

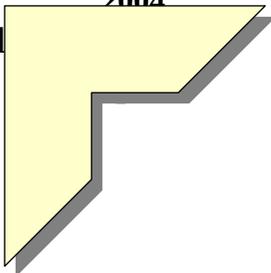
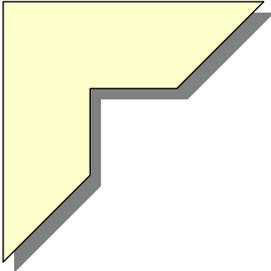
**The Federal Environmental Protection
Authority**



Guidelines on Soil Conservation on Cultivated Land

NOT FOR CITATION

This guidelines is still under development and shall be binding after consensus is reached between the Environmental Protection Authority and the Environmental Units of Competent Sectoral Agencies



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Table of Contents

	Page
INTRODUCTION.....	1
1. ALLEY CROPPING.....	1
2. GRASS STRIP.....	3
3. LEVEL BUND.....	5
4. LEVEL FANYA JUU.....	6
5. GRADED BUND.....	8
6. GRADED FANYA JUU.....	10
7. BENCH TERRACE.....	13

Introduction

Soil erosion is severe on cultivated lands. Appropriate physical conservation measures are not adequately introduced and practiced by the farmers. Hence, this guideline is intended to assist mainly, farmers, to take care of their cultivated lands. The guidelines have got six physical soil conservation techniques. Brief descriptions of the techniques are depicted here under:

1. Alley Cropping

- **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.

- **Area of Applicability:**

1. Agroclimatic Zones: All Dega, ,Moist and Wet Weina Dega, Moist kolla
2. Local Situation:
 - a) Slope Range: All
 - b) Soil Range: All, including shallow and degraded soils

- **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 cultivatee 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 light competition are less.

Bamboo, "true man's tree", and 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 5m. On hedgerows, trees and shrubs can be spaced 25-100cm apart.
 - When cutting down, take care that shrub is cut above lowest split of branches, and not below, to support fast regrowth.
 - Individual landholders on their land apply alley cropping, and the products are at their own use.
 - Trees are planted in rows of pits along the contour spaced with up to a 5 meter vertical interval 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 favorable conditions for soil organisms. Soil erosion is reduced. Bunds on steeper slopes are stabilized. Nitrogen is fixed and made available to companion plants.

- **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 the altitude. Below steep slopes, CUTOFF DRAIN is used to protect cultivated land. CUT AND CARRY, TREE PLANTING and REVEGETATION are used with alley cropping.

- **Material:**

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 1m). Weeding and pruning is needed. Grazing between rows of trees only with tied cattle, better even CUT AND CARRY. Crop production is shifting between trees, leaving strip fallow after cultivation for about five years. Use traditional knowledge about soil fertility improvement and tree management. Up bringing of trees needs 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. Regular cutting of tree branches for mulch and fodder.

2. Grass Strip

- **Definition:**

A grass strip is a ribbon-like band of grass laid out on cultivated land along the contours. Usually, grass strips are about 1 meter wide and spaced at 1m vertical intervals. They are mainly used to replace physical structures on soil with good infiltration (sandy, salty) 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.

- **Area of Application;**

1. Agro climatic Zones ;Moist and Wet Wurch, Moist band Wet Dega, Moist and Wet Weina Dega, Moist kolla
2. Local Situation:
 - a) Slope Range:
Slopes of less than 15% gradients
 - b) Soil Range: All

- **Specifications:**

Grass strips are planted along the contour or along CUTOFF DRAIN.

Spacing with 1 metre vertical interval means that on a 3% slope, grass strips will be 33m apart, and on a 15% slope, only 7m apart, still sufficient for ploughing between the strips.

- **Effects:**

Grass strips help 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. REVEGETATION as for bunds can be applied to improve grass strips.

- **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 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 he is allowed to CUT AND CARRY. Care must be taken that the strips are not narrowed with every ploughing. Width of one meter is the absolute minimum required for effectiveness.

3. Level Bund

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 10m, help to prevent runoff of flow sideways and to concentrate and overflow at one point of the bund.

Area of Applicability:

1. Agro climatic Zones: Moist Wurch, Moist Dega, Moist and Dry Weinadega, All Kolla
2. Local Situation:
 - a) Slope Range 3-50%
 - b) Soil Range:

All depths of more than 50cm, or according to farmer's consent

- **Specifications:**

The vertical interval between two bunds is 1 meter for slope gradients of less than 15%. For steeper slopes, the vertical interval must be two and a half times the depth of rework able soil. About every 50m, a gap can be left open to allow ploughing oxen 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 due to inappropriate lining of the bunds. Soil, which is eroded between two bunds, is deposited in the basin behind the lower bund.

Whenever the basin is full of sediments, the bund must be raised. Like this, a BENCH TERRACE will develop in the course of years.

- **Combination:**

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, suitable local grass and legumes for REVEGETATION.

- **Management and Maintenance:**

REVEGETATION is recommended on all bunds, especially on soil bunds in moist areas. Grazing in 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.

4. Level Fanya Juu

- **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. In difference to 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-meter are used also here to prevent runoff to flow sideways.

- **Area of Applicability:**

1. Agro climatic Zones: Moist Wurch, Moist Dega, Moist and Dry Weina Dega,

2. Local Situation:

- a) Slope Range: 3-50%

- b) Soil Range:

All depths of more than 50cm, according to farmer's consent

- **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 work able soil. Contoures are lined out as shown on page 85. The height of the Fanya juu is 50-75cm, and the ditch is about 50cm deep. The space between the ditch and the beam is at least 25cm. The width of the ditch depends on the soil fertility. On fertile subsoil, it may be very wide and crops can be planted in the ditch.

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

- **Effects**

Level Fanya juu are embankments to retain runoff between two bunds. Runoff is retarded behind them, and the overflow is collected in the ditch below the embankment. The tied ridges stop runoff in the ditch flowing sideways. Soil eroded between two Fanya juu's is deposited behind the lower one. Whenever the small basin behind and the ditch below the Fanya juu's are full of sediment, they must be raised with deposit material from the ditch. Like this, a BENCH TERRACE will develop in the course of a few years

- **Combination:**

CUTOFF DRAIN may be necessary in cases where not all runoff can be retained between the Fanya juu's. 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-faced embankment and suitable local grass and legumes for REVEGETATION

- **Management and Maintenance:**

REVEGETATION is recommended on all Fanya juu's, especially on soil bunds in moist areas. Grazing must be stopped on cultivated land treated with bund 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 his land. Every farmer is responsible for carrying out the maintenance of Fanya juu's on his own land. They must be maintained whenever they tend to break, especially in storms. Fanya juu's have to be increased annually until BENCH TERRACE is developed.

5. Graded Bund

- **Definition:**

A graded bund is defined like a LEVEL BUND, with the only difference that it is slightly graded sideways, with a gradient of up to 1%, towards a water way 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.

- **Area of Applicability:**

1. Agro climatic Zones: All Wurch, All Dega, Wet and Moist Weinadega and Moist kolla
2. Local Situation:

a) Slope Range:3-50%

b) Soil Range:

All soil in wet, clay soil in moist agriclimate zones

- **Specifications:**

The vertical interval between two bunds is 1 meter 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.

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. Make the waterways one year before the graded structures to stabilize them before use

If the bunds are long, the basins behind 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 25cm deep by 50cm wide at the beginning of the bund, but 50cm deep by 100cm wide after about 100-150m when the bund reaches the river.

- **Effects:**

Graded bunds retain normal amounts of runoff in their basins, but they can drain excess runoff of heavy storms, which would cause overflow and down slope 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 in wet areas as well as in moist areas with clay soils.

- **Combinations:**

WATERWAY must be developed one year before graded bunds are applied. This is needed for draining the excess runoff. REVEGETATION or ALLEY CROPPING must be used on the bunds for their stabilization. BENCH TERRACE develops from graded bunds with continuous increase over the years.

- **Material:**

Line level, digging instruments, blocks of stone for stone-faced bunds and suitable local grass and legumes for revegetation

- **Management**

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 land. Breakings have to be closed during and after storms. Bunds have to be increased annually until BENCH TERRACE is developed. Even thereafter, the drainage ditch going sideways to the next waterway or river must be maintained.

6. Graded Fanya Juu

- **Definition:**

A graded Fanya juu ("Throw uphill" in Swahili) is defined like a LEVEL FANYA JUU with the only difference 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.

- **Area of applicability:**

1. Agro climatic Zones: All Dega, Wet and Moist Weina Dega
2. Local Situation:
 - a) Slope Range:
3-50%, more on steeper slopes
 - b) Soil Range: All deep soils in wet, deep clay soils in moist agroclimatic zones

- **Specifications:**

Caution is needed when applying graded Fanya juu's because they need careful design, supervision and maintenance, although conservation is effective

The vertical interval between two graded Fanya juu's is 1m for slope gradients of less than 15%. For steeper slopes, the vertical interval is two and a half times the depth of reworkable soil. It is recommended to apply stone-faced bunds whenever possible to make them strong for overflow.

A typical cross-section is shown on page 44 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 drainage line, which cannot be interrupted.

Whenever possible, use and improve traditional waterways in the area one year before you apply graded Fanya juu's. Discuss with farmers about the measures lined out before you implement them.

If the Fanya juu's 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 50cm deep by 25cm wide at the beginning of the structure, but 75cm deep by 50cm wide after about 100-15-m when the graded Fanya juu reaches the waterway.

- **Effects:**

Graded Fanya juu's retain small amounts of runoff above their wall and they drain excess runoff of heavy storms through the ditch below which would cause overflow and downslope destruction on level (Fanya juu) structures. Some of the soil eroded between two Fanya juu's is deposited above the wall; some is deposited in the ditch, while the rest is drained sideways. Graded Fanya juu's are more difficult to manage, but support the development of BENCH TERRACE very well.

- **Combinations:**

WATERWAY is needed for draining the excess runoff. It must be developed one year before graded Fanya juu's are applied. REVEGETATION or ALLEY CROPPING is used on the Fanya juu's for their stabilization. BENCH TERRACE develops from graded Fanya juu's 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 juu's including the stone-faced ones. Most important is a 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's of his land. Breakings have to be closed during and after storms and the ditch emptied from sediment. Embankments have to be increased annually until BENCH TERRACE is developed. The drain sideways to the next waterway or river must be maintained.

7. Bench Terrace

- **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, it is either constructed directly on a slope or gradually developed from bunds and Fanya juu's. Bench terraces are level along the contour in dry to moist agroclimatic zones. In moist to wet agroclimatic zones, they are graded to drain excess runoff sideways to the next river or waterway.

- **Area of Applicability:**

1. Agro climatic Zones: All Wurch, All Dega, All Weina Dega, All Kolla

2. Local Situation:

- a) Slope Range:

Slopes up to 50% gradients

- b) Soil Range:

Vertical interval is two and a half times the soil depth

- **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 1m, the vertical interval is 2.5m. The slope gradient and the soil depth as shown in the Table below determine the width of cultivated area on a bench terrace:

Slope Gradient	Soil depth (c, m)					
	25	50	75	100	125	150
20%	2.81m	5.63m	8.44m	11.25m	14.06m	16.88m
30%	1.77m	3.54m	5.31m	7.07m	8.85m	10.63m
40%	1.25m	2.50m	3.25m	5.00m	6.25m	7.50m
50%	0.94m	1.88m	2.81m	3.75m	4.69m	6.63m

- **Effects:**

Leveling the cultivated land will greatly reduce soil erosion, mostly to tolerable amounts. If the spacing between two riser slopes is carried out with the vertical interval as described here, the cultivated land will be almost level when the terrace is developed. On the riser slope, grass and legumes can be developed through REVEGETATION. Maintenance is essential for terrace development from Fanya juu's and bunds, and indispensable also to the prevention of terrace destruction later on.

- **Combinations:**

LEVEL or GRADED BUNDS or FANYA JUU's, GRASS STRIP and ALLEY CROPPING can all be used for starting terrace development if the terraces are not constructed directly. Stabilization of the riser slope through REVEGETATION. Add CUTOFF DRAIN for protecting the terraces from runoff coming from upslope. Start with 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 is indispensable if terraces are developed from bunds. Stabilization of the riser slope through REVEGETATION is necessary. 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 deposited soil after every heavy storm. This is the duty of the farmer to whom the terraces belong and must be supervised by the Peasant Association. The terraces have to be increased and repaired continually until a stable situation is reached.