were different according to slope gradients, soil depths and soil types. For grassland and forestland, other measures were proposed.

The soil and water conservation measures in Step 2 were not described, but only listed in **bold**. Reference was made to the list on page 54 (opposite this page), which can be used for quick location of the description of each measure in this book.

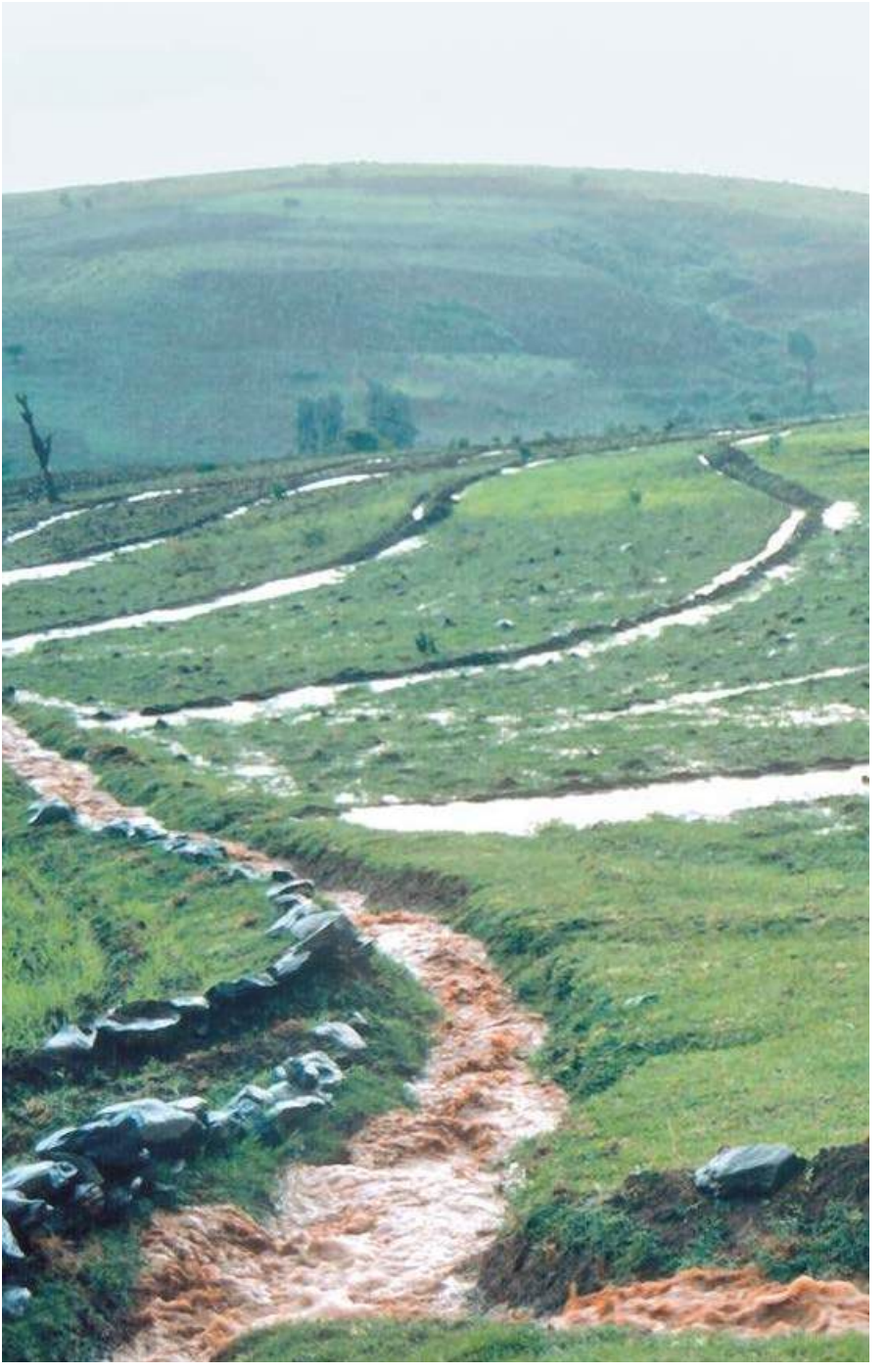
Step 3 on the following pages will assist you in obtaining instructions for each soil and water conservation measure that you find written in bold in this book. Two pages are used for each measure. Again, reference to other measures is given in **bold**, so that these measures can be found with the list on the opposite page.

We have grouped the soil and water conservation measures in this chapter into four sections. Three sections correspond to the three land use types mainly found in an area. A fourth section compiles the measures that are common to all land use types:

- Conservation measures on cultivated land (pages 58–80).
- Conservation measures on grassland (pages 84–88).
- Conservation measures on forestland (pages 92–98).
- Conservation measures common to all land use types (pages 102–114).

Lists of the measures are given at the beginning of each section. However, do not try to apply all measures given in a section to your area. As you know from Step 2, a certain agroecological zone requires only some of the measures, while others are not suitable. Therefore, just select the measures that have been recommended for your agroecological zone in Step 2. Fill in Form 2 on page 130 when you have made a selection of measures that you consider most suitable. Use this form when discussing with farmers. In the Individual Farmland Plan in Form 3, you may jointly decide on other measures than the ones you considered most suitable.

Have you filled Form 2 on page 130 with your recommended measures as a basis for individual farmland planning together with farmers?



Graded Fanya Juu soil bunds with functioning drainage ditches during a storm in Anjeni, Gojam (1985).

Conservation Measures on Cultivated Land

Definition

Cultivated land is land under cultivation or under temporary fallow, or land that will be used for cultivation in the immediate future.

List

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Conservation Tillage 64
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Grass Strip 70
Level Bund 72
Level Fanya Juu 74
Mulch 76
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The next list is on page 83.

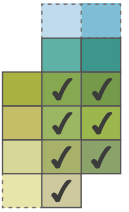
Alley Cropping

LOCAL APPLICABILITY

Local Situation

Slope Range: All
Soil Range: All, including shallow and degraded soils

Agroecological Zones



DEFINITION

Alley cropping is an agroforestry system in which food crops are grown in alleys between rows of hedges. The hedges follow the contour and consist of trees and shrubs such as Leucaena or Pigeon peas. Leguminous perennials are more suitable as they fix nitrogen. Hedges can also be placed on conservation structures.

SPECIFICATIONS

The following tree species are commonly used in agroforestry in Ethiopia:

Acacia albida: This tree occurs in the moist Kolla and moist Weyna Dega, and is used on cultivated land to improve soil fertility and as fodder. Branches are cut short to minimize shadow when planted with tef.

Sesbania and Leucaena: These have been introduced and are used like Acacia albida on cultivated land. They may be cut short at the end of the dry season to keep shadow to a minimum, especially with tef. With sorghum and maize, problems of competition for light are less.

Bamboo, 'true man's tree'; many local species known to farmers can be used for alley cropping at the altitudes of their natural occurrence.

Spacing between rows of hedges should not be more than 5 metres. On hedgerows, trees and shrubs can be spaced 25–100 cm apart. When cutting, take care that shrub is cut above lowest split of branches and not below, to support fast regrowth. Alley cropping is applied by individual landholders on their land, and the products are at their own use. Trees are planted in rows of pits along the contour spaced with a vertical interval of up to 5 metres on steep slopes.

EFFECTS

Trees and shrubs provide green manure or mulch for recycling nutrients to the soil. Prunings, applied during fallow, suppress weeds and create favourable conditions for soil organisms. Soil erosion is reduced. Bunds on steeper slopes are stabilized. Nitrogen is fixed and made available to companion plants.

Twigs and leaves may also be used as fodder for **Cut and Carry** in zero grazing units.

Alley cropping on a steep slope. Rows of trees and hedges alternate with strips of grassland or cultivated land. Controlled grazing with cattle is possible between the rows. Crops can be grown for some time until the soil is left fallow to improve fertility, supported by organic material from tree leaves and fixation of nitrogen through some trees.

COMBINATIONS

Alley cropping can be used with physical measures applied on steep degraded slopes, even in the Dega belt for certain leguminous trees growing at that altitude. Below steep slopes, **Cutoff Drain** is used to protect cultivated land. **Cut and Carry**, **Tree Planting** and **Revegetation** are used with alley cropping.

MATERIALS

Besides the trees mentioned, bushes and shrubs, which are traditionally known as fodder perennials, can also be used for alley cropping. Additional materials are line level and digging instruments.

MANAGEMENT AND MAINTENANCE

Planting must be narrow in the hedge (every 1 m). Weeding and pruning is required. Grazing between rows of trees only with tied cattle; **Cut and Carry** is even better. Crop production shifts between trees, leaving a strip fallow after cultivation for about 3–5 years to let the soil regenerate. Use traditional knowledge about soil fertility improvement and tree management. Raising trees requires careful supervision by the farmer who applies alley cropping on his land. Grazing should not degrade the grass cover. Crops are allowed only if soil fertility has improved. Crop rotation is a must. Regular cutting of tree branches for mulch and fodder gives the desired benefit.

Bench Terrace

LOCAL APPLICABILITY

Local Situation

Slope Range: Slopes with gradients up to 50%

Soil Range: Vertical interval is two-and-a-half times the soil depth

Agroecological Zones

DEFINITION

A bench terrace is a conservation structure where a slope is converted into a series of steps, with a horizontal cultivated area on the step and steep risers between two steps. In Ethiopia, a bench terrace is usually developed from bunds and Fanya Juus over a period of 5–15 years through careful maintenance and buildup. Bench terraces are level along the contour in dry to moist agroecological zones. In moist to wet agro-ecological zones, they are graded to drain excess runoff sideways to the next river or waterway.

SPECIFICATIONS

Bench terraces must be spaced with a vertical interval, which is two-and-a-half times the depth of reworkable soil. If the soil is 1 m deep, the vertical interval is 2.5 m (see page 123). Horizontally, level terraces are lined out with the line level as shown on page 121, and graded terraces are lined out as shown on page 124.

The width of cultivated area on a bench terrace is determined by the slope gradient and the soil depth, as shown in the Table below:

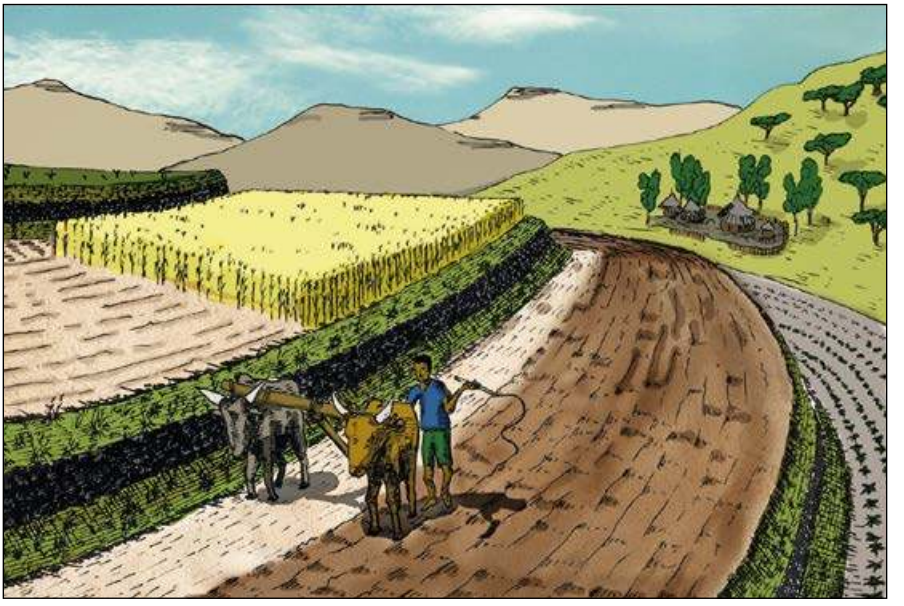
Slope gradient	Soil depth (cm)					
	25	50	75	100	125	150
20%	2.80 m	5.60 m	8.40 m	11.30 m	14.10 m	16.90 m
30%	1.80 m	3.50 m	5.30 m	7.10 m	8.90 m	10.60 m
40%	1.30 m	2.50 m	3.30 m	5.00 m	6.30 m	7.50 m
50%	0.90 m	1.90 m	2.80 m	3.80 m	4.70 m	6.60 m

Table: Width of cultivated land on bench terraces in metres for variable slope gradients and soil depths.

Measure the slope gradient and the average soil depth and check the table for the width of cultivated land you can expect when using a vertical interval of two-and-a-half times the soil depth.

EFFECTS

Levelling the cultivated land will greatly reduce soil erosion, usually to tolerable amounts. If the spacing between two riser slopes is carried out with the vertical interval as described here, the cultivated land will almost level when the terrace is developed. On the



The bench terraces shown here are slope slightly outwards. They have been developed from stone-faced bunds still visible in the middle of the riser slope. Above and below the stone wall, there are grasses and legumes which can be used for fodder. Ploughing is automatically along the contour. Erosion from such terraces is reduced to almost zero.

riser slope, grass and legumes can be developed through **Revegetation**. Maintenance is essential for terrace development from Fanya Juu and Bund, and also indispensable to the prevention of terrace destruction later on.

COMBINATIONS

Level or **Graded Bund** or **Fanya Juu**, **Grass Strip** and **Alley Cropping** can all be used to start terrace development if the terraces are not constructed directly. Stabilize the riser slope through **Revegetation**. Add **Cutoff Drain** to protect the terraces from runoff coming from upslope. Start **Waterway** in the first year for graded terrace development.

MATERIALS

Digging instruments, line level, materials as indicated for combined measures.

MANAGEMENT AND MAINTENANCE

Continuous upgrading over 5–20 years is indispensable if terraces are developed from bunds. Stabilization of the riser slope through **Revegetation** is recommended. **Cutoff Drain** for level terraces and continuous improvement of the ditches below graded terraces is necessary to drain excess runoff during storms. Drainage ditches have to be emptied from soil deposited after every heavy storm. This is the duty of the farmer to whom the terraces belong. The terraces have to be increased and repaired continually until the situation stabilizes.

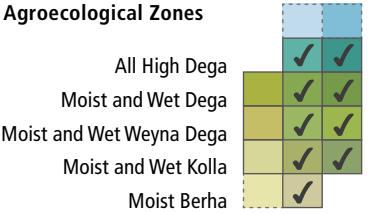
Broadbed and Furrow

LOCAL APPLICABILITY

Local Situation

Slope Range: Gentle slopes of less than 15%
Soil Range: Heavy soils, e.g. Vertisol

Agroecological Zones



DEFINITION

Broadbed and furrow is a soil management system applied to crop cultivation in waterlogging areas. On heavy soils like black cotton soils (Vertisols), a broad seedbed is heaped up with a furrow system in between the beds so that excess water can be safely drained out without disturbing the seedlings. At the same time the roots of the crop are raised above the groundwater table in the bed.

SPECIFICATIONS

Broadbed and furrow systems are alternating broadbeds and furrows with a spacing of 1 m to 2 m between furrows, in other words the bed-width is 1 m – 2 m. The furrows are slightly inclined by 0.5% to drain the water out safely.

EFFECTS

Broadbed and furrow systems discharge excess water safely from waterlogged areas and thus allow crops to be grown that would otherwise fail without draining the soil. One example is sorghum (mashilla) or maize (bekollo) which do not produce any yield under waterlogged conditions.

Double-plough system for broadbed and furrow preparation. Source: ILRI.

Broadbed and Furrow is applied on flat fields where flooding and lack of drainage is a problem. In order to drain the water, furrows are made at 1–2 m intervals. They can first be made by a plough and later deepened with a shovel, as illustrated here.

COMBINATIONS

Broadbed and Furrow systems may have to be combined with safe **Waterway** if no natural drainage pattern is to be used.

MATERIALS

Special 'broadbed-makers' are available as farm-inputs, but it is possible to use any plough to draw the furrows. However, this is rather cumbersome with the traditional 'maresha'. A line level or A-frame is needed to properly align the furrows. Pegs are needed to mark the alignment of the furrows.

MANAGEMENT AND MAINTENANCE

It is of utmost importance to keep the slope of the furrows at the right inclination of 0.5% to avoid scouring of the soil and to prevent siltation of the furrow. If one of the two occurs, corrections have to be made, either during the same cropping period or eventually when doing layout for the next season.

Conservation Tillage

LOCAL APPLICABILITY

Local Situation

Slope Range: All slopes (above 15%, however, combine with contour structures)

Soil Range: All

Agroecological Zones

DEFINITION

Conservation tillage is a tillage practice aimed at creating a favourable soil environment for germination, establishment and plant growth with minimal soil disturbance. Conservation tillage reduces or avoids full ploughing operations, which are used to remove weeds and prepare moisture uptake, but destroy the soil structure and disturb soil organisms. For conservation tillage practices, the control of weeds is a major concern, involving either considerable manual labour or herbicides.

SPECIFICATIONS

There are different types of conservation tillage:

Minimum or reduced tillage: ploughing the whole field as lightly as possible, just to break up hard pans or compacted layers. This can be used with crops that are broadcast, such as tef, wheat or barley.

Strip tillage: ploughing just the strips of the soil where the crop will be planted, leaving the spaces in between undisturbed. This can be used with row crops such as maize and sorghum.

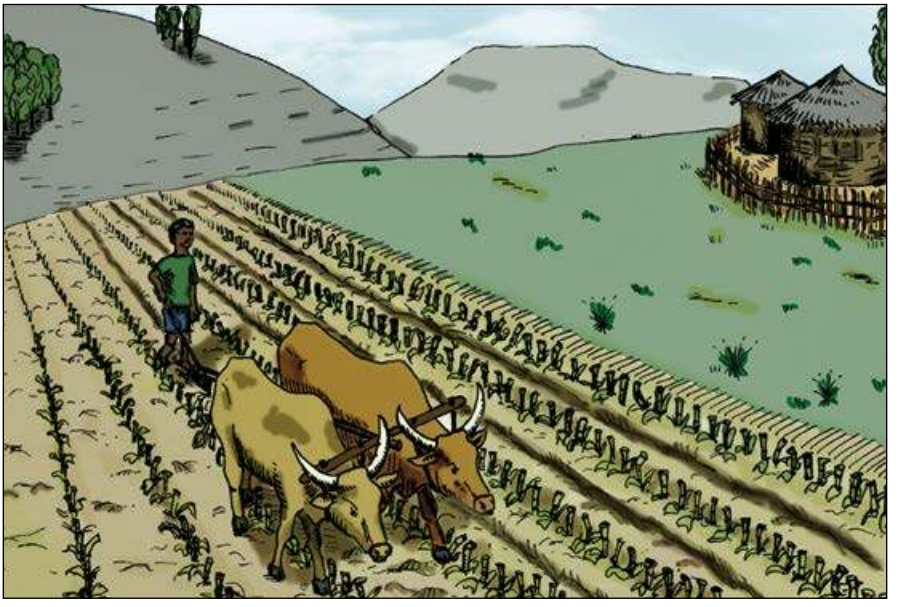
Zero tillage: planting directly into the soil, using equipment to make planting holes or narrow furrows to put the seeds and fertilizer in. Mulch or cover crops or herbicides can be used to control weeds.

EFFECTS

Conservation tillage reduces runoff and conserves water in the soil after the soil organisms soften the soil. It greatly reduces erosion, improves the soil structure and conserves organic matter in the soil. It saves work during cultivation although extra efforts may be required to control weeds, either manually or with herbicides. It does not take any land out of production as bunds do. It may require some special tillage/planting equipment depending on the type chosen. Conservation tillage prevents the building up of fertile and less fertile strips as caused by the soil movement between bunds.

COMBINATIONS

Conservation tillage can be combined with cover crops, green manure or **Mulch**.



This farmer is applying Conservation Tillage on a field where he previously harvested maize. He is applying strip tillage, meaning he only ploughs single rows where he will plant new crops, but not the area in between. This way he can minimize soil erosion and considerably improve soil moisture.

MATERIALS

The traditional 'maresha' plough is suitable for reduced tillage operations, but even better is specialised equipment such as a mouldboard plough for reduced tillage; a subsoiler ('tenkara kend') for braking up hard pans; a row planter for opening furrows and placing the seeds and fertilizer at once, or a winged cultivator, which is an attachment to the 'maresha' that cuts and uproots emerging weeds.

All this equipment requires some investment – but this is worthwhile and the result is better yields. So it is important to assist the farmer to select the most appropriate equipment for his/her specific conditions.

MANAGEMENT AND MAINTENANCE

The most important thing in conservation tillage is weed control, which requires special attention. In most countries where conservation tillage is applied, herbicides are widely used for weed control. The application of herbicides requires special training and protective clothing; therefore, it should be carried out by specialists on a contract basis rather than by the farmers themselves. The alternatives to herbicides are manual weeding, which requires additional work during the first two months after seeding (a winged cultivator is very helpful to control weeds between row crops), or cover crops or **Mulch** to suppress the weeds.

Graded Bund

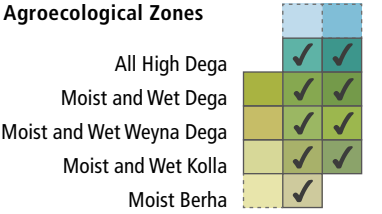
LOCAL APPLICABILITY

Local Situation

Slope Range: 3–50%

Soil Range: All soils in wet, clay soil in moist agro-ecological zones

Agroecological Zones



DEFINITION

A graded bund is defined similar to a **Level Bund**, with the only difference being that it is slightly graded sideways, with a gradient of up to 1%, towards a waterway or river. Such a gradient is for surplus runoff to be drained if the retention of the bund is not sufficient. Tied ridges with top heights lower than the bund height serve to retard such flow and to provide small basins for water storage.

SPECIFICATIONS

The vertical interval between two bunds is 1 m for slope gradients of less than 15%. For steeper slopes, the vertical interval must be two-and-a-half times the depth of reworkable soil. Gradients of 1% are lined out as shown on page 124.

For a typical cross-section, refer to **Level Bund** because it is not different from this.

No gaps can be provided for ploughing oxen to cross (as for level bunds) because the graded bund serves as a drainage line which cannot be interrupted. Whenever possible, use and improve traditional waterways in the area where you intend to apply graded bunds. Discuss with farmers the measures lined out before you implement them. Make the waterways one year before the graded structures to stabilize them before use.

If the bunds are long, the basins behind them must be increased towards the waterway, as more and more runoff will have to pass during storms. The size of the ditch can be 25 cm deep by 50 cm wide at the beginning of the bund, but 50 cm deep by 100 cm wide after about 100–150 m when the bund reaches the river or the waterway.

EFFECTS

Graded bunds retain normal amounts of runoff in their basins, but they can drain excess runoff from heavy storms which would cause overflow and downslope destruction on level bunds. Most of the soil eroded between two bunds is deposited, while some will be drained sideways during heavy storms and lost from the land. However, graded bunds are more effective than level bunds in wet areas as well as in moist areas with clay soils.

The graded bund in the foreground enters a natural drainage channel which has been protected with a checkdam just below the entry point of the graded bund. The basin behind the bund still has small tied ridges to prevent runoff from flowing too fast and creating erosion behind the bund. Earth bunds are stabilized with revegetation and their outlets reinforced with stones.

COMBINATIONS

A **Waterway** must be developed one year before graded bunds are applied. This is needed to drain excess runoff. **Revegetation** or **Alley Cropping** must be used on the bunds to stabilize them. **Bench Terrace** develops from graded bunds with continuous increase over the next 5–15 years.

MATERIALS

Line level, digging instruments, blocks of stone for stone-faced bunds and, as mentioned, for combined measures (such as suitable local grass and legumes for **Revegetation**).

MANAGEMENT AND MAINTENANCE

Revegetation is needed especially on soil bunds in wet areas. Continuous repair during and after heavy storms is indispensable, especially in the first years after construction. The entry point to the **Waterway** has to be constructed carefully with dry masonry. Every farmer is responsible for carrying out continuous maintenance on the graded bunds of his/her land. Breakings must be closed during and after storms. Bunds have to be increased annually until **Bench Terrace** is developed after several years (10–20). Even thereafter, the drainage ditch leading sideways to the next waterway or river must be maintained.

Graded Fanya Juu

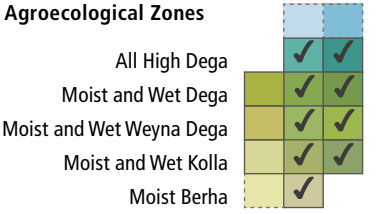
LOCAL APPLICABILITY

Local Situation

Slope Range: 3–50%, more on steeper slopes

Soil Range: All deep soils in wet, deep clay soils in moist agroecological zones

Agroecological Zones



DEFINITION

A graded Fanya Juu ('Throw uphill' in Swahili) is defined similar to a **Level Fanya Juu** with the only difference being that it is slightly graded sideways towards a waterway, with a gradient of up to 1%. This gradient is for surplus runoff to be drained if the retention of the Fanya Juu is not sufficient. Tied ridges behind the embankment provide small basins for water storage and guide the water over the bund into the ditch below, from where it is drained sideways.

SPECIFICATIONS

Caution is needed when applying graded Fanya Juu because they require careful design, supervision and maintenance, although conservation is effective.

The vertical interval between two graded Fanya Juus is 1 m for slope gradients of less than 15%. For steeper slopes, the vertical interval is two-and-a-half times the depth of reworkable soil. Gradients of 1% are lined out as shown on page 124. It is recommended to apply stone-faced bunds whenever possible to make them strong for overflow.

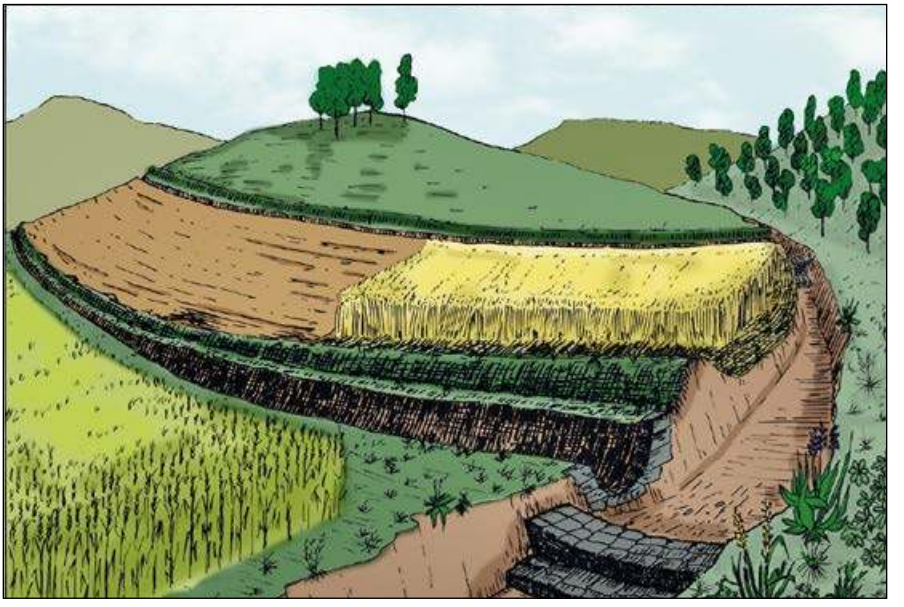
A typical cross-section is shown on page 74 for **Level Fanya Juu**, also applicable for graded Fanya Juu.

No gaps can be provided for ploughing oxen to cross (as for level Fanya Juu) because the graded Fanya Juu serves as a drainage line which cannot be interrupted. Whenever possible, use and improve traditional waterways in the area one year before you apply graded Fanya Juu. Discuss with farmers the measures lined out before you implement them.

If the Fanya Juu structures are long, the ditches below them have to be increased towards the waterway because more and more runoff will have to pass during storms. The size of the ditch can be 50 cm deep by 25 cm wide at the beginning of the structure, but 75 cm deep by 50 cm wide after about 100–150 m when the Graded Fanya Juu reaches the waterway.

EFFECTS

Graded Fanya Juu retains small amounts of runoff above their wall and they drain excess runoff from heavy storms through the ditch below, which causes overflow and downslope destruction on level (Fanya Juu) structures. Some of the soil eroded between two Fanya Juus is deposited above the wall, some is deposited in the ditch, and the rest is drained sideways. Graded Fanya Juus are more difficult to manage, but support the development of **Bench Terrace** very well.



The graded Fanya Juu in this drawing enters a natural drainage channel, where a checkdam has been constructed just below the inlet to prevent erosion.The drainage ditch of the Fanya Juu is also reinforced with stone. Small tied ridges are barely visible behind the embankment of the Fanya Juu. They help to prevent sideways flow of water above the embankment. Instead, excess runoff will flow over the wall and enter the ditch. Revegetation is absolutely necessary on the wall to make it strong.

COMBINATIONS

Waterway is needed for draining the excess runoff. It must be developed one year before Graded Fanya Juu is applied. **Revegetation** or **Alley Cropping** is used to stabilize the Fanya Juus. **Bench Terrace** develops from Graded Fanya Juu with the continuous increase of the wall.

MATERIALS

Line level, digging instruments, blocks of stone for stone-faced embankments and as mentioned for combined measures (such as suitable local grass and legumes for **Revegetation**).

MANAGEMENT AND MAINTENANCE

Revegetation is recommended on all Fanya Juus, including the stone-faced ones. Most important is continuous repair during and after heavy storms. Otherwise, the ditch will be filled with sediment. The entry point to the **Waterway** has to be constructed with careful dry masonry. Every farmer is responsible for carrying out continuous maintenance on the Graded Fanya Juu on his land. Breakings have to be closed during and after storms and the ditch emptied of sediment. Embankments must be increased annually until **Bench Terrace** is developed after relatively few years (5–10). The drain sideways to the next waterway or river must be maintained.

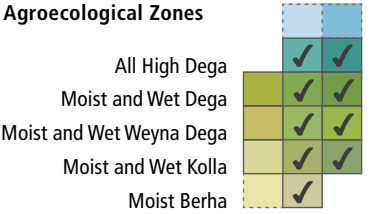
Grass Strip

LOCAL APPLICABILITY

Local Situation

Slope Range: Slopes with gradients of less than 15%
Soil Range: All

Agroecological Zones

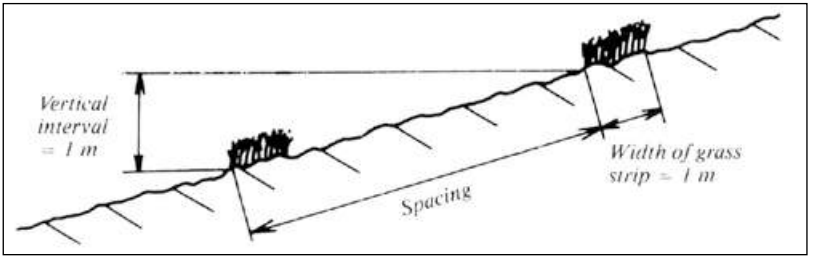


DEFINITION

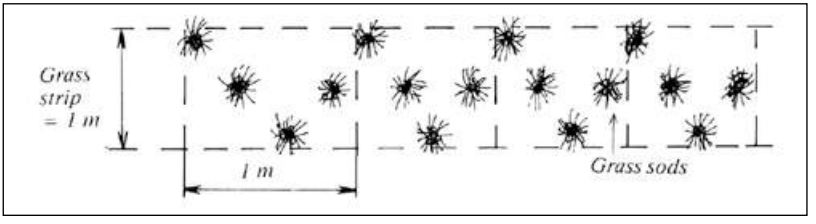
A grass strip is a ribbon-like band of grass laid out on cultivated land along the contour. Usually, grass strips are about 1 m wide and spaced at 1 m vertical intervals. They are mainly used to replace physical structures on soil with good infiltration (sandy, silty) on gentle slopes. Cattle must be excluded from this measure all year long to provide for sufficient length of the grasses to slow runoff and retain soil sediment.

SPECIFICATIONS

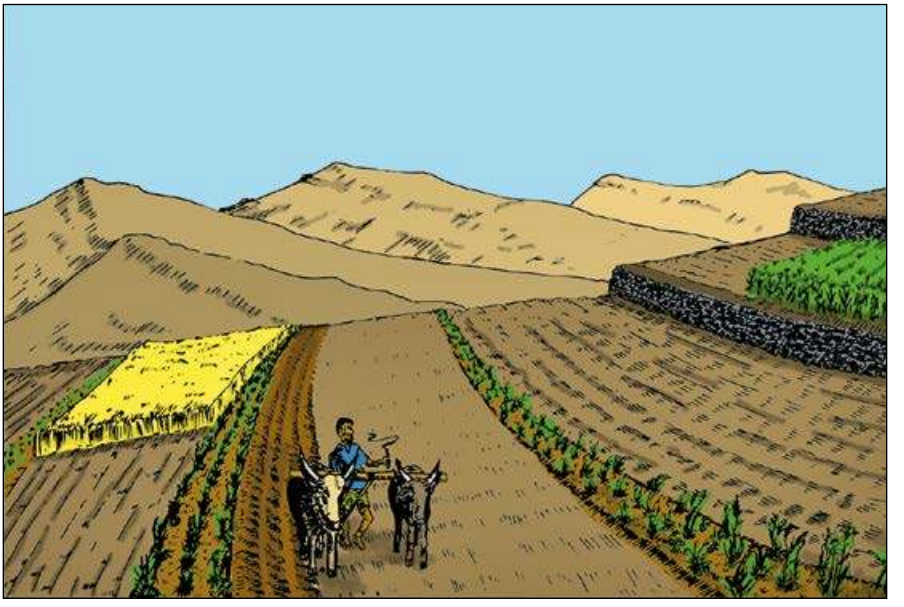
Cross-section:



View from top:



Grass strips are planted along the contour or along **Cutoff Drain**. Spacing with 1 m vertical interval means that on a 3% slope, grass strips will be 33 m apart, and on a 15% slope, only 7 m apart, still sufficient for ploughing between the strips.



Grass strips are used on gentle cultivated land to the left. On the steeper slopes to the right, terrace development is needed. The farmer automatically ploughs parallel to the strips, a measure which reduces erosion further. The individual sods of grass planted into the strip can still be seen. To the right, the grass strip has already developed into a small terrace.

EFFECTS

Grass Strip helps to reduce runoff and to filter out sediments carried by runoff. They are especially suitable on soil with good infiltration and where the climate is not too dry for dense grass development. If grazing is totally prevented, the grass strips will effectively build up into terraces and provide good fodder for cattle which can be used with **Cut and Carry**.

COMBINATIONS

Use **Cut and Carry** for grass management. Sometimes, **Cutoff Drain** between grass strips is useful for safety reasons if heavy storms occur.

MATERIALS

Local grass sods from well-developed grassland for planting. Digging instruments, line level, stakes for marking strips. Grass seeds if available or collected nearby.

MANAGEMENT AND MAINTENANCE

Select grass carefully and consult farmers. Runner grass is not suitable because it will disturb the crops. Introduced grass may be used, but generally the local species known to the farmers will do. Grass strips can be improved to **Alley Cropping**. Every farmer maintains the grass strips on his own land and there he is allowed to **Cut and Carry**. Care must be taken that the strips are not narrowed with every ploughing. A width of one metre is the absolute minimum required for effectiveness.

Level Bund

LOCAL APPLICABILITY

Local Situation

Slope Range: 3–50%

Soil Range: All depths greater than 50 cm, or according to farmer's consent

Agroecological Zones

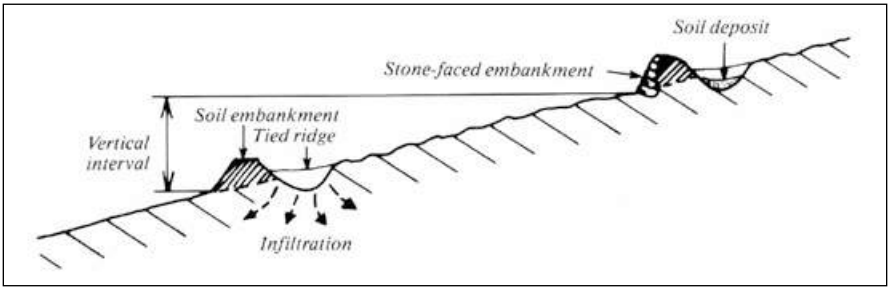
DEFINITION

A level bund is an embankment along the contour, made of soil and/or stones, with a basin at its upper side. The bund reduces or stops the velocity of overland flow and consequently soil erosion. Level bunds are about 50–75 cm high and have a bottom width of 100–150 cm and a water retention basin on their upper side. Usually, tied ridges, placed in the basin about every 10 m help to prevent runoff from flowing sideways and to concentrate overflow at one point along the bund.

SPECIFICATIONS

The vertical interval between two bunds is 1 m for slope gradients of less than 15%. For steeper slopes, the vertical interval must be two-and-a-half times the depth of reworkable soil. Contours are lined out as shown on page 121.

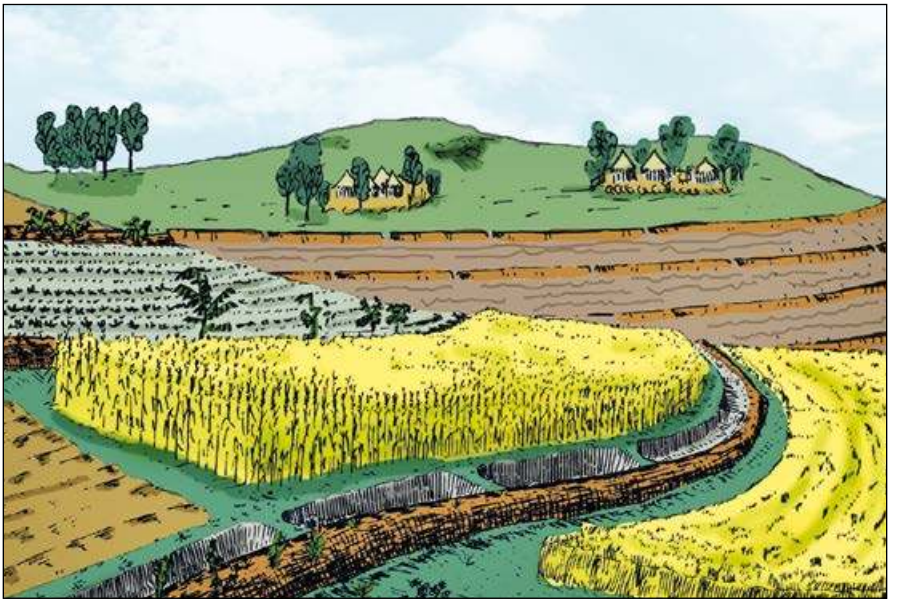
A cross-section through bunds looks as follows:



About every 50 m, a gap can be left open to allow oxen pulling ploughs to cross and reach their land.

EFFECTS

Level bunds are walls to retain all runoff between two bunds. Overflow should never occur, and runoff sideways will occur only as the result of inappropriate lining of the bunds. Soil which is eroded between two bunds is deposited in the basin behind the lower bund. Whenever the basin fills with sediment, the bund must be raised. This way, a **Bench Terrace** will develop in the course of several years.



The level bund in front of the slope follows a horizontal line. The basins behind the bund are separated by tied ridges about every ten metres. The newly constructed embankment still needs more revegetation. For this gentle slope, a 1 m vertical interval was used because the slope gradient is less than 15%. In the background, parallel bunds which allow cattle to cross the land during ploughing are set up with some alternating gaps between them.

COMBINATIONS

A **Cutoff Drain** may be necessary in cases where not all runoff can be retained between the bunds. Revegetation is essential as is a combination with **Alley Cropping**.

MATERIALS

Line level, digging instruments, stone for stone-faced bunds and, as mentioned, for combined measures (such as suitable local grass and legumes for **Revegetation**).

MANAGEMENT AND MAINTENANCE

Revegetation is recommended on all bunds, especially on soil bunds in moist areas. Grazing on cultivated land treated with bunds must be stopped throughout the year. **Cut and Carry** can be used as an alternative. The farmer must be present and agree to the design and lining out of bunds on his land. Otherwise, discuss alternatives. Every farmer is responsible for carrying out the maintenance of bunds on his own land. Bunds must be maintained whenever they tend to break. Bunds have to be increased annually until **Bench Terrace** is developed after several years (about 10–20 years on average).

Level Fanya Juu

LOCAL APPLICABILITY

Local Situation

Slope Range: 3–50%

Soil Range: All depths greater than 50 cm, according to farmer's consent

Agroecological Zones

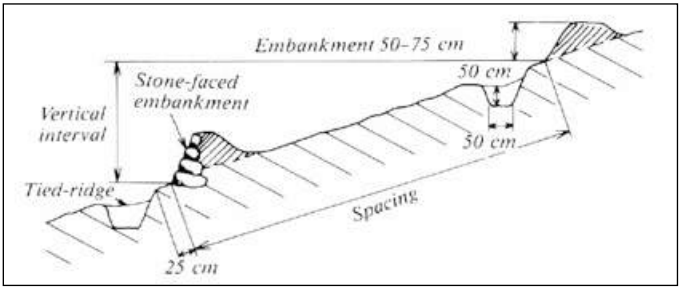
DEFINITION

A level Fanya Juu ('throw uphill' in Swahili language) is an embankment along the contour, made of soil and/or stones, with a basin at its lower side. The Fanya Juu reduces or stops the velocity of overland flow and consequently soil erosion. By contrast with the **Level Bund**, the soil in a Fanya Juu is moved upslope for construction. The water retention basin is thus at the lower side of the wall. Tied ridges about every 10 metres are also used here to prevent runoff from flowing sideways.

SPECIFICATIONS

The vertical interval between two bunds is 1 m for slope gradients of less than 15%. For steeper slopes, the vertical interval must be two-and-a-half times the depth of reworkable soil. Contours are lined out as shown on page 111. The height of the Fanya Juu is 50–75 cm, and the ditch is about 50 cm deep. The space between the ditch and the berm is at least 25 cm. The width of the ditch depends on soil fertility. On fertile subsoil, it may be very wide and crops can be planted in the ditch.

A cross-section through a Fanya Juu looks as follows:



About every 50 m, a gap can be left open to allow oxen pulling ploughs to cross and reach their land.

EFFECTS

Level Fanya Juus are embankments to retain runoff between two bunds. Runoff is retarded behind them, and the overflow is collected in the ditch below the embankment. Runoff in the ditch flowing sideways is stopped by the tied ridges. Soil eroded

The level Fanya Juu in the foreground shows how the ditches are placed below the embankment. Tied ridges here also stop the runoff from flowing sideways to the deepest point where it would overflow. The embankments still need revegetation for better stabilization. The farmer ploughs along the contour between two Fanya Juus, helping them to develop a Bench Terrace.

between two Fanya Juus is deposited behind the lower one. Whenever the small basin behind and the ditch below the Fanya Juu are full of sediment, they must be raised with deposit material from the ditch. This way, a **Bench Terrace** will develop in the course of a few years.

COMBINATIONS

Cutoff Drain may be necessary in cases where not all runoff can be retained between the Fanya Juus. **Revegetation** is essential, as is a combination with **Alley Cropping**. Both can be used for better stabilization of the Fanya Juu.

MATERIALS

Line level, digging instruments, blocks of stone for stone-face embankment, and materials mentioned for combined measures (such as suitable local grass and legumes for **Revegetation**).

MANAGEMENT AND MAINTENANCE

Revegetation is recommended on all Fanya Juus, especially on soil bunds in moist areas. Grazing must be stopped on cultivated land treated with bunds throughout the year. **Cut and Carry** can be used as an alternative. The farmer must be present and agree to the design and lining out of the structures on hisland. Every farmer is responsible for carrying out the maintenance of Fanya Juus on his/her own land. They must be maintained whenever they tend to break, especially in storms. Fanya Juus have to be increased annually until **Bench Terrace** is developed after relatively few years (about 5–10 years on average).

Mulch

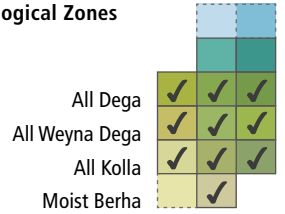
LOCAL APPLICABILITY

Local Situation

Slope Range: All (combined with contour structures on steeper slopes)

Soil Range: All, in particular shallow and degraded soils, but less suitable on heavy soils where waterlogging is a problem

Agroecological Zones



DEFINITION

Applying mulch means covering the soil with crop residues such as straw, maize and sorghum stalks, tree leaves, or other plant material, or standing stubble. The cover protects the soil from the hot sun and from the impact of raindrops, minimizing soil crusting, erosion and runoff. Maintaining crop residues or mulch on the field reduces soil erosion and has a considerable potential for the restoration and maintenance of soil fertility.

SPECIFICATIONS

Applying mulch is of the most practical use with row crops such as maize and sorghum, and for widely spaced perennial fruit trees such as mango, avocado, citrus, inset and banana.

What to use as mulch:

Large amounts of organic materials are needed to get the full benefit of mulching. Any organic debris (straw, prunings from hedgerows, weeds removed from the fields) can be used. Research findings show that using mulch on maize increased biomass production so much that it compensated for the mulch used and the remaining crop residues were still enough to feed the cattle. There, farmers were first worried about not having enough fodder for their animals when mulching.

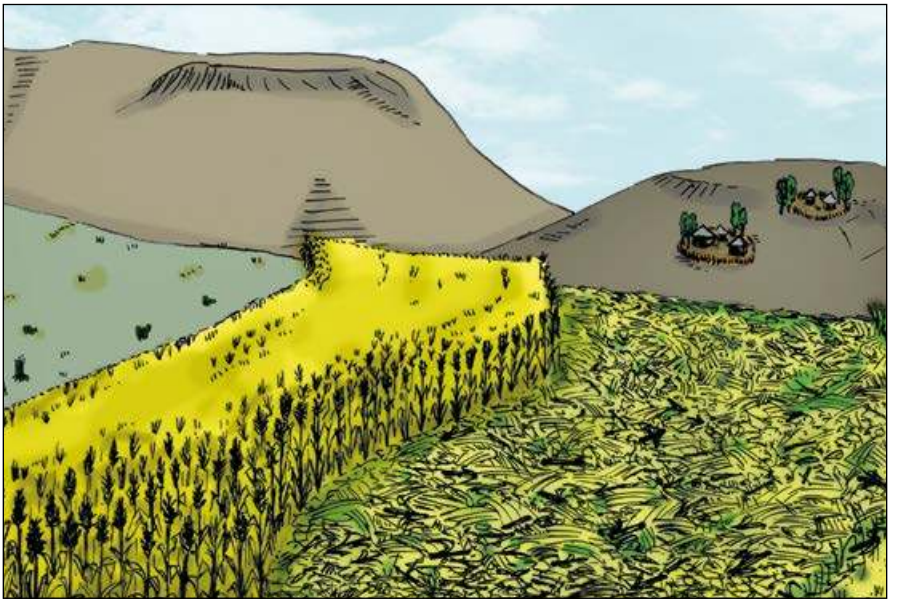
When to use mulch:

– Under conventional tillage: plough under the mulch before planting the main crop to incorporate it into the soil.

– Under conservation tillage: keep the mulch on the field while the crop is growing so the mulch controls weeds.

EFFECTS

Applying mulch is an effective method to reduce soil erosion, in particular on slopes up to 15%. A crop residue covering the ground intercepts raindrop impact, prevents splash erosion, and slows down the water flow and increases infiltration. It also encourages insects and worms to make holes into the ground, thus increasing the permeability of the soil and enabling rainwater to soak into the soil. And it reduces evaporation and increases the moisture content of the soil. On the other hand, it protects the soil from



Mulch is a system in which part of the crop residues are spread over the field after harvest instead of being removed. This retains soil moisture and softness, so that direct seeding is possible, unless the material is ploughed into the soil to improve humus content. Post-harvest grazing should be avoided if possible.

getting burnt and crusted by the sun. It increases the organic matter and nutrient content of the soil. Mulch also suppresses weeds. All of these effects help to increase yields.

COMBINATIONS

Mulch can be used everywhere: in combination with physical and other biological measures on flat and on steep, degraded slopes. However it is not suitable in High Dega, since it is too cold there to decompose the organic material.

MATERIALS

Large amounts of organic materials are needed to get the full benefits of mulching. Any organic debris (straw, prunings from hedgerows, weeds removed from the fields) can be used. Avoid crop residues that harbour pests such as the maize stalkborer. Of course you should never use residues infested by striga.

MANAGEMENT AND MAINTENANCE

It is advisable to spread the mulch thinly to allow the sun to burn weed and pests (e.g. maize stalkborer may be burnt out). However, the best is to avoid infested crop residues.

Trash Line

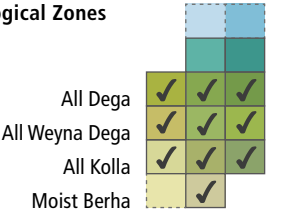
LOCAL APPLICABILITY

Local Situation

Slope Range: Gentle slopes of less than 15%

Soil Range: All

Agroecological Zones



DEFINITION

Trash lines are made from crop residues, grass or other organic materials collected from the field or its surrounding. Trash lines can be used instead of physical structures on gentle slopes. They slow down runoff and reduce soil erosion.

SPECIFICATIONS

Trash lines are aligned along the contour at appropriate intervals exactly like physical structures.

Mark out the contour line by using a line level. The spacing between the trash lines depends on the slope. The spacing is normally about 5 m, but on gentle slopes it can be more than 5 m. The trash lines are usually up to one metre wide.

Trash lines are made from crop residues, but also grass, weed or any other organic material from the fields and the surrounding area can be used. You may knock pegs (e.g. stalks from maize or sorghum) to keep the trash lines in place.

Where to use trash lines:

– Trash lines are useful in areas where crop residues and other trash are found in the field and its surroundings and which are not used for livestock or fuel.

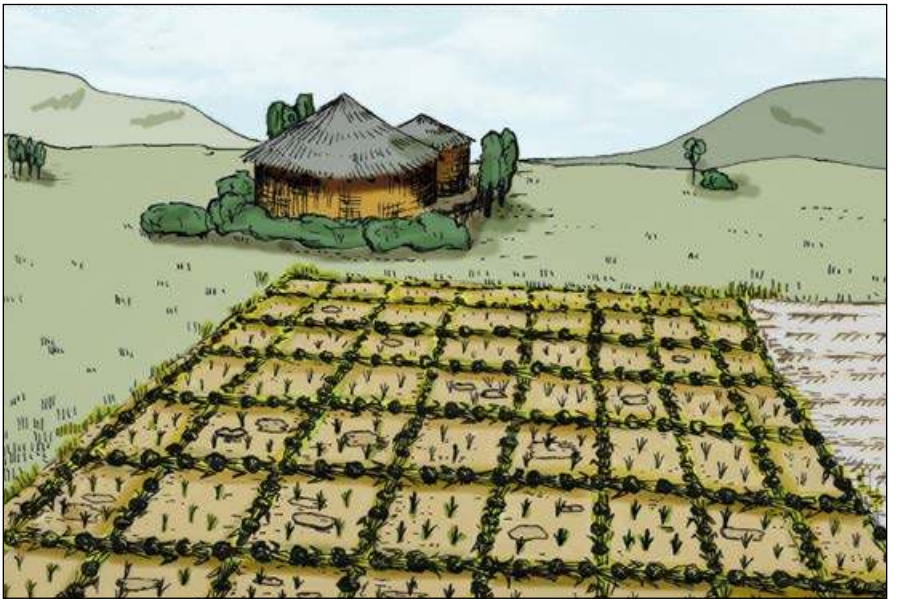
– Trash lines are not restricted to any agroecological zones and can be used in all zones except the High Dega where decomposition is too slow.

– Trash lines are best on gentle slopes and should only be used on slopes with less than 15% gradient.

– Trash lines may not be possible where trash is in short supply.

EFFECTS

Trash lines slow down surface runoff and thereby reduce soil erosion. They retain soil and may gradually build up terraces along the contour. They also allow rainwater to seep into the soil, increasing its moisture content. The trash eventually decomposes, adding organic matter and nutrients to the soil. All these effects of trash lines help to increase yields.



Trash lines reduce soil erosion on gently sloping cultivated land and improve soil moisture and humus, like mulch. They are widely applied in southern Ethiopia in places such as the Gidole lowlands.

COMBINATIONS

Trash lines can be combined with **Alley Cropping** covering the space from tree to tree.

MATERIALS

Crop residues, grass or other organic material from the field or its surroundings.

Some pegs (twigs or stalks from maize or sorghum).

Line level.

MANAGEMENT AND MAINTENANCE

Trash lines do not require any special management when kept in place by pegs. Otherwise it may occasionally be necessary to rearrange them after heavy rains.

Trash lines may occasionally attract rats and insects; if this becomes a problem, then simply plough the trash lines into the soil (adding nutrients) and consider other soil and water conservation techniques.

Vetiver

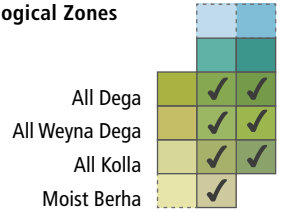
LOCAL APPLICABILITY

Local Situation

Slope Range: All

Soil Range: All

Agroecological Zones



DEFINITION

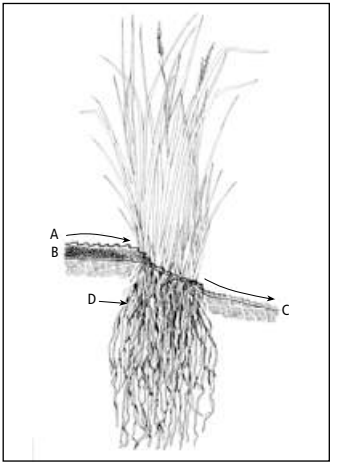
Vetiver grass (Vetiveria zizanioides) is a tough grass, which is very suitable for erosion control in various forms. In its general appearance a vetiver plant looks like a big, coarse clump of grass. It can grow very tall; under favourable conditions the erect stems (culms) can reach up to 3 m in height. It develops a dense, interwoven root system. Its growing point (crown) is below the surface; therefore, it can withstand fire or grazing (however, the mature plant is not palatable to animals). Thus, when well developed, it forms a dense, indestructible barrier. And due to its vegetative multiplication it can easily be controlled so that it does not spread into crops.

SPECIFICATIONS

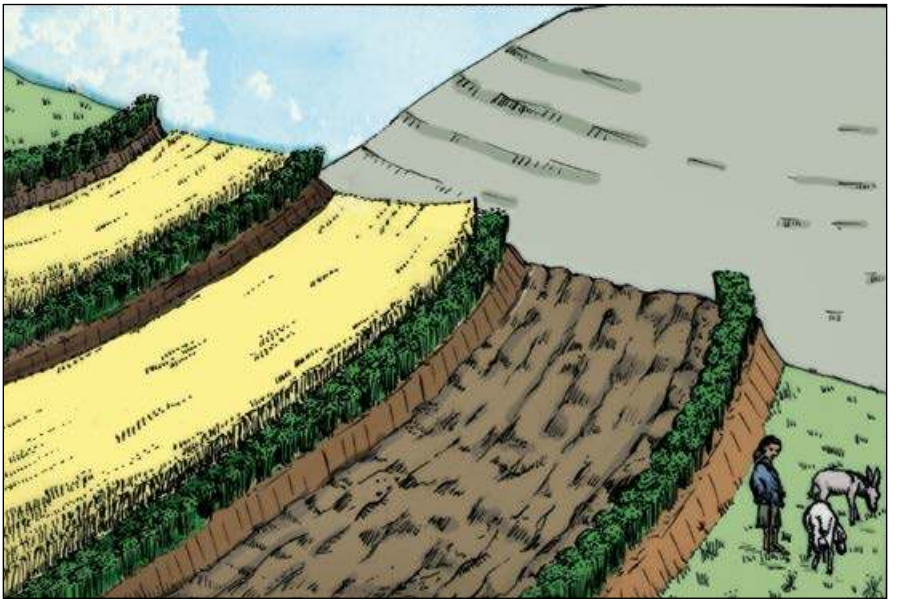
Vetiver barriers are planted along the contour in two alternating rows, 10 cm apart, with 10 cm spacing.

The vertical interval of the Vetiver barrier may vary from case to case: on cultivated land on slopes below 15% the vertical interval is 1 m. Spacing with a 1 m vertical interval means that on a 3% slope, the Vetiver strips will be 33 m apart, and on a 15% slope, only 7 m apart, still sufficient for ploughing between the strips. On slopes above 15%, the vertical interval is two-and-a-half times the depth of the reworkable soil.

In gully rehabilitation the Vetiver barriers may be very close, just 1 m apart, depending on local conditions. Vetiver barriers are planted along the contour, be it on cultivated land or along gully slopes. They can also be used along road or river embankments. With their dense root system they develop into a very good stabilizer.



Cross-sectional view of a functioning Vetiver barrier: The leaves and stems of the vetiver plant slow the silt-loaded runoff at A and cause it to deposit the silt behind the plant at B, while the water continues to flow down the slope at C, but at a much slower pace. The plant's strong root system, D, binds the soil beneath the plant to a depth of up to 3 m, forming a dense curtain-like wall, thus the roots prevent rilling, gullying and tunnelling. (Source: World Bank 1993)



This sketch shows well-developed Vetiver barriers which have built up terraces due to tillage combined with soil erosion. The Vertical Interval between the barriers is about 2 m on this picture, and the Vetiver has been cut recently.

EFFECTS

Vetiver barriers can effectively build up terraces and provide good grass for thatching. Vetiver is particularly suitable for mattress filling since it has an insect repelling effect. Vetiver strips do not harbour any rats or snakes.

COMBINATIONS

Use **Cut and Carry** for Vetiver management. Please note that Vetiver is not very palatable to cattle, but can be used as straw-bedding in cattle-sheds or, as mentioned above, for hatching or mattress-filling, and is also favoured for the coffee ceremony with its insect-repelling effect.

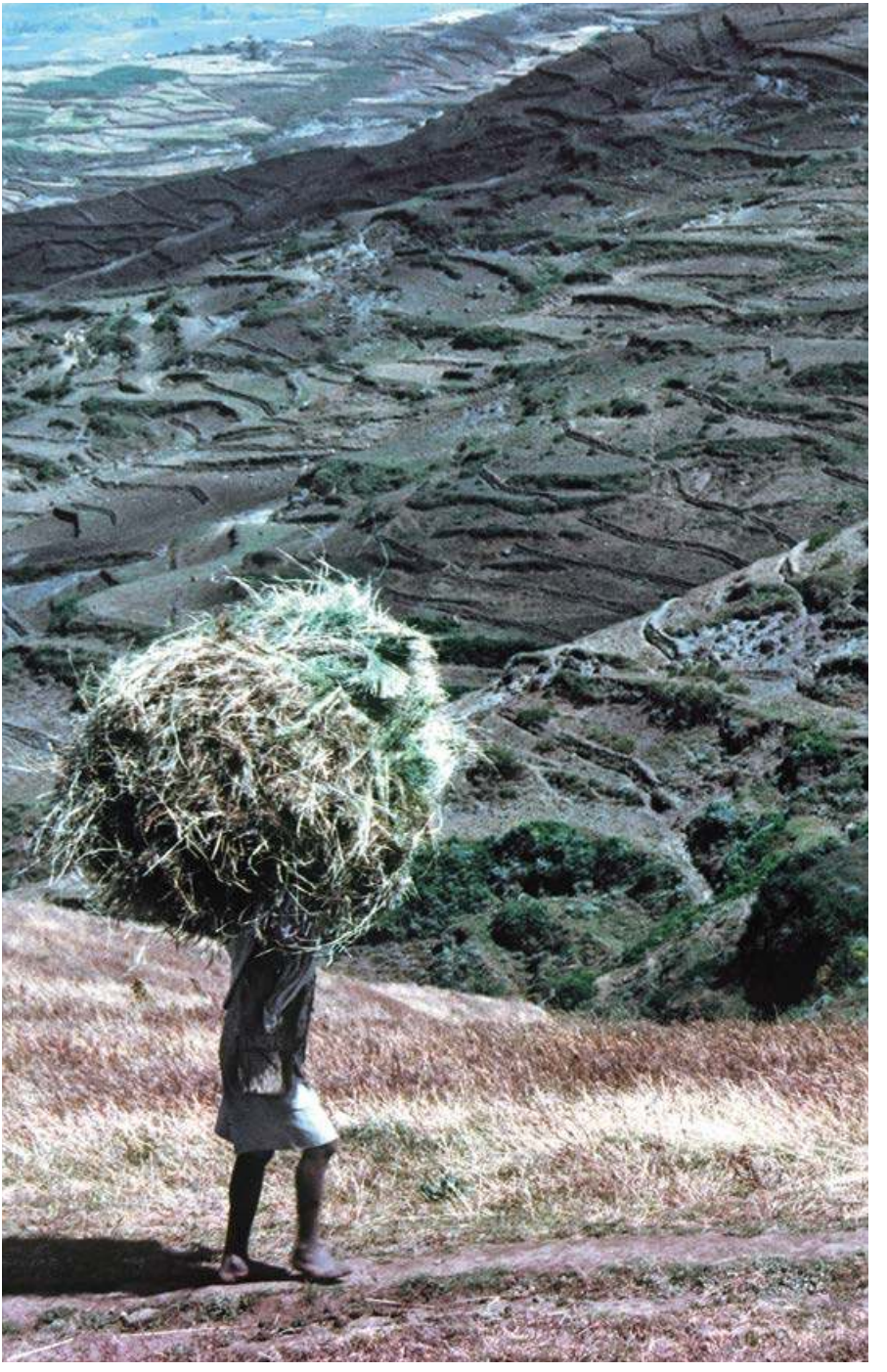
MATERIALS

Vetiver splits can be taken either from existing, well-developed vetiver barriers, or from specific vetiver nursery sites. Planting stick, line level, and stakes are needed for marking contour lines.

MANAGEMENT AND MAINTENANCE

Usually little management is needed once the vetiver barrier is established. Cutting the top produces more tillering and a denser hedge is the result. It does not produce any runners, and any spreading can easily be controlled with the plough.

However, care is needed when vetiver is freshly planted, as all plants, even Vetiver are soft at that time and can therefore be grazed by livestock, which need to be kept away until the vetiver grass is matured and no longer palatable to animals.



Cut and carry applied in Andit Tid, North Shewa, (1984).

Conservation Measures on Grassland

Definition

Grassland is a land use type where the dominant species are grasses. Also included is cultivated land that was or will have to be abandoned from cultivation and changed into grassland.

List

Controlled Grazing 84
Cut and Carry 86
Grassland Improvement 88

The next list is on page 91.

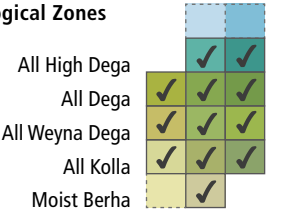
Controlled Grazing

LOCAL APPLICABILITY

Local Situation

Slope Range: On gentle, well-covered rangeland
Soil Range: All except heavily degraded soil

Agroecological Zones



DEFINITION

Controlled grazing is defined as direct utilisation of grassland with livestock in such a way that no degradation of vegetation and soils occurs, allowing the grass to recover and to retain the quality of the rangeland. Controlled grazing can be in rotation or continuous if well managed.

SPECIFICATIONS

Rotational grazing is the best method of providing for periodic recovery of grassland (see drawing). There is a shortage of grazing land in the second half of the dry season for which additional fodder must be produced on fodder banks or in **Area Closure**.

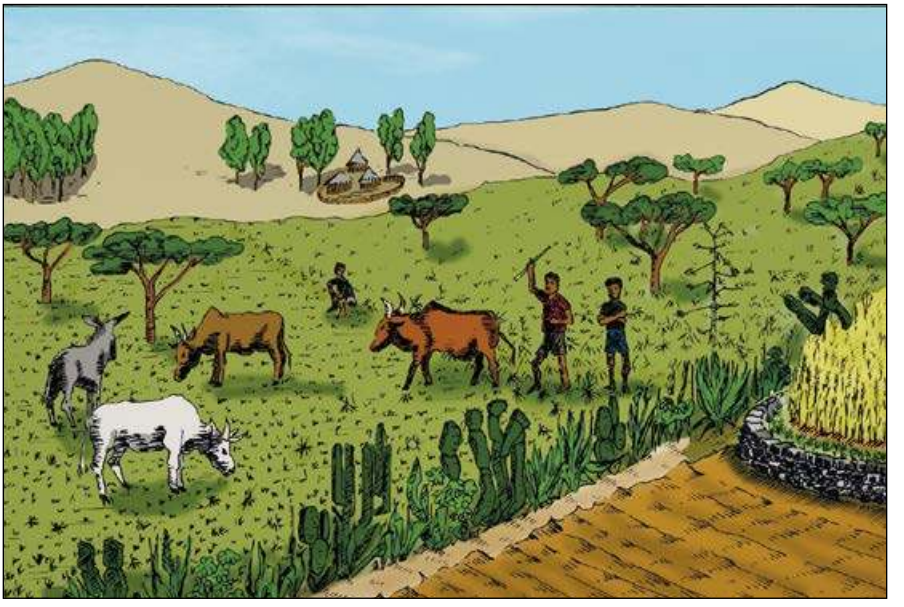
Usually little management is needed once the vetiver barrier is established. Cutting the top produces more tillering and a denser hedge is the result. It does not produce any runners, and any spreading can easily be controlled with the plough.

However, care is needed when vetiver is freshly planted, as all plants, even Vetiver are soft at that time and can therefore be grazed by livestock, which need to be kept away until the vetiver grass is matured and no longer palatable to animals.

Continuous grazing requires careful decisions about the number and type of livestock allowed to graze on a certain area. The maximum number allowed varies during the year, being highest after the rainy season when the soil is dry, but low during the rainy season and again especially at the end of the dry season. Therefore, additional fodder has to be produced in **Area Closure**, by **Revegetation** and with **Grassland Improvement** to overcome shortages in periods of limited access to grassland.

EFFECTS

All forms of controlled grazing provide for better animal fodder, in amount as well as in quality, and help to prevent degradation of grassland and conserve soil, water and vegetation.



Controlled grazing is applied here by herders who prevent livestock from entering the portion of grassland to the right. They do this merely by guarding, while the animals are allowed to move freely in the area to the left. When all the grass has been eaten by livestock, the herd shifts to the right part of the grassland so that the left part can re-generate.

COMBINATIONS

Area Closure is indispensable for the production of fodder for periods of shortage on grazing land. About 30% of a Kebele needs to be reserved for this purpose in order to produce sufficient fodder. **Revegetation** is needed for degraded parts of the grassland, and **Grassland Improvement** to increase production. A **Cutoff Drain** protects cultivated land below from excessive runoff from the grassland.

MATERIALS

Plants to make live fence (Cactus, Euphorbia, Aloe, Sisal, Acacia, and other trees such as Juniperus).

MANAGEMENT AND MAINTENANCE

Controlled grazing has to be organized by the Kebele or the range-user association. Close supervision and training of herders is required to keep the rules of rotational (or other forms of) grazing. The responsibility for controlled grazing lies with the community using the rangeland, which manages controlled grazing, supervises when rotation is needed, and trains and supervises herders. Live fences are the responsibility of landholders who have to protect cultivated land from grazing.

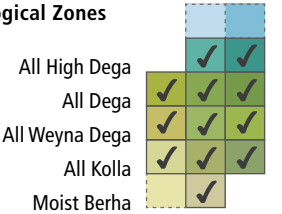
Cut and Carry

LOCAL APPLICABILITY

Local Situation

Slope Range: After grass established, all slopes
Soil Range: All except heavily degraded soil

Agroecological Zones



DEFINITION

Cut and carry is a system of utilising forage for stall feeding. It can be applied in **Area Closure,** in forests, on conservation structures, and in all areas where livestock are excluded from grazing

SPECIFICATIONS

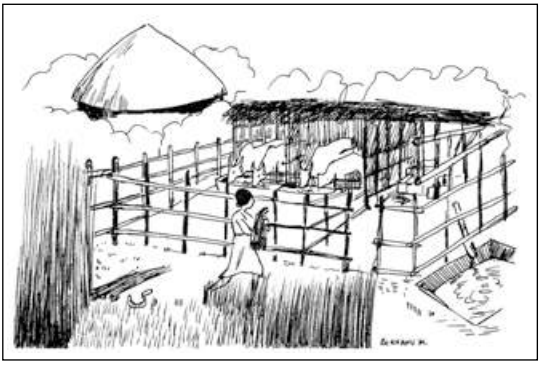
Cut and carry is a conservation-based management technique to preserve soil and vegetation. It also provides fodder for livestock, and firewood and small fuelwood from **Area Closures**.

Cut and carry is applied only after the grass has recovered or if certain types of grass, legumes or bushes have to be removed. Fire incidence should not develop. Therefore, it is advisable to cut grass once during the rainy season for immediate feeding of livestock and immediately after the rainy season before the grass is completely dry.

Forage should be cut at about 10 cm above the ground before or at the flowering stage, but only if sufficient soil coverage is assured. Forage can be conserved as hay or silage for dry season feeding.

Forage trees should not be lopped in the first year until they are established well. At later stages, they should be lopped for forage or fuel once a year or every two years. About 10 to 15% of top growth should be left on the plants.

The community decides who shall be allowed to cut and carry from a given area.



Sketch of a livestock shed. An adult cow requires about 3 m^2 (e.g. 1.5 m x 2 m). Ideally, a forage plot should be planted near the shed to cut and easily carry feed to the animals in the zero-grazing unit.

The farmer to the right cuts the grass at flowering stage in a closed area. Cows and oxen are tied at a place nearby and fed directly. This way, they do not disturb the grassland. Therefore, more fodder is produced. Leguminous trees are planted in rows in the closed area, and they can be lopped when they are well established. Branches of grown-up Acacia trees on the slope can be cut and fed to goats and donkeys.

EFFECTS

Cut and carry allows an excellent recovery of vegetation and maximum soil protection. Livestock trampling and extreme grazing down to the roots is excluded and greater productivity will result. Water is retained better during storms and runoff is reduced. Natural vegetation grows with better competition between plants because there is no more selective grazing by livestock. However, animal droppings are reduced, with negative effects on soil fertility due to their absence.

COMBINATIONS

Cut and carry is usually made in **Area Closure** as well as between **Hillside Terrace** and **Tree Planting**. **Grassland Improvement** increases productivity. For fodder trees, Microbasin may be useful. Cut and carry may be replaced by **Controlled Grazing** at a later stage.

MATERIALS

Sickle for cutting grass and ropes for cattle or simple shed to keep the animals.

MANAGEMENT AND MAINTENANCE

Cut and carry must be organised by the community themselves on communal land. The community provides for management of cut and carry. Frequency of harvesting depends on the weather conditions, mainly on rainfall. Live fences have to be developed by the landholders on cultivated land which has to be protected from grazing.

Construct a livestock shed that shelters the animals from sun and rain and protects them from predators and thieves. Add a space to store feed.

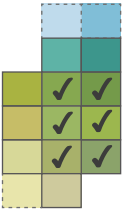
Grassland Improvement

LOCAL APPLICABILITY

Local Situation

Slope Range: All
Soil Range: All

Agroecological Zones



DEFINITION

Grassland improvement includes all activities aimed at improving the productivity of grassland whereby runoff and soil erosion are reduced. Activities include the introduction of better forage species, moisture conservation, removal of unpalatable species, the cutting of shrubs, regular weeding and maintenance of fertilisation.

SPECIFICATIONS

Introduction of better forage species can be done by seeding, applying introduced species of grass or legumes, or using seed collected from native species in a particular zone. Another way of introducing better forage species is planting sods which are cut from areas with dense stands of such plants. Only part of the plant may be removed for quick regrowth of the remaining plant.

Moisture conservation is possible either directly with improved grass cover attained through **Controlled Grazing** or **Area Closure** or with physical structures as applied to cultivated land.

Removal of unpalatable species is very important for grassland improvement. Weeds and grass not suitable for forage can be regularly cut out and stored in composts for natural fertiliser production.

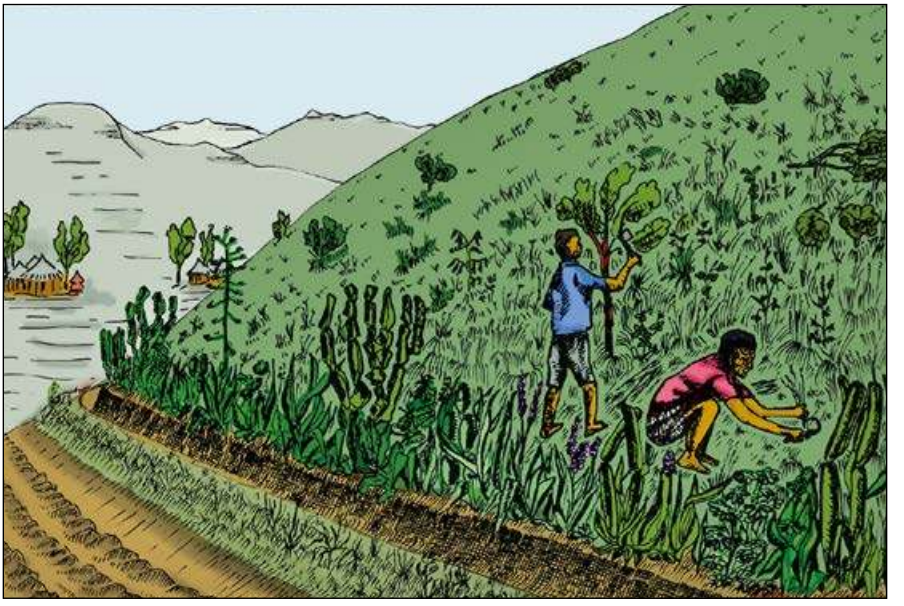
Cutting of shrubs that impede forage production is necessary. They can then be used for fuelwood.

Regular weeding and maintenance through cutting, **Cut and Carry** and hay making increases production and improves the density of the grassland.

Fertilising with natural or artificial fertilisers can improve production and result in better conservation of the area.

EFFECTS

Grassland improvement has two main effects: first, it increases the productivity of the area for fodder and second, it reduces runoff and soil erosion as there is better ground cover.



Grassland improvement includes activities shown here, such as regular weeding and cutting of forage after the flowering stage, and removal of shrubs that prevent better growth of vegetation underneath. Improved grassland has to be protected from grazing as shown by the live fence. A cutoff drain below the area diverts surplus runoff safely.

COMBINATIONS

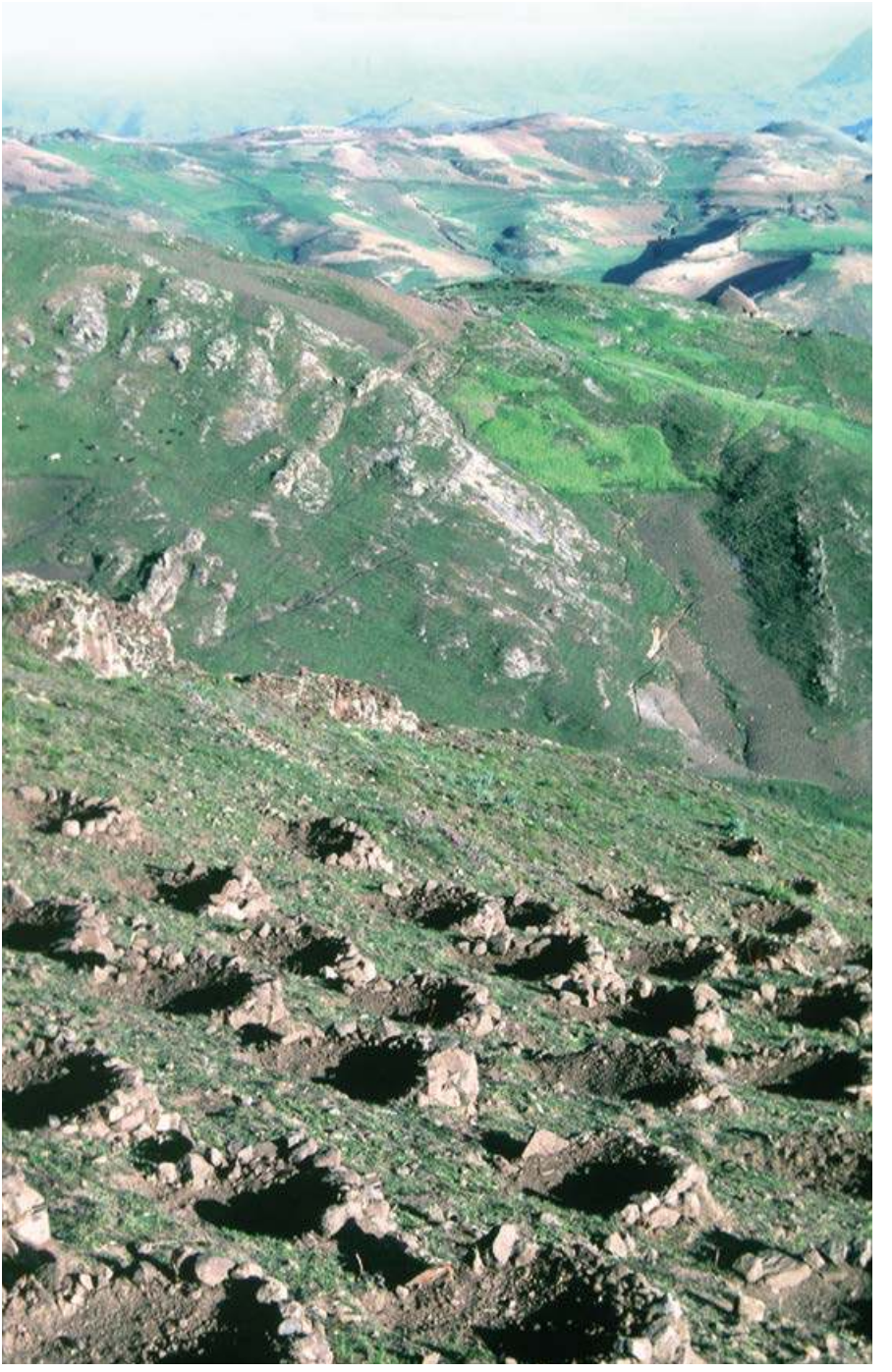
Grassland improvement is best combined with **Revegetation**, **Area Closure** and **Cut and Carry**. Eventually, it can also be used with **Controlled Grazing**. **Cutoff Drain** below grassland is still required.

MATERIALS

Suitable legumes and grasses, either introduced from nurseries or selected from nearby areas. Digging and cutting tools.

MANAGEMENT AND MAINTENANCE

The development of the grassland has to be carefully observed. Weeds are removed regularly, places where the stands are weak have to be replanted, and the forage has to be regularly harvested, either for direct feeding or for haymaking. The village or the Kebele is responsible for grassland improvement on communal land and also for privately used land when there is public interest in reducing runoff and soil erosion from the land.



Microbasins near Lege Ambo, Wello (1986).

Conservation Measures on Forestland

Definition

Forestland is a land use type where the dominant species are trees. Also included is land that has been, or will be, selected for reforestation.

List

Hillside Terrace 92
Microbasin 94
Tree Planting 96
Trench 98

The next list is on page 101.

Hillside Terrace

LOCAL APPLICABILITY

Local Situation

Slope Range: 50 to 100%
Soil Range: On heavily degraded land

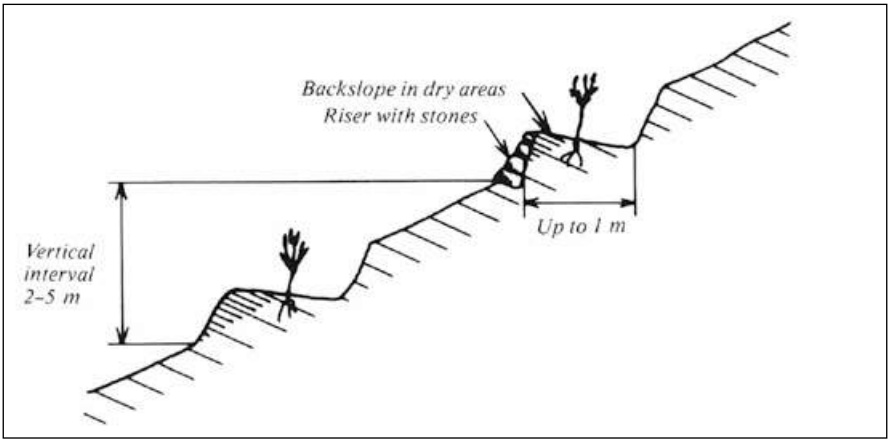
Agroecological Zones

DEFINITION

A hillside terrace is a structure along the contour, where a strip of land is levelled for tree planting. Hillside terraces are up to 1 m wide and constructed at about 2–5 m vertical intervals. Hillside terraces are only applied if there is a strong reason to justify their construction.

SPECIFICATIONS

Cross-section:

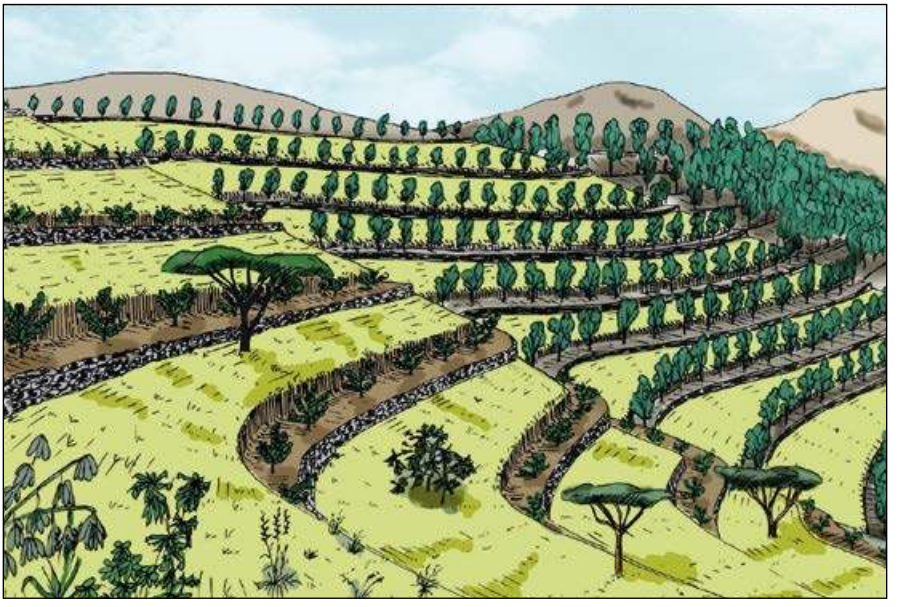


Hillside terraces are mainly used to prevent damage from flooding below steep slopes.

They are lined out along the contour, the vertical interval between two terraces being 2–5 metres.

EFFECTS

Hillside terraces help to retain runoff and sediment on steep sloping land and to accommodate tree seedlings planted on them. They are also effective for conserving water on badlands and in areas with low rainfall.



On these heavily degraded slopes, hillside terraces were necessary. Trees were planted just recently, while terrace construction was done in the previous year to support soil formation around the pits. Spacing between trees is 2 m, and the vertical interval between terraces is also 2 m. The area between two terraces is undisturbed and used for forage production.

COMBINATIONS

Wherever **Area Closure** produces the same results, and if **Tree Planting** or **Microbasin** is sufficient, no hillside terraces should be constructed. If degradation makes hillside terraces indispensable, combine with **Cutoff Drain** and **Area Closure**, or mix with **Microbasin**. Add **Tree Planting**.

MATERIALS

Line levels, digging instruments, stones and other materials as needed for combined measures.

MANAGEMENT AND MAINTENANCE

Hillside terraces used for afforestation need little management except that **Tree Planting** has to be done carefully at the right location on the terrace (see figure on the left) and at the right time. Regular weeding around the seedlings supports their stabilization and growth. The community is responsible for hillside terraces on afforestation land. It also organises the use of the grassland between the terraces.

Microbasin

LOCAL APPLICABILITY

Local Situation

Slope Range: All
Soil Range: All except highly degraded land

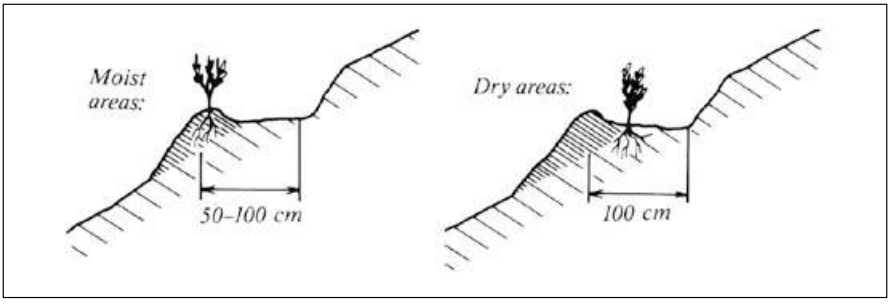
Agroecological Zones

DEFINITION

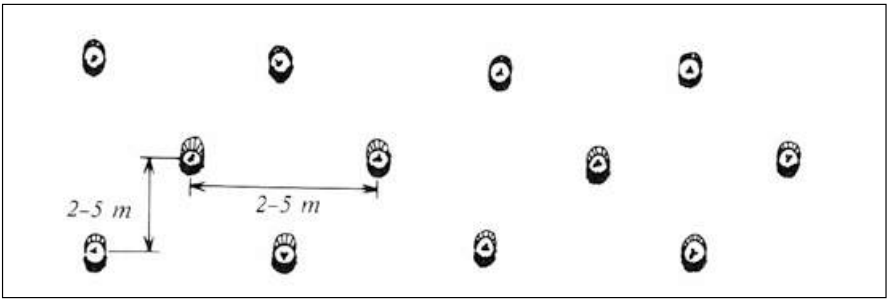
A microbasin is a small structure with the shape of a half or a full circle, excavated to obtain a small basin for planting a tree. Microbasins vary in size according to their designation to conserve water; they are small in moist agroecological zones and large in dry ones.

SPECIFICATIONS

Cross-section:



Spacing/placement (top view)



Microbasins are used for tree planting in this dry area. Pits are dug in the centre of the basin for optimum use of stored water. The farmer plants a tree after removing the plastic around the roots of the seedling. Soft earth is prepared beside the pit to accommodate the seedling in the pit. The microbasins are prepared in rows, always one microbasin in the lower row between the two microbasins in the higher row.

EFFECTS

Microbasins have multiple effects: In moist areas, they provide a small platform for **Tree Planting**. In dry areas, they are used to harvest water from a larger area (2–3 m diameter) on gentle slopes, sometimes with additional water collection ditches.

COMBINATIONS

Area Closure is combined with microbasins, as is **Cutoff Drain** below or within degraded forestland. Mixed with **Hillside Terrace**, they are used as an economic means of water conservation.

MATERIALS

Digging instruments, line level, tree seedlings and other materials as needed for combined measures.

MANAGEMENT AND MAINTENANCE

Microbasins have to be carefully lined out on the slope with intermittent placements for runoff control and proper spacing. They should be small in moist (1 m diameter), and large in dry areas (2 m). After tree planting, microbasins require little maintenance but weed control may be needed. Area Closure management must be organised by the community and Kebele.

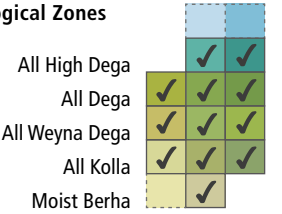
Tree Planting

LOCAL APPLICABILITY

Local Situation

Slope Range: All
Soil Range: All except highly degraded land

Agroecological Zones



DEFINITION

Tree planting for conservation is an activity to improve the vegetative ground cover, thereby reducing runoff and soil erosion and producing wood. Tree planting supports many other conservation activities when combined with them. Tree planting by itself is a soil and water conservation measure because the tree roots stabilise the soil and the tree protects the ground from the impact of raindrops.

SPECIFICATIONS

Select planting site after consultation with the concerned community. Prepare pits for planting, either on physical structures or simply along the contour (page 121): Each pit has a width of 25 cm, and a depth of 40 cm. Generally, they are spaced 2 m apart, and for eucalyptus trees 5 m.

In highly degraded areas, apply **Area Closure** for 1–2 years before planting.

Pits are kept open for 3–12 months before trees are planted in order to support soil formation around them.

In areas with two cropping seasons per year, plant trees during the first rains. Plant drought-resistant species as early in the rainy season as possible.

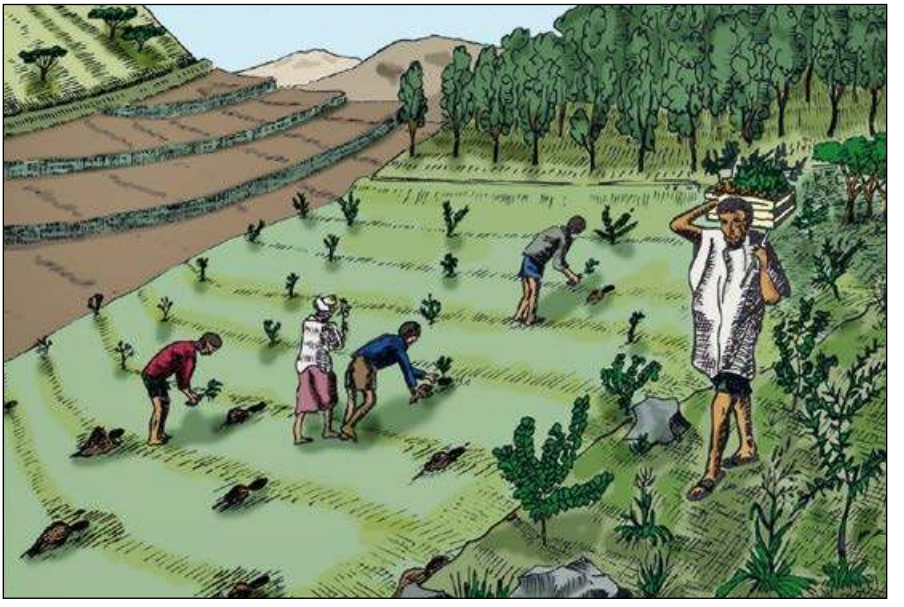
For nursery development, collect direct information from existing nurseries as well as specific manuals (page 125).

Select suitable tree species for different agroecological zones.

Transport of seedlings must be done very carefully. Put enough soil around roots. Check that the soil has sufficient moisture. Seedlings must be transported in boxes, tins or other containers.

EFFECTS

Tree planting by itself conserves soil and water. Only a minimal amount of soil is moved through pitting. Thus, the slope remains stable and resistant against erosion. Especially in wet agroecological zones, tree planting does not require any additional conservation measures. Trees provide close canopy, improve infiltration of moisture in the soil, provide mulch and organic matter, recycle nutrients, and provide high protein manure or animal feed. They also produce wood and other products for various uses.



This drawing shows how tree planting is carried out. In the foreground to the right, a man carries a box with well-protected seedlings. Trees are planted in rows on the slope. Pits have been excavated months earlier. After the plastic sack is removed, tree seedlings are planted by putting soft earth around each one. A cutoff drain protects the field from runoff coming from the mature forest above.

COMBINATIONS

Area Closure is always combined with tree planting. **Hillside Terrace** is applied mainly on steep slopes in moist and dry areas. **Microbasin** is applied mainly on gentle to medium slopes in moist and dry areas. **Cut and Carry** is used with undergrowth vegetation.

MATERIALS

Seeds or seedlings of tree species are selected according to the requirements of the farmers. A small nursery can be established nearby if knowledge about seed preparation and raising seedlings exists. Line level and digging instruments are required.

MANAGEMENT AND MAINTENANCE

Tree planting has to be organised through the concerned community or Kebele Administration, which also has the responsibility for common woodlots. Plants are observed for weed competition and insect damage as they grow. Fodder trees are allowed to grow for two years without pruning. Maintain planted trees for at least 5 years until survival is ensured. Irrigate during short drought periods. Completely exclude cattle from planting site. Supervision of the growth of planted trees is organised by the village or Kebele.

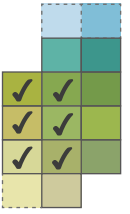
Trench

LOCAL APPLICABILITY

Local Situation

Slope Range: All
Soil Range: All

Agroecological Zones



DEFINITION

A trench is a short ditch dug along the contour (i.e. across the slope) to trap runoff water in dry and moist areas. The trees will be planted in a planting pit in the centre of the trench. Trenches are particularly useful to help rehabilitate degraded lands.

SPECIFICATIONS

A trench is normally 2–3 m long and 0.3–0.5 m deep, depending on soil depth. Trenches should be spaced about 1 m apart along the contour, and the rows should be staggered with a distance of 2–3 m so that overflow flows into the next trench below. The soil dug out to make the trench should be used to form a ridge along the embankment on the lower side of the trench.

EFFECTS

The trenches trap water that would otherwise run down the slope and be lost. The trench allows the water to seep into the soil. Trenches are good places to plant trees, particularly in dry places, due to the water they collect.

The sketch shows alternating trenches. Note that the level of the soil left in the centre of the planting hole is slightly lower than the trench!

COMBINATIONS

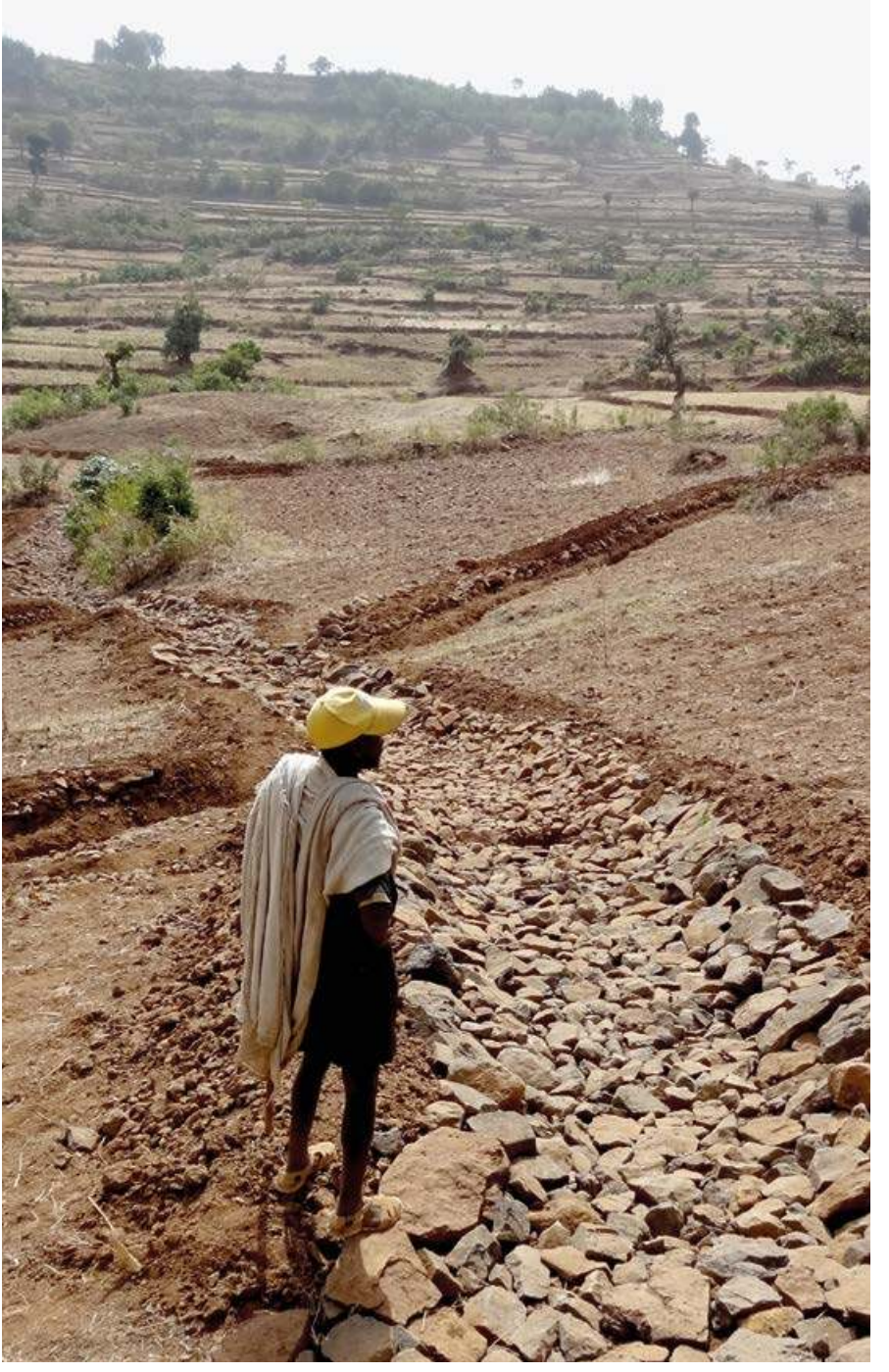
Trenches can be used in combination with **Area Closure**, to ensure the safety of the young seedling.

MATERIALS

Digging tools, a line-level, various tree-seedlings.

MANAGEMENT AND MAINTENANCE

The trenches need to be controlled and maintained: silt has to be dug out, and the broken embankment ridges need to be maintained. And when tree seedlings die, they need to be replanted.



Stone-paved Cutoff Drain in Abagerima area, South Gonder (2013).

Conservation Measures Common to All Land Use Types

Definition

Soil and water conservation measures common to all land use types are measures applicable to cultivated land, grassland and forestland. Their specifications are almost similar for all land use types, with only slightly different applications.

List

Area Closure 102
Checkdam 104
Cutoff Drain 106
Gully Rehabilitation 108
Revegetation 110
Water Harvesting 112
Waterway 114

A list of more useful information is on page 117.

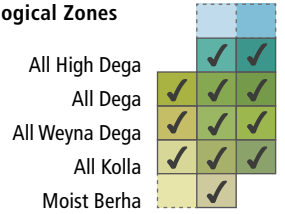
Area Closure

LOCAL APPLICABILITY

Local Situation

Slope Range: All
Soil Range: All

Agroecological Zones



DEFINITION

Area closure is a protection system to improve land with degraded vegetation and/or soil through natural regeneration. No livestock are allowed to graze, and no human interference tolerated for 2–3 years, until a 50% natural grass cover is obtained. Utilisation of these areas has to be planned and initiated as soon as a satisfactory state of recovery has been reached.

SPECIFICATIONS

Area closure is a temporary action to protect degraded land until a certain degree of recovery has been attained.

In area closures no specific actions are taken, except that all human and livestock interference is excluded.

Sometime after natural recovery, the grass may be cut regularly to minimise fire incidence. Hay can be prepared and fed to livestock.

During the time of closure, a decision must be made in consultation and with the agreement of the community members involved about how to increase the productivity of the closed area while maintaining the conservation mandate.

There are three main possibilities for the management of area closures:

– Return the area to cultivation while applying proper conservation measures.

– Use it as grassland while applying proper grassland conservation and development measures.

– Develop it into forestland while applying forest conservation and development measures.

EFFECTS

Soil and water conservation is best attained through dense ground cover by grass and legumes, while roots stabilise the soil. Growth of vegetation is improved considerably after the exclusion of livestock from the area and future use can be decided according to the conservation status and local need.

This closed area has been fenced by living plants to protect it from livestock grazing. A cutoff drain diverts excess runoff from the area. After a good recovery of the natural vegetation for a period of years, it was decided to develop the closed area here into forestland. Therefore, trees are now planted in rows, the grass is regularly cut, and tree seedlings are well managed for rapid growth.

COMBINATIONS

During area closure **Cut and Carry** may be applied occasionally to reduce fire incidence. If very good vegetation cover results, **Controlled Grazing** is possible on gentle slopes. A **Cutoff Drain** below area closure protects cultivated land. Live fencing can be used to exclude livestock from grazing.

MATERIALS

Plants for live fencing. Line level and digging instruments for cutoff drain. Tools for grass cutting.

MANAGEMENT AND MAINTENANCE

Closed areas have to be well protected. It is important to totally exclude the livestock from the area. Degraded parts require a long recovery time. The responsibility for closed areas lies with the village or Kebele, which provides for the management of such closed areas, for organising the future use of the area, for **Cut and Carry**, and for eventual **Controlled Grazing**.

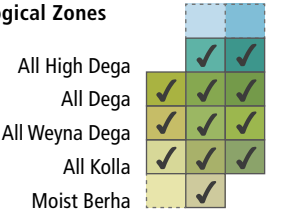
Checkdam

LOCAL APPLICABILITY

Local Situation

Slope Range: All
Soil Range: Take care on deeply weathered rock or loosely accumulated deposits

Agroecological Zones

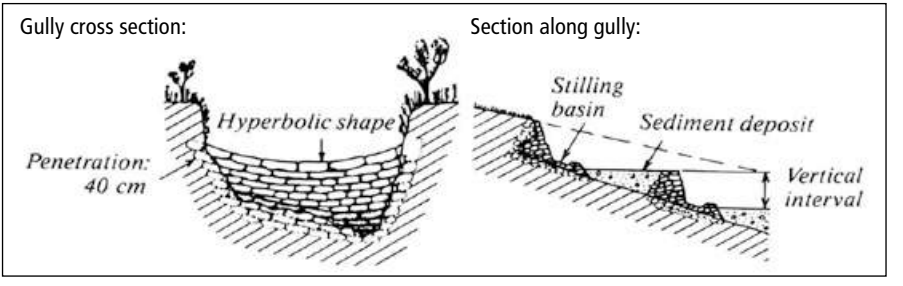


DEFINITION

A checkdam is an obstruction wall across the bottom of a gully or a small river to reduce the velocity of the runoff and prevent deepening or widening of the gully. Checkdams can be made of any material available locally, such as stones, live or dead branches, wooden poles, gabions, etc.

SPECIFICATIONS

Below are a gully cross-section and a section along the gully to show dimensions and the vertical interval of checkdams (the picture shows stone checkdams):

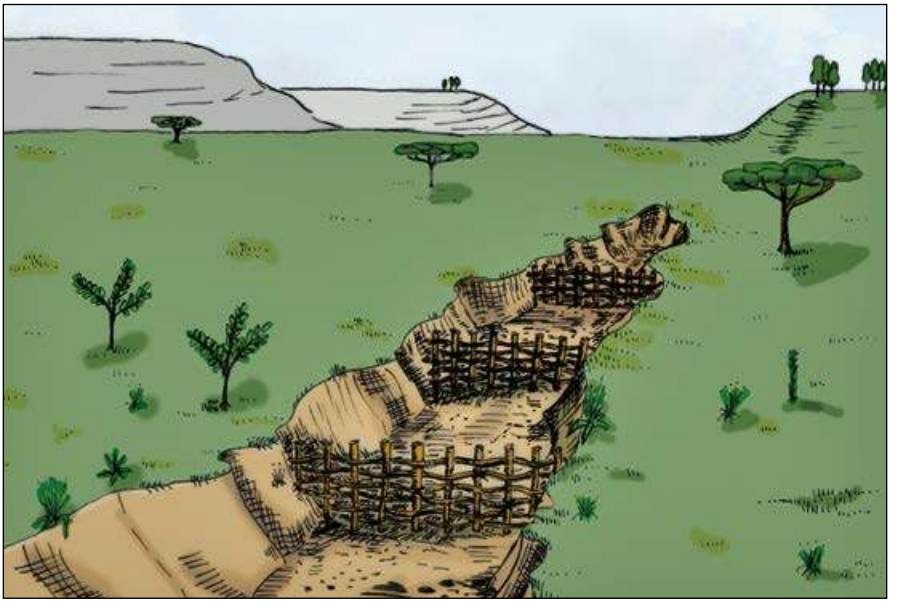


The vertical interval between checkdams is equal to the height of a checkdam; e.g. for stone checkdams, it is 1 m (as its height is 1 m). If made of stone, such a wall is up to 1 m high and about 1 m thick and has a depression in the middle to allow runoff to flow through. Note the hyperbolic shape: the centre of the checkdam has to be at the lowest point to guide the waterflow to the gully centre.

Checkdams can be easily applied in all gullies less than 2 m deep and 5 m wide. Larger or steep gullies require more attention and careful design for treatment (see list of technical documents page 125).

EFFECTS

Checkdams prevent the widening and deepening of a gully, and help to fill it up with sediment. They reduce the velocity of runoff in the gully. The potential energy is absorbed below the vertical drops of the overfall. Sediments are deposited behind the checkdams so that the slope gradient of the gully is also reduced.



This gully has been treated with a checkdam, which in this case consists of brushwood. This can be very effective, particularly for smaller gullies, which are refilled with soil over a longer period. The structures should not be too far apart.

COMBINATIONS

Checkdams are often part of **Gully Rehabilitation**; therefore, the same combinations are possible.

MATERIALS

For Brushwood Checkdams: wooden poles and branches interwoven between the posts (also live poles may be used). Wire or sisal ropes to keep them together.

For stone Checkdams: large boulders, preferably with flat sides. Gabions (wire nets, see page 114) if available. Line level. Grass and trees for **Revegetation** (Eucalyptus, Bamboo, Vetiver, Rhodes grass and Elephant grass. Any material suitable for checkdam construction.

MANAGEMENT AND MAINTENANCE

Checkdams have to be repaired annually, or after every heavy storm. For bigger gullies or rivers, refer to technical documents (page 118), as there is a danger that improperly designed or constructed checkdams are removed in a big storm. Checkdams have to be maintained by the group of farmers that have land either in the catchment above the gully, along the sides of the gully, or below the gully. They all have an interest in reducing gullying. Maintenance is needed regularly, with somebody assigned by the village or Kebele to supervise how the checkdams behave during the rainy season.

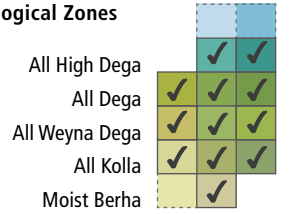
Cutoff Drain

LOCAL APPLICABILITY

Local Situation

Slope Range: 3–50%
Soil Range: All

Agroecological Zones



DEFINITION

A cutoff drain is a channel used to collect runoff from the land above and to divert it safely to a waterway or river, thus protecting the land below from excessive erosion. Cutoff drains usually protect cultivated land from upslope forestland or grassland.

SPECIFICATIONS

Assuming a 70 mm/hr storm intensity, a poor grassed cutoff drain, a hilly pasture above the drain, clay loam soil, and a freeboard of 20 cm in the drain, the dimensions of the cutoff drain, given for different sizes of the catchment are as follows:

Size of catchment (ha)	Depth of cutoff drain (cm)	Width of cutoff drain (cm)	Maximum gradient (%)
1	35	50	4.0
2	45	70	2.5
4	55	100	1.5
8	70	140	1.0
16	85	200	0.5
32	115	280	0.4
64	155	400	0.2

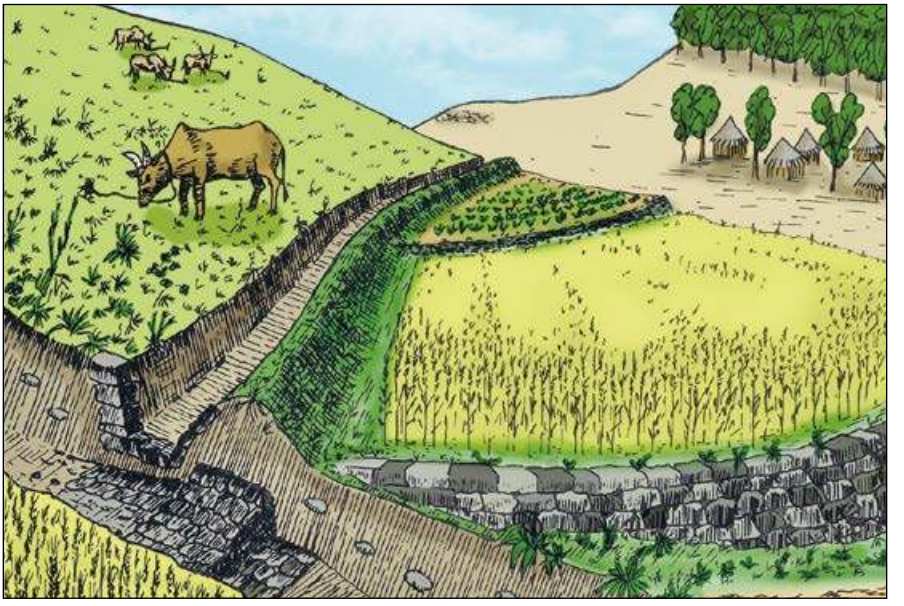
The gradient of the cutoff drain should not exceed the maximum gradient given. However, in some cases, it will be necessary to follow a natural line instead of a technical one. If the maximum gradient is exceeded, take care about erosion in the drain, improve the grass cover, or apply **Checkdam**.

The gradient of the cutoff drain is lined out with the line level (see page 124).

Bigger cutoff drains have to be approved by an expert.

EFFECTS

Cutoff drains protect downslope land from upslope runoff and erosion.



This cutoff drain protects the terraced cultivated land to the right from excessive runoff from the grassland to the left and above, where controlled grazing is used with tied cattle. At the point where the cutoff drain enters the waterway, stone protection is needed and a checkdam has been constructed in the waterway just below the entry point, as shown. Cutoff drains have to be covered with much more vegetation than on the recently constructed embankment shown here.

COMBINATIONS

Cutoff drains are combined with **Waterway**, to be constructed one year earlier, with **Area Closure**, **Controlled Grazing**, **Cut and Carry**, **Hillside Terrace** and **Microbasin**. For stabilization of the ditch, **Revegetation** is needed. On very long slopes, repeat cutoff drains several times as needed according to the amount of water collected.

MATERIALS

Line levels, digging irons, shovels, stones, and materials as needed for combined measures, such as grass sods or seeds.

MANAGEMENT AND MAINTENANCE

Cutoff drains have to be carefully designed and lined out in the field. The table on the left gives some indications of the dimensions of a drain. An expert is needed to approve the bigger drains that you want to apply in your area. During heavy storms, the cutoff drains have to be supervised. If overflow occurs, the dimensions must be increased. If erosion in the drain takes place, **Checkdam** and **Revegetation** are needed. All farmers that have land below the cutoff drain are responsible for maintenance and repair. For construction, the members of the village or Kebele must cooperate, since everybody benefits from the grassland above the drain. Cutoff drains have to be maintained annually or after heavy storms if necessary.

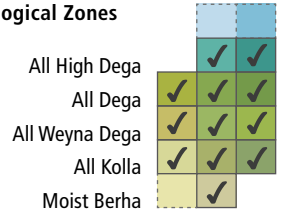
Gully Rehabilitation

LOCAL APPLICABILITY

Local Situation

Slope Range: 0–30%
Soil Range: All, but take care on deeply weathered soils or loosely accumulated deposits

Agroecological Zones



DEFINITION

A gully is formed when rill erosion expands by deepening and widening into a growing channel. As the channel deepens, it undercuts its head- and sidewalls, eventually forming a steadily expanding gully. Gullies eat deep into the land, mostly in accumulated sediments or deeply weathered soils, and often on good arable land. And if the gully is not checked, more and more land gets lost.

SPECIFICATIONS

First of all keep in mind: 'prevention is better than cure'. Save money and labour by treating a gully in its early stage, when it is easy, rather than waiting until it is too late.

There are three major principles for controlling gullies:

1. Reducing the runoff coming into the gully by conserving water in the catchment so that it does not reach the gully e.g. by Bunds, **Mulch**, **Microbasin**, **Trench** or **Area Closure**, etc.
2. Diverting the water away from the gully with a **Cutoff Drain** or safe **Waterway**.
3. Conveying the water safely through the gully by reducing its speed and breaking its erosive force with **Checkdams** and or various vegetative barriers.

In order to stop further undercutting of the gully head, a reshaping of the gully head is needed. The reshaped gully head has to be protected by grass or a stone rip-rap. In order to revegetate the gully walls, reshaping is also necessary here to allow the seed or seedlings to take root, as plants cannot establish themselves on the vertical gully walls. The gully and its immediate surroundings must be closed to animals (area closure for the gully). Check and control the waterflow with checkdams or vegetative barriers, so-called 'score checks' (e.g. **Vetiver** or sisal, and trees later on) on the gully bottom. At a later stage, and depending on the agroecological zone you are in, useful trees such as fodder trees or fruit trees such as bananas can be grown on the gully bottom.

EFFECTS

Gully rehabilitation is a cumbersome process – but not at all hopeless. A rehabilitated gully can become productive land once again, thus transforming this line of destruction into a line of production. In addition, the bordering productive land remains intact, instead of falling victim to the gully's destructive forces if the gully goes unchecked.

Gully rehabilitation involves Revegetation and other measures to stabilize and even remove the gully. Gully borders are cut; pits are prepared, and grass sods planted on the gully border. A Cutoff Drain has been made above the gully to divert the runoff from the afforestation site. The cultivated land to the right is terraced.

COMBINATIONS

A **Cutoff Drain** above major gullies is useful for the time of establishment of **Revegetation** in the gully if the diverted water can be drained safely. **Area Closure** reduces the amount of runoff into the gully. Also **Trench** and or **Microbasin** help to reduce the runoff into the gully. In dry agroecological zones, **Level Bund** should be used to retain water in the catchment above the gully. Protection of gully borders and river banks.

MATERIALS

For Brushwood Checkdams: wooden poles and branches interwoven between the posts (live poles may also be used). Wire or sisal ropes to keep them together.

For Stone Checkdams: large boulders, preferably with flat sides. Gabions (wire nets, see page 104) if available. Digging tools and line level. Any material suitable for checkdam construction.

MANAGEMENT AND MAINTENANCE

Gully rehabilitation is a long and cumbersome process and requires permanent supervision until safely established.

Gully rehabilitation must be carried out by the group of farmers that have land either in the catchment above the gully, along the sides of the gully, or below the gully. They all have an interest in reducing gullying. Maintenance is needed regularly, with somebody assigned by the community or Kebele Administration to supervise how the gully behaves during the rainy season.

Revegetation

LOCAL APPLICABILITY

Local Situation

Slope Range: All
Soil Range: All

Agroecological Zones

DEFINITION

Revegetation is a system of forage establishment on land with an unsatisfactory vegetation cover. Such land may be newly constructed bunds, cutoff drains, waterways or degraded land and gullies. Forage includes grass, legumes and selected trees and bushes.

SPECIFICATIONS

Three steps are important for revegetation:

1. Exclude all grazing animals throughout the year. Use **Cut and Carry** instead.
2. Regularly cut the weed which grows during the rainy season, so that grass and legumes can develop.
3. Plant sods of grass and legumes. Such sods can be taken from good natural grassland nearby or from forage nurseries. However, native species will grow best, and are well known to the farmers for their quality and value.

EFFECTS

Revegetation is the most effective way to conserve soil and water. Grass is able to reduce soil erosion greatly if established well. Grass also helps to stabilize bunds and other structures significantly if cattle are excluded from grazing all year. Revegetation provides forage which is essential for livestock.

COMBINATIONS

Revegetation can be used on all physical structures such as bunds and **Fanya Juu**, **Cutoff Drain** and **Waterway** and for gully control. The most important issue for successful revegetation is the complete exclusion of grazing animals from the area throughout the year.

MATERIALS

Natural grass and legumes from nearby areas selected by farmers for revegetation. Digging instruments for collection of grass sods and legumes.

Revegetation is used here together with other conservation measures to stabilise a gully or a badland area. Small pits are prepared, sods of grass and legumes are taken from nearby grassland or from nursery and planted on the bare land.

For Revegetation: Grasses and trees, e.g. vetiver grass (Vetiveria zizanioides), sisal (sisalis sisal), elephant grass (Pennisetum purpureum) or Kuduzu (Peuraria phaseoloides) for the lower agroecological zones and oats (Avena sativa) for the Dega areas; trees e.g. pioneer trees such as Acacia salgina, Sesbania sesban, willow (salix spp.), Eucalyptus sp., bamboo and banana. All trees and grasses that bring benefits to the farmer, if taken care of, can be selected.

MANAGEMENT AND MAINTENANCE

Regular cutting of weeds and **Cut and Carry** of grass and legumes is important. Cattle must be excluded from the revegetation area all year, especially after harvest. Sods are planted about every 25 cm. Every farmer is responsible for regularly maintaining the revegetation on his/her land. The concerned village or Kebele is responsible for revegetation on communal land and in gullies.

Water Harvesting

LOCAL APPLICABILITY

Local Situation

Slope Range: All (note specific limitation)
Soil Range: All

Agroecological Zones

DEFINITION

Water harvesting collects and uses runoff from various sources for farming or domestic use. Water is 'harvested' from the ground, a road, a rock, a roof or a stream and then taken to where it is needed: on a field or into a pond or basin, from where it is available for farming or domestic use.

SPECIFICATIONS

There are three major types of water harvesting:

1. Rainwater harvesting: rainwater is collected 'in situ' in the field to infiltrate into the soil rather than to run off unused.
2. Runoff water harvesting: here water is collected from the ground, rocks, roads or roofs.
3. Floodwater harvesting: diverts water from a seasonal water course.

Rainwater harvesting: The simplest way to effectively store moisture in the field is tie-ridging, stopping the in situ rainfall water from running off and allowing it to infiltrate into the soil instead. This is particularly suitable for row crops like maize and sorghum. All types of **micro-basins** collect water in situ and avail it to the plants (mainly trees).

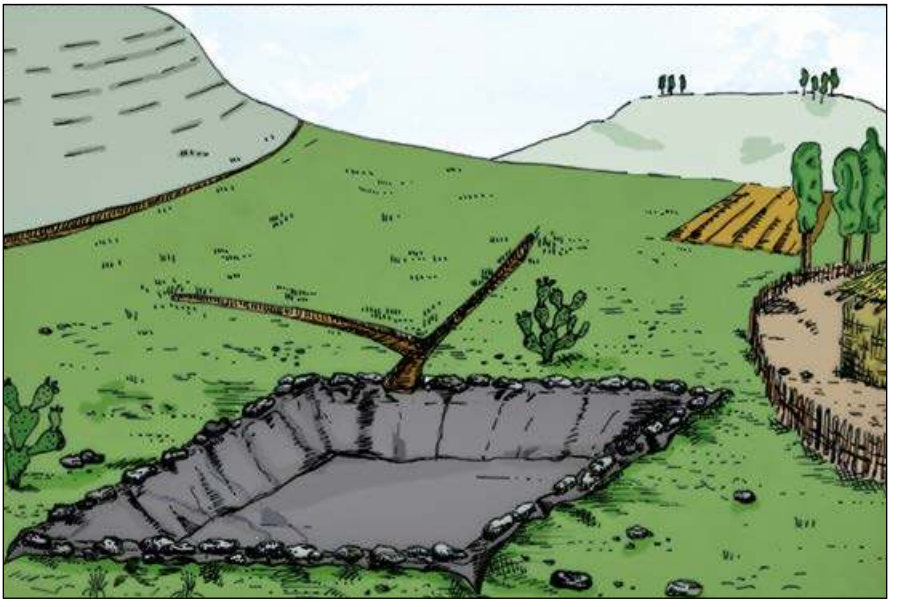
Runoff water harvesting: This technology collects water from the ground, e.g. the farm compound or a road, or from a rocky area or from roofs, and brings it through a channel or a pipe to where it is needed, i.e. to the field, a pond, a tank, or a basin.

Floodwater harvesting: Floodwater harvesting uses channels, weirs and dams to divert the water from the seasonal flooding of a river into the fields.

For a detailed description and formulas for the proper design of water harvesting structures, please refer to one of the following books:

– *Managing Land*, a practical guidebook for development agents in Ethiopia, Regional Land Management Unit (RELMA) Nairobi and Ministry of Agriculture and Rural Development, Ethiopia, 2005.

– *Soil and Water Conservation: a Manual/Guideline for Ethiopia* reviewed by Daniel Danano, Soil and Water Conservation Team, Natural Resource Management and Regulatory Department, Ministry of Agriculture, Addis Abeba, 2001.



This is an artificial rectangular pond constructed to harvest floodwater from a grazing area by means of two ditches. The pond has a plastic sheet and is partly filled with water, which can be used for animals or garden irrigation. It is not suitable as drinking water, however.

EFFECTS

Water harvesting helps to secure and increase production in arid and semi-arid areas where rainfall is irregular and often not sufficient to satisfy the demand for crops and livestock.

COMBINATIONS

These water harvesting structures can be combined with **Level Bund** and **Fanya Juu** and **Bench Terrace**.

MATERIALS

Line-level, measuring tape, digging instruments for ponds or tanks, respective construction materials.

MANAGEMENT AND MAINTENANCE

All water harvesting structures require very careful follow-up and immediate maintenance work in case of any damage.

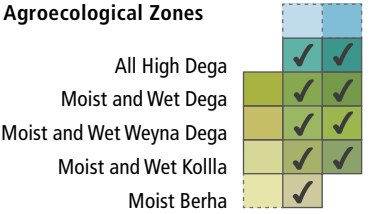
Waterway

LOCAL APPLICABILITY

Local Situation

Slope Range: 3–50%
Soil Range: All, but take care on deeply weathered subsoils

Agroecological Zones



DEFINITION

A waterway is a natural or artificial channel along the steepest slope or in the valley used to accommodate runoff. Artificial waterways as discussed here need to be paved with grasses or stone. Traditional waterways need improvement according to the technical standards given.

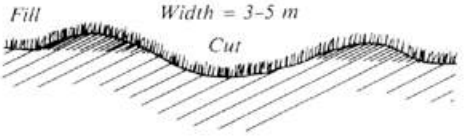
SPECIFICATIONS

On cultivated land with graded structures, waterways must be placed every 250 m to avoid graded ditches that are too long.

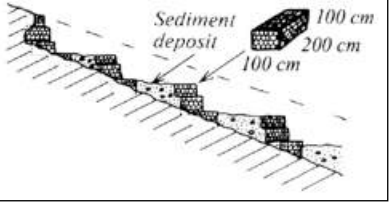
Waterways must always be constructed and grass developed on them one year before graded structures are applied on the land.

If there is enough land, cross-sections of waterways should be gentle, as shown below:

Cross-section:



Gabion drop structure:

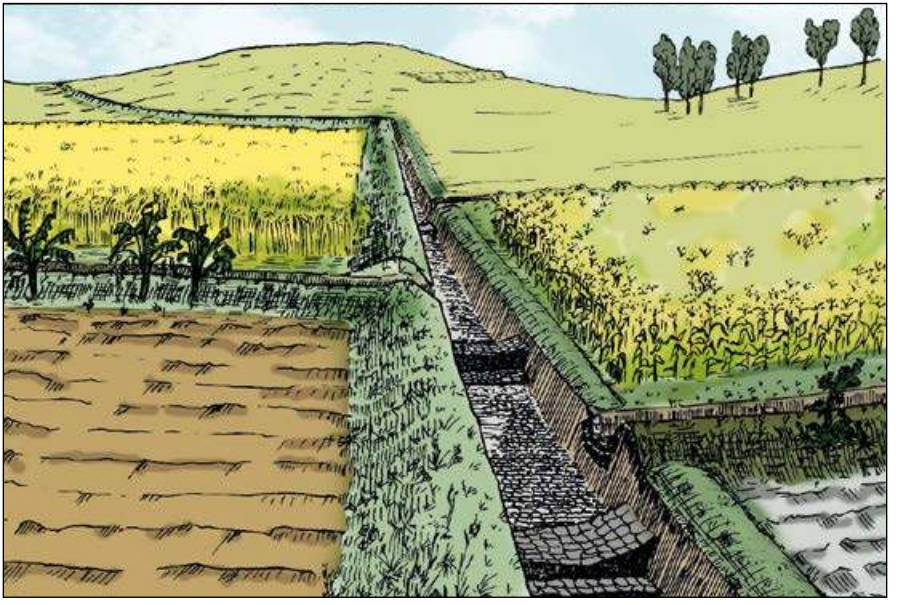


If, for lack of land, only narrow waterways are feasible, they must be made deeper, up to 1 m, and more narrow, about 1.5 m. In such cases, the bottom of the waterway has to be paved very densely with big, flat stones.

In long waterways and difficult situations, gabions made of wire nets can be used as a drop structure (see also **Checkdam**).

EFFECTS

Waterways enable runoff water that is not stored behind bunds or does not infiltrate on the land during a storm to be drained safely to the next river.



This is a typical artificial waterway in an area with land scarcity. Therefore, it has been dug deep into the soil, with steep borders and a stone pavement with intermittent small checkdams at the bottom. At the top, a cutoff drain leads into the waterway from the left side, while, graded bunds are led into it from the cultivated land, alternating from each side.

COMBINATIONS

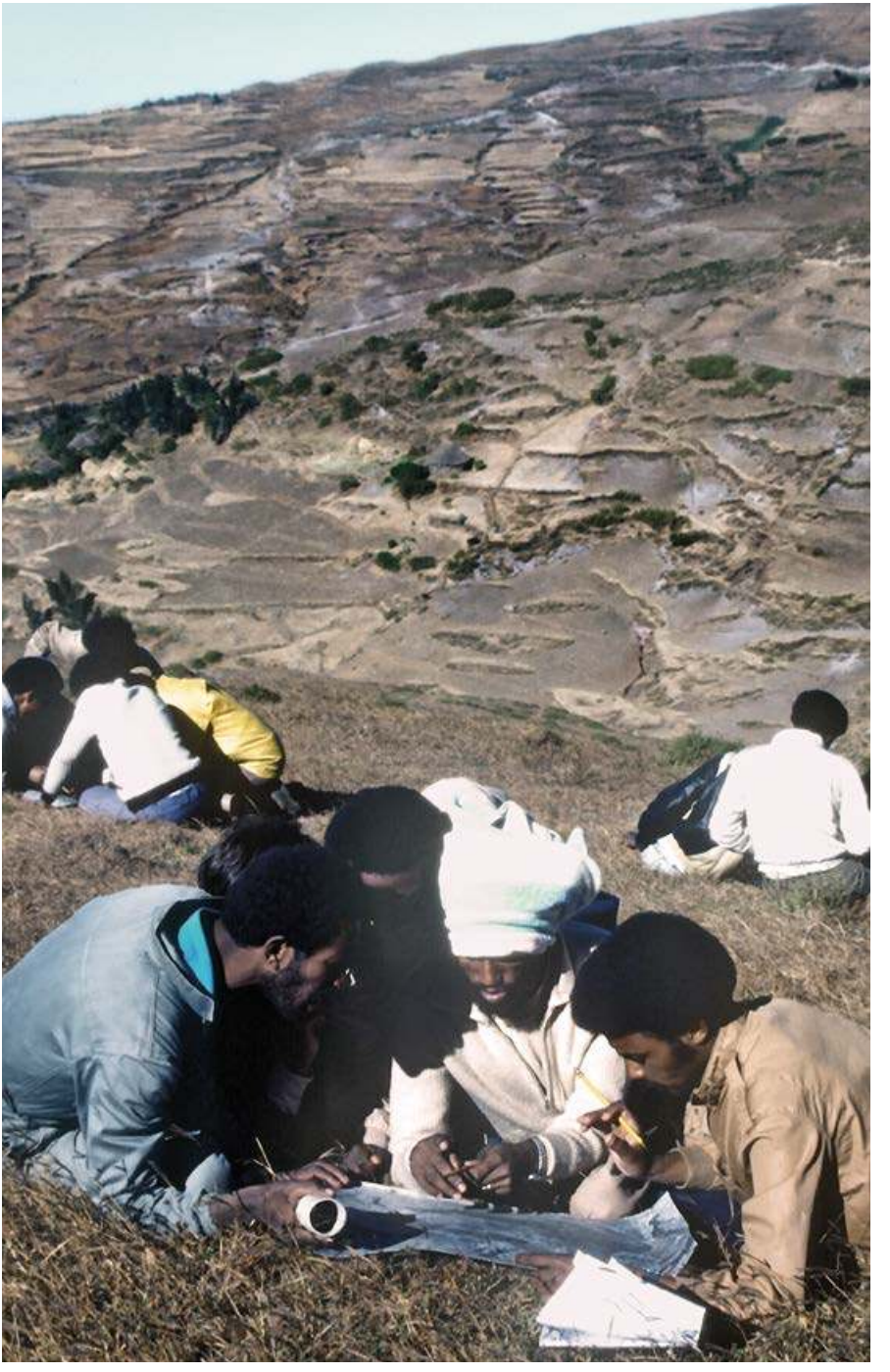
Waterways are needed for all Graded structures on cultivated land and for **Cutoff Drains**. **Revegetation** along borders of waterway and, if possible in the waterway, is necessary. A **Checkdam** may be needed on steeper slopes to prevent scouring, especially if vegetation does not grow at the bottom of the waterway.

MATERIALS

Big, flat stones, line level, digging instruments, gabions (wire nets for stones) and materials needed for combined measures.

MANAGEMENT AND MAINTENANCE

Waterways should not create a gully and not endanger land below them through overflow. Continuous management and repair of breakage, disruptions of the stone pavement, and excessive scouring are needed. Waterways have to be maintained by the group of farmers who have land above and on the sides of the waterways, or from whose land there are graded structures leading into them, as well as by farmers who have land below them. Maintenance is needed to cut the grass along and in waterways, to repair the stone paving or to improve drop structures. If gullying is observed, additional measures have to be put into waterways.



Watershed planning. Andit Tid (1984).

More Useful Information

List

List of items needed by development agents 118
How to identify the texture of a soil 119
Marking contour lines with the line level 121
Measuring slope gradients 122
Measuring vertical intervals with the line level 123
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LIST OF ITEMS NEEDED BY DEVELOPMENT AGENTS

COMPULSORY ITEMS

Two items are absolutely necessary for Development Agents when carrying out soil and water conservation activities in the field:

1. Line level: Small waterlevel, 2 poles (2 m), plastic rope 11 m long; or A-frame
2. Meter tape (30 m) or meter stick (2 m)

ITEMS THAT ARE OPTIONAL BUT VERY USEFUL

1. This book: *Guidelines for Development Agents on Soil and Water Conservation in Ethiopia*
2. Forms 1–3 (see pages 126–133 of this book), and notebook to use as 'Field Information and Record Book' during conservation activities, and a ring binder to keep the forms
3. Other reference books and handouts concerning soil and water conservation activities in Ethiopia (see p. 125)
4. Sketch map or enlarged topographical map of the area
5. Altimeter (to measure elevation above see level)
6. Compass (to assess horizontal direction)
7. Clinometer (to measure slope steepness)

HOW TO IDENTIFY THE TEXTURE OF A SOIL

DEFINITION

Soil texture is mainly concerned with the size and shape of the mineral particles in the soil. Particles are sand, silt and clay, and they have the following diameters:

Sand: 0.05–2 mm (particles visible)
Silt: 0.002–0.05 mm (particles merely visible)
Clay: less than 0.002 mm (particles not visible)

Clayey soils have more than 50% clay particles.
Silty soils have more than 50% silt particles.
Sandy soils have more than 50% sand particles.
Loams are soils with mixed particles of sand, silt and clay.

SIGNIFICANCE OF SOIL TEXTURE FOR SOIL AND WATER CONSERVATION

Soil erosion depends much on the infiltration rate and water-holding capacity of a soil. The infiltration rate in turn depends on soil texture. In a sandy soil, the infiltration rate is higher than in a silty soil. In a clayey soil, it may be initially high (for heavy black clay with cracking), but becomes low when the soil is moist to wet. Other factors influencing the infiltration rate are soil structure, humus content, soil moisture, soil depth, and soil surface roughness.

In most agroecological zones, the decision to select graded or level structures on cultivated land mainly depends on the soil texture found on the slope where conservation is planned. For clayey soil, graded structures are recommended, because infiltration is too slow. For silty to sandy soil, level structures are recommended because the water retained in the basins will infiltrate more quickly.

HOW TO DIFFERENTIATE BETWEEN CLAYEY, SILTY AND SANDY SOIL

1. Take a small handful of fine earth from the slope.
2. Slowly add small amounts of water and mix it very well with the earth sample. Stop adding water as soon as the soil ball formed starts to stick to your hand.
3. The soil texture can be roughly estimated with your moist soil sample. Try to form the sample into the different shapes demonstrated on the next page. See how many of the pictures you can form with your soil. If you cannot form it any further, stop at the previous picture and read the soil texture description to the right. This is the texture of your soil.

Now proceed to the next page and start forming your soil sample following the pictures from top down.

POSSIBLE SOIL TEXTURE

Form your sample according to each picture below, until the next one is no longer possible.

1. The soil remains loose and single-grained and can only be heaped into a pyramid:

Sand (1)

2. The soil contains sufficient silt and clay to become somewhat cohesive and can be shaped into a ball that easily falls apart:

Loamy sand (2)

3. The soil can be rolled into a short thick cylinder:

Silt loam (3)

4. The soil can be rolled into a cylinder of about 15 cm length:

Loam (4)

5. The soil can be bent into a U:

Clay loam (5)

6. The soil can be bent into a circle that shows cracks:

Light clay (6)

7. The soil can be bent into a circle without showing cracks:

Heavy clay (7)

Note: Texture classes (1) to (4) are sandy to silty soils which have generally good infiltration. Texture classes (5) to (7) are clayey soils which have generally poor infiltration.

MARKING CONTOUR LINES WITH THE LINE LEVEL

DEFINITION

Contour lines are horizontal lines across the slope joining points at the same elevation. Contour lines are used to line out conservation measures which have to be level.

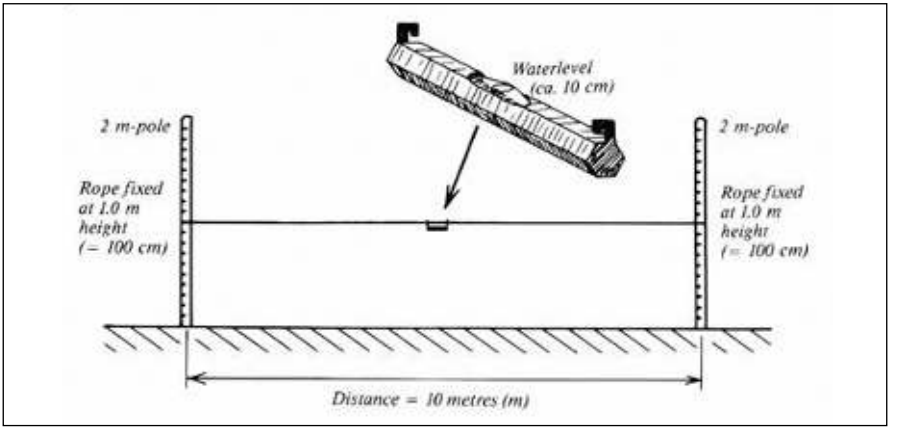
MATERIALS

The following items are needed:

Waterlevel; Thin plastic rope, 11 m long; Two wooden poles, 2 m long, marked every 10 cm; Meter band or meter stick; Short poles for marking the ground

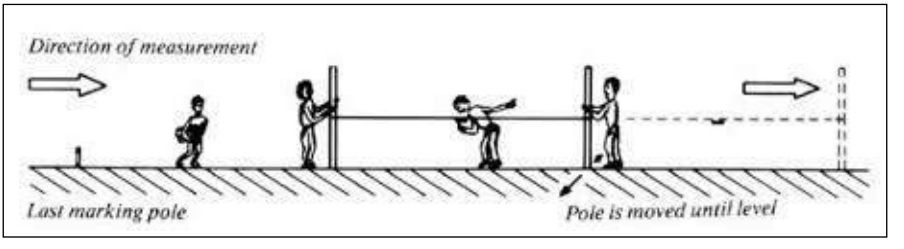
PREPARATION

Fix the thin rope with each end to one wooden pole so that exactly 10 m of rope is between the poles. Check length regularly. Mark the middle of the rope at 5 m with a knot. Hang the small waterlevel in the middle of the rope. Three to four people are needed to survey a level line and to mark it on the ground.



MARKING CONTOUR LINES

Proceed across the slope as shown in the drawing below. Survey 10 m at a time; in difficult topography only 5 m (half the rope).



MEASURING SLOPE GRADIENTS

DEFINITION

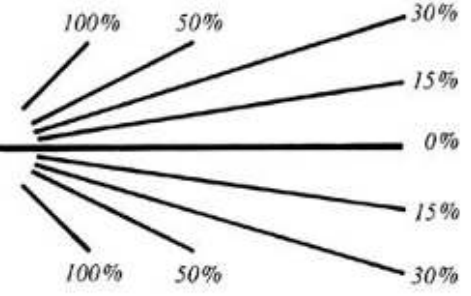
Slope gradient is the steepness of a slope. It is expressed in terms of height as a percentage of length (%), or sometimes also in degree.

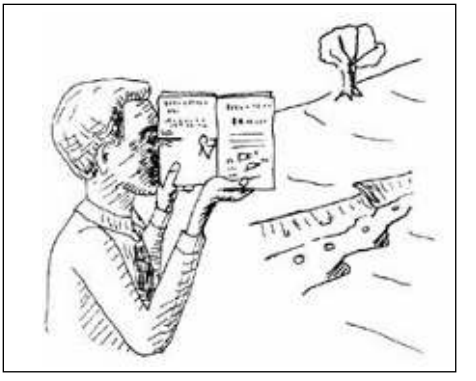
MATERIALS

The following items are needed: Waterlevel, or this page of the book (see 'estimating slope gradients' below); Thin plastic rope, 11 m long, meter tape or meter stick; Two wooden poles, 2 m long, marked every 10 cm; Small poles for marking on the ground.

ESTIMATING SLOPE GRADIENTS WITH THE FIGURE BELOW

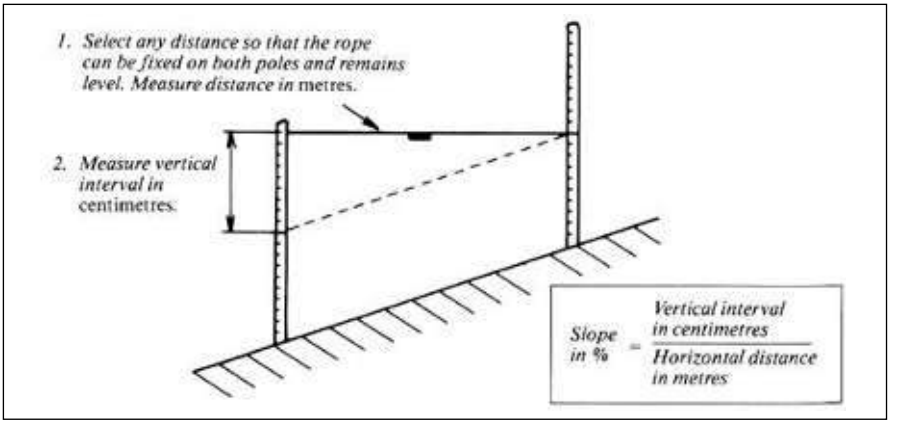
Hold the book horizontally as demonstrated (somebody may help you in checking) and look with one eye along the book upslope or downslope. Select the line that best fits the actual slope and read the percentage given or make an estimation between two lines.





MEASURING SLOPE GRADIENTS WITH THE LINE LEVEL

Follow the steps given below and use the formula to calculate the slope percentage. Take care that you use the correct units (1 metre = 100 centimetres).



MEASURING VERTICAL INTERVALS WITH THE LINE LEVEL

DEFINITION

A vertical interval between two points is the difference in elevation between them. Vertical intervals are used along the slope to mark the spacing between two conservation measures. Vertical intervals of structures on slopes steeper than 15% are calculated on the basis of the depth of soil observed on the slope.

MATERIALS

The following items are needed: Waterlevel or the opposite page of the book (see 'estimating slope gradients' below); Thin plastic rope, 11 m long, meter band or meter stick; 2 wooden poles, 2 m long, marked every 10 cm; Small poles for marking on the ground.

ASSESSING THE CORRECT VERTICAL INTERVAL

On slopes with gradients of less than 15% (see page 122 for slope measurement), the vertical interval is 1 metre.

On slopes with gradients of more than 15%, the vertical interval is two-and-a-half times the soil depth.

Examples:

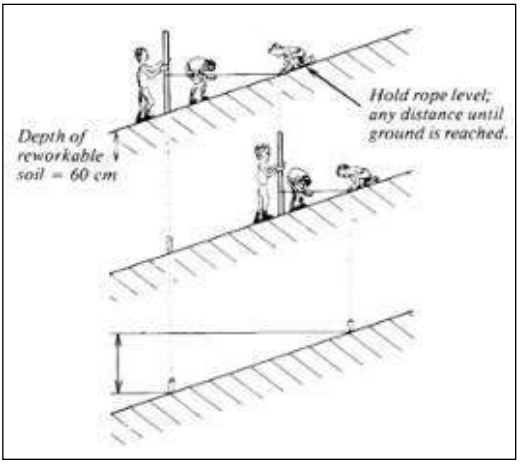
Slope (%)	Depth of Soil	Vertical Interval, m (cm)
5	(more than 50 cm)	1 m (= 100 cm)
10	(more than 50 cm)	1 m (= 100 cm)
18	60 cm (= 0.60 m)	1.50 m (= 100 cm)
25	80 cm (= 0.80 m)	2.00 m (= 200 cm)
35	50 cm (= 0.50 m)	1.25 m (= 125 cm)
45	25 cm (= 0.25 m)	0.62 m (= 62 cm)

MARKING a 1.5 m (150 cm) VERTICAL INTERVAL

Step 1: Measurement of 1 m vertical interval

Step 2: Measurement of 0.5 m vertical interval

Step 3: Total vertical interval = 150 m (150 cm)



MARKING GRADED LINES WITH THE LINE LEVEL

DEFINITION

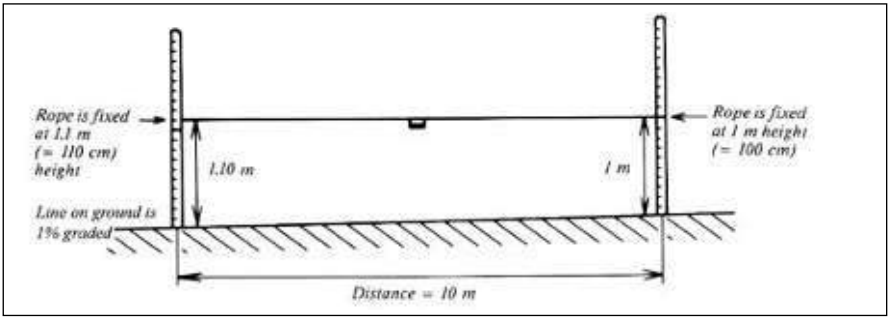
Graded lines are lines across the slope, which have a very small lateral gradient. They are used to line out conservation measures which are graded and have a ditch to drain excess water.

MATERIALS

The following items are needed: Waterlevel or page 122 of the book (see 'measuring slope gradients'); Thin plastic rope, 11 m long, meter band or meter stick; Two wooden poles, 2 m long, marked every 10 cm; Small poles for marking on the ground.

PREPARATION

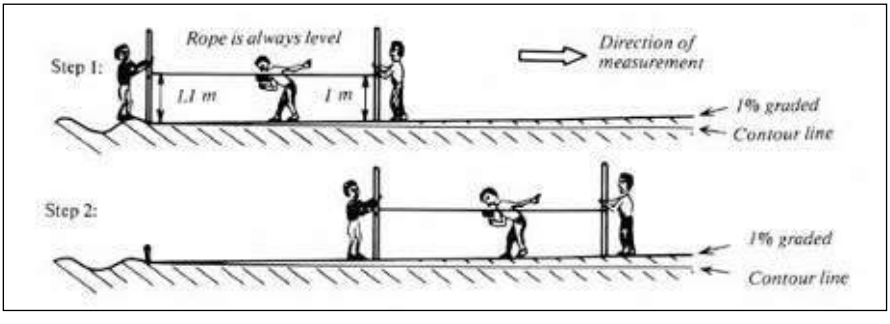
For lining out 1% graded measures, the line level also uses a difference of 1% over a length of 10 m. This means the rope has to be fixed on the poles at two levels with a difference of 10 cm, as shown below:



For lining out 2% graded measures, fix one end of the rope at 1.2 m (= 120 cm) on the pole, and one end at 1 m (= 100 cm) to give a total difference of 20 cm over a length of 10 m. For 0.5% graded measures, fix rope with a difference of 5 cm.

MARKING 1% GRADED LINES ON THE GROUND

Always start lining out at waterway or river and proceed slightly upslope (1%). Always use the pole with the rope fixed higher up, nearer to the waterway, and the pole with the rope fixed at 1 m, farther away, as shown below:



LIST OF USEFUL TECHNICAL DOCUMENTS

The following documents can be ordered through the Ministry of Agriculture or other agencies (restricted distribution):

Community Based Participatory Watershed Development. A Guideline, Part 1. Edited by Lakew Desta, Voli Carucci, Asrat Wendem-Agegnehu and Yitayew Abebe. Ministry of Agriculture and Rural Development. Addis Abeba, Ethiopia. 2005, 176 pp.

Economics of Land Degradation (ELD) Ethiopia Case Study. Soil Degradation and Sustainable Land Management in the Rainfed Agricultural Areas of Ethiopia: An Assessment of the Economic Implications. Directed by Dr Kaspar Hurni. Report for the Economics of Land Degradation Initiative. 2015, 94 pp.

Improving cattle for milk, meat and traction. ILRI training Manual 4. By Ibrahima H and E Olaloku, 2000. International Livestock Research Institute, Nairobi, Kenya.

Indigenous agroforestry practices and their imlications on sustainable land use and natural resources management. The case of Wonago Woreda. SLUF Sustainable Land Use Forum, Research Report No. 1, 2006, 93 pp.

Managing Land. A practical guidebook for developmet agents in Ethiopia. Technical Handbook No. 36, RELMA, MoARD and World Agroforestry Centre. 2005, 282 pp.

Multipurpose Plant Species for Soil and Water Conservation. Field Document 14, FAO ETH/81/003

Non-Conventional Feed Resources for Livestock in the Soil and Water Conservation Programme. Field Document 15, FAO ETH/81/003

Pasture and Seed Production for Soil and Water Conservation. Field Document 13, FAO ETH/81/003

Soil and Water Conservation: a Manual/Guideline for Ethiopia. Reviewed by Daniel Danano, Soil and Water Conservation Team, Natural Resource Management and Regulatory Department, Ministry of Agriculture, Addis Abeba, 2001.

Some Farm Management Practices for Soil and Water Conservation. Field Document 9, FAO ETH/81/003

Sustainable Land Management Technologies and Approaches in Ethiopia. Edited by Daniel Danano. EthioCAT Network Members. The FDRE Ministry of Agriculture and Rural Development, Addis Abeba, 2010, 320 pp.

Vetiver Grass – the Hedge against Erosion. World Bank, 1993.

Form 1:
Description and Problems in Your Area

IDENTIFICATION OF YOUR SUB-CATCHMENT

Your Name: Date:

Kebele:

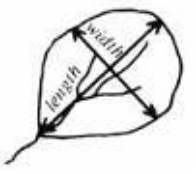
Wereda: Zone: Region:

Name of Catchment:

Agroecological Zone(s):

SIZE OF SUB-CATCHMENT WHERE YOU ARE LOCATED

Measure total length and total width of the area (in metres), and calculate the approximate area in hectares assuming an elliptical shape:



$$\text{Area} = \frac{\text{Length (m) x Width (m) x 3.14}}{40{,}000} = \ldots\ldots\ldots \text{ ha}$$

Remember: 1 ha = 1 hectare = 100 m x 100 m = 10,000 m^2.

Preferably, one sub-catchment should be 50–200 hectares.

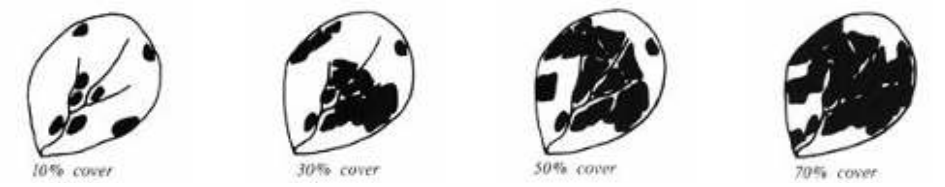
LAND USE AND TOPOGRAPHY IN YOUR SUB-CATCHMENT

Estimate the proportions of each land use type as a percentage of the total catchment and write the figures in the table below. The next page shows how to estimate percentages and how to calculate corresponding areas in hectares.

Land use type in catchment	Proportion as % of total	Proportion in hectares (ha)	Average slope gradient (%)
I. Cultivated Land:			
II. Grassland:			
III. Forestland			
– Existing:			
– Planned:			
IV. Other land:			
Total	100%		

Main land use types, sizes and average slope gradients in your sub-catchment.

You can see some percentages of land cover in the following drawings and compare them with your sub-catchment to estimate the percentages of each land use type in your area:



With the estimated percentages, calculate the hectares of each land use type by multiplying the total catchment area (ha) by the percentage and dividing it by 100. Enter your estimations in the table on the previous page. Also measure the average slope gradient (in %) for each land use type (see page 122) and write it in the same table.

Describe in writing the following points: Main crops grown in the area:

Cropping season(s): Give months between seeding and harvesting of each season:

Trees and grass in the area:

Describe traditional types of soil and water conservation/water conservation/water drainage for the different land use types, with a focus on cultivated land:

SOIL

Mark the nearest soil colour observed on the different slope types with a cross. Give the texture (see page 119) and the average soil depth for each slope and land use type in the table below:

	Soil colour:				Soil texture	Soil depth
	black	red	brown	yellow		cm
I. Cultivated land – Steep slopes:						
– Gentle slopes:						
– Flat land:						
II. Grassland – Steep slopes:						
– Flat land:						
III. Forestland – Existing:						
– Planned:						

Inventory of soils for different slopes and land use types in your sub-catchment

EROSION PROBLEMS IN YOUR SUB-CATCHMENT

First describe sheet and rill erosion problems for each land use type. Observe signs of sheet erosion that you can see as shallow soil depths. Ask farmers whether rills develop during the rainy season and if yes, on which slopes. Write down your observations and describe where they are located and why erosion is occurring there.

Cultivated land:

Grassland:

Forestland

Existing:

Planned:

Also, measure length, width and depth of all gullies (in metres), and indicate in the table below together with the location within the catchment:

Location	Length (m)	Width (m)	Depth (m)	Land use above gully

Dimension of major gullies in your sub-catchment.

OTHER MAJOR PROBLEMS IN YOUR SUB-CATCHMENT

List other (non-conservation) problems as identified by the farmers:

_____

_____

_____

CONSERVATION ALREADY CARRIED OUT

Cultivated land:

_____

_____

Grassland:

_____

_____

Forestland (Afforestation)*:*

_____

_____

Form 2:
Soil and Water Conservation Measures that You Recommend for Your Area

Select from the conservation measures recommended for your agroecological zone in this book the ones that you consider best in your sub-catchment and give reasons for your selection below, using the three main land use types:

CULTIVATED LAND

1. For slopes with gradients of less than 15%:

Recommended measure	Size of area (ha)	Reason for selection
1.		
2.		
3.		

2. For slopes with gradients of 15-50%:

Recommended measure	Size of area (ha)	Reason for selection
1.		
2.		
3.		

3. For cultivated slopes with gradients steeper than 50%, cultivation is changed to the following land use type:

GRASSLAND

Recommended measure	Size of area (ha)	Reason for selection
1.		
2.		
3.		

FOREST LAND

Recommended measure	Size of area (ha)	Reason for selection
1.		
2.		
3.		

Form 3:
Individual Farm Land Plan

Farm Name:

Village:

Kebele:

Sketch map of Individual Farm Land Plan:

What is there?

Crops (with estimated field size per crop in ha):

Vegetables (with estimated garden size):

Animals (give numbers):

Trees:

Anything else:

Challenges

(which the farmer lists):

Solutions

(discussed and agreed, including a plan of action with time frame):

How to Order More Copies of This Book

Do you want a copy of this book?

Copy the form below, fill it out, and send it to:

Water and Land Resource Centre
P.O. Box 3880
Addis Abeba

(Development Agents and employees of the the line ministries and bureaus in Ethiopia may receive one copy free of charge)

Copy this slip

Please send me a copy of *Guidelines for Development Agents on Soil and Water Conservation in Ethiopia (Revised edition 2016)*

Name:

Address:

P.O. Box:

Postal Office:

Town:

Wereda:

Region:

Reason why I need this book:

Signature:

This revised edition of the *Guidelines for Development Agents on Soil and Water Conservation in Ethiopia* is more than timely. Soil degradation in the highlands is caused primarily by soil erosion on rainfed cropland, and is thus the main reason for declining yields. While some 3.5 million hectares of steep cropland have been treated in the past 40 years, there remain nearly 12 million hectares to be treated in the coming years; this is more than three times as much as has been achieved in the past. In addition, grassland and forest land showing signs of soil degradation need to be treated as well. Taking the same systemic perspective as the first edition in 1986, this revised edition proposes 26 conservation technologies suited to the different land use types and agro-ecological zones in Ethiopia, and suggests more participatory approaches.

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