Training Module No. 9

1 Day Training Program on Soil Conservation Measures in Hill Slopes

Date :_________ **Venue:__________**

Participants: 30 Persons

- Staff members of Partner NGO
- Field level workers involved in direct implementation (VSS Members)
  *Concerned forester and forest guard need to attend to facilitate the participants.

Objective of the Training

The main objective is to enhance and improve conceptual understanding of participants on various soil conservation measures/treatment adopted in hill slopes for conserving soil and moisture.

Training Outcomes

1. Understanding on theoretical aspects of various soil and moisture conservation techniques
2. Acquainted with the various options of drainage-line treatments.
3. Acquainted with the different mechanical and biological methods for soil conservation

Overall Format for Training

One day training program

- One day- Theory (Class room teaching with use of audio- visual aids for better understanding)

Minimum Competency Requirement

The participants should have basic understanding on the project objectives, activities and outputs. In addition to these, they must have minimum level of understanding on engineering measures and units etc.

Instructional Requirements

1. White board with marker
2. LCD projector
3. Power Point Presentation
4. Pointer (stick/ Laser)

5. Film on various SMC measures

Materials and Aids Required

1. Drawing sheet
2. Flip chart
3. Colour sketch pen (2- 3 sets)

Details of Session Plan

Duration (Min)	**Aid/ Materials Required**	**Methods**	**Aid/ Materials Required**
Session 1: Training on Soil Conservation Measures in Hill Slopes			
90 min	Land degradation and erosion	Lecture	PPT,AV & Whiteboard
90 min	Soil and moisture conservation in hill slopes	Lecture	PPT,AV & Whiteboard
90 min	Different types of Gully control Measures	Lecture	PPT, AV & Whiteboard
105 min	Biological measures for soil and moisture conservation	Lecture	PPT,AV & Whiteboard
Session 2: Importance of Soil & Moisture Conservation and methods			
15 min	**Introduction** Land degradation & importance of soil and moisture conservation and broad understanding **Interest riser** What is the average annual rainfall of your area ? Objectives, Programme	**Interaction**	
50min **15 min**	**Part 1** Types of Erosion and Impact of Soil & Moisture Conservation **Part 2.** Video On Erosion and impact of Soil and Moisture conservation	**Lecture** **Lecture**	**PPT** **AV**
10 min	**Concluding Session**		

	- Summary, review : Participants - Test/exercise - Home Work - Hints for next lesson		
Session 3: Soil and Moisture Conservation in hill slopes			
15 min	**Introduction** Understanding different methods of Bunding and trenching works in hill slopes for soil and moisture conservation **Interest riser** What is the average annual soil loss of India? Objectives, Programme	**Interaction**	
30 min **25 min** **10 min**	**Part 1** Methods of Bunding in hill slopes **Part 2** Methods of Trenching in hill slopes **Part 3** Methods of Terracing in hill slopes	**Lecture** **Lecture** **Lecture**	**PPT and AV** **PPT and AV** **PPT and AV**
10 min	**Concluding Session** - Summary, review : Participants - Test/exercise - Home Work - Hints for next lesson		
Session 4: Different types of Gully control Measures			
15 min	**Introduction** Understanding different methods of gully control. **Interest riser** How to calculate percentage of slope? Objectives, Programme	**Interaction**	
10 min	**Part 1**		

55 min	Use of A Frame for drawing Contour lines. **Part 2.** Methods of Gully Control Measures in hill slopes	**Lecture** **Lecture**	**Whiteboard and AV** **PPT and AV**
10 min	**Concluding Session** - Summary, review : Participants - Test/exercise - Home Work - Hints for next lesson		
Session 5: Biological measures for soil and moisture conservation			
10 min	**Introduction** Understanding biological measures Importance of biological measures **Interest riser** How to calculate volume of earth work? Objectives, Programme	**Interaction**	
30 min **30 min**	**Part 1** Different types of biological measures **Part 2.** In situ rain water conservation	 **Lecture** **Lecture**	 **Whiteboard and PPT** **Whiteboard and PPT**
20 min	**Concluding Session** - Case study analysis - Summary, review : Participants - Test/exercise - Home Work	**Interaction**	**Learning exercise**

Learning exercise

Title of the assignment	Soil and Moisture conservation in hill slopes
Size of the group	25
Module contents	Soil erosion factors and types Various soil and moisture conservation techniques Different options of drainage-line treatments. mechanical and biological methods for soil conservation
Task	The facilitator / trainer will initiate the brainstorming with the participants and lead the process. ✓ The participants may be asked detail their experiences in execution of SMC work in their villages ✓ They may also be asked to identify possible technologies including ITKs for treatment of hill slopes
Different working steps	Brainstorming Discussions should be initiated on the above mentioned topics (module contents) after dividing the large group in to sub groups of 4-5 members. Plenary Discuss and compare the outcomes of the different groups and draw a valid conclusion on the most realistic one as per the hand out. Discuss the plan of action to initiate the enterprise.
Presentation of the result	The individual group findings will be discussed in the plenary.
Material	Flash card, Brown sheet, Marker
Time Frame	15 min
For the exercise / Group work	10
For the presentation	5
Criteria for the evaluation	Analysing the level of awareness of farmers regarding the Soil and moisture conservation techniques

Session 1

Land Degradation and Soil Erosion

Land degradation generally signifies the temporary or permanent decline in the productive capacity of the land .It refers to a decline in the overall quality of soil, water or vegetation condition commonly caused by human activities. Degradation includes soil erosion, rising water tables, salinity and alkalinity, landslides, stream bank instability and poor quality of water. The factors responsible for land degradation are: Soil erosion, Water logging ,Soil acidity and Stalinization, Soil pollution, Deforestation, Loss of vegetative over, Weed infestation ,Brick making and mining.

Land Improvement

The interventions like soil conservation measures, rehabilitation of waterlogged land, soil amendment to correct acidity and Stalinisation, a forestation, agro forestry, cover crops, management of weeds, water management and nutrient management would help improvement of degraded lands for sustainable use.

Soil Erosion

Soil erosion is the process of detachment of soil particles from the parent body and transportation of the detached soil particles by water and/ or wind. Water erosion causes severe soil erosion and this category of soil erosion can be distinguished in three forms, namely sheet erosion, rill erosion, and gully erosion.

Sheet erosion, Although less noticeable than other types of erosion, typically is the main erosive force. Sheet erosion is less noticeable, as it does not leave obvious cuts in the soil surface as with rill or gully erosion. Sheet erosion is the removal of a relatively uniform, although thin, layer of soil from the land surface by unhandled runoff, or sheet flow.

Rill erosion is the process by which numerous small channels--less than three inches in depth--are formed. This type of erosion results from concentration of overland water flow associated with sheet erosion. Sheet and rill erosion leads to gully erosion.

Gully erosion, including ephemeral gully erosion, refers to the cutting of narrow channels resulting from concentration of sheet and rill flow of runoff water. Ephemeral gullies are small channels of approximately 3 to 12 inches deep. Gullies may be one to several feet deep. Gully erosion occurs when rill erosion is neglected. The tiny grooves develop into wider and deeper channels, which may assume a huge size. This state is called `gully` erosion.

Stream Bank erosion occurs when torrents or hill streams come down by wide-spreading beds on emergence from the hills with ill-defined banks, flashy flows and swift currents.

Ravine formation begins along river side's and encroaches upon the catchment area by headword growth. Active gully systems commonly develop in unconsolidated materials due to changing patterns of land use and associated change in catchments hydrology.

Wind erosion takes place normally in arid and semi-arid areas that is devoid of vegetation, where the wind velocity is high. The soil particles on the land surface are lifted and blown off as dust storms.

Session -2

Soil and Moisture Conservation in hill slopes

Of the total amount of rainfall arriving at the surface, part infiltrates and the remainder becomes runoff, which concentrates in natural zones of depression. As runoff increases, so does its velocity, volume and its ability to cause erosion. Efficient control of erosion due to rainwater can be achieved by systematic planning and protection of the area from runoff, land preparation, cultivation of crops and soil cover. The measures required for soil and water conservation can be broadly divided into two categories, i.e., mechanical measures and biological measures.

Mechanical Measures

The structures, among others include bunds, terraces, trenches, grassed waterways, diversion drains and gully control

A. Bunding

Bunds are more or less like narrow base terraces, and consist of earth embankments built across the slope of the land. They are also constructed along field boundaries and are referred to as peripheral bunds. Based on the functional requirements, they can be divided into two types. They are classified as contour bunds, graded bunds and compartmental of field bunds.

Purpose

To reduce the runoff velocity before attending erosive velocity, check the soil loss and to improve the local soil moisture profile. Bunds control the formation of rills, arrest soil erosion, reduce water velocity and increase soil moisture status.

1. **Contour Bunding**

Contour bunds are narrow based trapezoid bunds on contours to impound rainwater such that it percolates and recharge the root profile on either side of the bund up to 50% of the distance between two such bunds

Purpose

The basic purpose is to intercept the runoff flowing down the slope by an embankment. Contour bunds are constructed following the contour as closely as possible. A series of such bunds divide the area into strips and acts as barriers to the flow of water, thus reducing the amount and velocity of the runoff. Studies have shown that contour bunds result in a saving of soil ranging from 25 to 162 tons/ ha/ annum. In addition to controlling soil erosion and maintaining soil fertility, the construction of bunds helps in better infiltration of water into bunds ultimately replenishing the groundwater.

2. **Graded Bund**

Graded bunds are narrow-based versions of the channel terraces.

- ✓ They are used for safe disposal of excess runoff in high rainfall areas and regions where the soil is relatively impervious.
- ✓ They may have uniform grade or variable grade.
- ✓ Normally bund is constructed along a suitable grade and water is allowed to flow behind the bund.
- ✓ The design of graded bund involves the selection (or determination) of vertical interval, grade and cross section of bund and channel.

Purpose

- ✓ Breaking the length of slope and removing excess water at a non erosive velocity.
- ✓ Checking soil loss.
- ✓ Improving local soil moisture profile.

3. Compartmental Bunding (Field Bunding)

These bunds control the formation of rills, arrest soil erosion, reduce water velocity and increase soil moisture.

Purpose

- ✓ Breaking the length of slope.
- ✓ Checking the soil loss.
- ✓ Improving local soil moisture profile.

Constructed along the field boundaries in upper middle and lower reaches. Such structures should be constructed across the slope for maximum impact

4. Semi-Circular Bunds

Semi-circular bunds are earth bunds in the shape of a semi-circle with the tip of the bunds on the contour. The bunds are constructed to increase soil moisture and reduce erosion.

B. Trenching

Trenches are dug around the hill slope at a given contour especially used for treating non-arable area of hill slopes. Continuous contour trench is recommended in the upper reaches of watershed. Trenches that are dug on contour lines is called as counter trench, whereas the trenches constructed continuously are called as continuous contour trenches. They hold water in upper reaches leading to increased percolation and soil moisture and recharge of ground water and to reduce erosion.

1. Contour Trenching

Contour trenching is excavating trenches along a uniform level across the slope of the land in the top portion of catchment. Bunds are formed downstream along the trenches with material taken out of them.

a) In-line Contour Trenching

Where these trenches are inline then called as inline contour trenches.

b) Continuous Contour Trench (CCT)

Trenches dug on contour lines are called as contour trenches. Where these trenches are continuous then called as continuous contour trenches.

c) Staggered Contour Trench (SCT)

Where these trenches are staggered then called as staggered contour trenches.

Important to note

- Most suitable in steep & irregular sloping lands and high rainfall areas.
- In highly undulating land align trench in the direction of flow of water
- Boulders & gravels from excavation should be stalked on the lower side of the bund/spoil bank to serve as the toe of the bund.

- Top soil should be kept towards the trench as it can be used for refilling if necessary.
- Trenching is preferably carried out during winter and spring so that sowing and planting can be done during the first monsoon.

Protection of trench area from animal and human interference is a must till it is fully covered by vegetation until achievement of the desired results.

2. **Water Absorption Trench (WAT)**

A WAT is nothing but a CCT of larger dimension excavated along the contour line.

Purpose

- Reducing the runoff velocity.
- Checking soil loss.
- Storing excess rain water and recharge ground water
- Providing protection to the lower treated area from heavy rain.

C. Terracing

It consists of construction of step like fields along contours by half cutting and half filling. Original slope is converted into level fields.

1. Bench terrace

The original bench terrace system consists of a series of flat shelf like areas that converts a steep slope of 20 to 30 percent to a series of level or nearly level benches. They are costly to construct. It consists of an earthen embankment and a very broad nearly flat channel that resembles a level bench.

2. Stone Terracing

Stone terracing, also known as stone wall terraces are small embankment constructed with stones across the hill slopes. These can be adopted in any slope where stones are available in plenty at the spot.

D. Stone Lining

Description: Stone lining along the contour are popular technology in dry stony areas. Stones are placed along contour lines to serve as a barrier to surface runoff.

Purpose: Since the runoff water can pass through the stone lines slowly the water gets filtered and spread over the field. Thus enhancing water infiltration and reduces soil erosion.

Session -3

Different types of Gully Control Measures

A. Loose Boulder Structure (LBS)

These are the structures made up of loose stones and boulders in upper reach gullies.

Purpose

It reduces velocity of runoff water and traps silt and soil which promotes vegetation in the upstream side.

Location

Gully size of 1.2 to 1.5 m. depth with contributory runoff area less than 2.00 ha and areas where plenty of stone and boulders are available are suitable for construction of LBS. The specific requirements are:

- ✓ Constructed in series on a drainage line.
- ✓ Independent catchment of LBS should not be more than 1 ha.
- ✓ Should not be constructed where bed slope is more than 20%.
- ✓ Locate the structure where the upstream slope is flatter to store more water and more recharge
- ✓ Height of gully = max depth of flow in stream + design height of structure in central portion of gully.

B. **Diversion Drains**

Diversion drains are constructed on the top of the arable area to intercept the uncontrolled flow of runoff water from the non-arable area and to safely divert the excess rain water to the natural/improvised water courses.

Purpose

The purpose is to divert the water flowing down from the upper reaches towards the natural water course, thus preventing from eroding of cultivable lands. It also effectively protects bottomland from hillside runoff and diverts water from uncontrolled areas

C. Gully Plugging

Gully plugs (also called check dams) protect the gully beds by reducing the velocity of the flow, redistributing it, increasing its infiltration, encouraging silting and improving the soil moisture regime for establishing grasses and other vegetative cover.

Purpose

To check further widening and deepening of these gullies and to arrest soil erosion, collect silt and level the fields.

I) Temporary Structure

As far as possible such structures should have low heights, proper provision for dissipating kinetic energy, and be spaced closely enough.

Such structures may usefully be combined with vegetative measures to help stabilization. Various types of gully plugs or temporary structures are made of locally available materials like hedges or sod checks, woven wire, earth, sand bags, loose rock dams, and others.

II) Permanent structure

Permanent masonry structures are very costly structures and, therefore, justifiable only in case of extreme erosion. Drop spillways, chute spillways, and drop inlet spillways are the basic permanent structures.

1. Surplus weirs

Outlets are provided for each bund at suitable locations mostly in depression points for safe disposal of excess water from one field to other. For design of each outlet, the cumulative catchment contributing runoff is calculated. The standard size of length of clear overfall stone weir for different catchment area is mentioned in the table.

2. Channel weir

A channel weir is provided at one end of the bund to prevent the nose of the bund from getting breached and the fill of the channel weir is kept at 0.30m above the contour level of the bund. It also comprises a stone wall underground with one end of the bund pitched. Stone works for these walls may be dry rubble.

3. Cut outlet

It is a channel weir and is cut as an ordinary channel about 1.75m away from the end of the bund with its fill kept 0.03m above the contour level. It has an approach and a tail channel to give runoff water proper entry and exit from the weir. Such outlets are suitable when the soil is very hard.

4. Ramp-cum waste weir

During the period of construction of bund or other structures, it is not possible to construct weir immediately. Therefore, ramp-cum-waste weirs are constructed which are temporary in nature. It consists of an earthen bund with its top 22.5cm above the contour level and having a slope 1: 10 like a ramp both on the upstream and on the down stream side of the bund.

5. Pipe outlet

A pipe outlet comprises of a pipe discharging surplus water. The design consists of a hume pipe of required diameter with one well at the upstream side. A 15cm. diameter pipe is suitable for 4.0 ha catchment. The well consists of 0.4m diameter and 30 cm outlet. The top of the well is kept 0.30m above the contour level.

6. Gabion structure

A gabion is a rectangular shaped cage made of galvanized wire, which is filled with locally found rocks or stones. To facilitate easy transport, gabions are kept flat and are folded to desired shape at the construction site. If abundant stones are available, but their shape makes them unsuitable for loose stone construction, or if the expected water velocity is very high, gabions can be used

Purpose

Gabion structures reduce the velocity of water flowing through the drainage line. These structures are built to cushion the impact of water, preventing it from eroding the banks. On high slopes surrounding roads or railway lines, such structures are built along contour lines to prevent landslides.

Location

The minimum independent catchment area for a gabion structure is 5 ha. For a catchment area smaller than this even a loose boulder check may suffice. On stream embankments, these should be located in stretches prone to severe erosion. The length of the embankment to be strengthened has to be determined. Along this length the rectangular boxes have to be placed as a straight wall with a vertical face.

An important advantage of a gabion structure is its flexibility; it will shape itself according to the stream bed even when this changes due to erosion, without loosing its stability.

7. Masonry drop structure

The drop structure is one of the most commonly used gully control structures. It is mainly used to act as a control point along the gully bed. But at times, the drop structure is also used at the gully head.

Water enters the drop structure through the weir or stream, falls on the apron and then leaves the structure. Sedimentation gradually occurs on the upstream side. The apron, longitudinal and end sills help in the energy dissipation of the falling water.

Functions

- ✓ To control gradient in either natural or constructed channel.
- ✓ To control tail water at the outlet of a spillway or conduit.
- ✓ To serve as reservoir spillway where the total drop is low.
- ✓ To serve as inlet/ outlet structure of tile drainage system.

8. Chute Spillway

A chute spillway is an open channel with a steep slope, in which flow is carried at supercritical velocities. It usually consists of an inlet, vertical curve section, steep-sloped channel and outlet. Flow passes through the inlet and down the paved channel to the floor of the outlet.

9. Drop Inlet Spillway

A drop inlet spillway is a closed conduit generally designed to carry water under pressure from above an embankment to a lower elevation. An earthen embankment is required to direct the discharge through the spillway. Thus, usual function of a drop inlet is to convey a portion of the runoff through or under an embankment without erosion.

Session 4

Biological Measures for Soil and Moisture Conservation

1. Contour cultivation

Contour cultivation is nothing but carrying out agricultural operations like planting, tillage and inter-cultivation very neatly on the contour. Contour cultivation reduces the velocity of overland flow and retards soil erosion. Crops like maize, sorghum, pearl millet which are normally grown in rows are ideally suited for contour cultivation. When contour cropping is adopted, the downward movement of soil and erosion by rains is reduced considerably

2. **Strip cropping**

Strip cropping is the growing of a soil-exposing and erosion-permitting crop in strips of suitable widths across the slopes on contour, alternating with strip of soil-protecting and erosion-resisting crop. Strip cropping reduces soil erosion by reducing the effective slope length and facilitating absorption of rain water by the soil in undulating terrain .The dense foliage of the erosion resistant crop prevents the rain from beating the soil surface directly. The alternate strip consists of close growing erosion resisting crop (close growing crops such as moong, urad, moth bean, groundnut, grasses) to erosion permitting crops like (row crops such as maize, jowar, bajra, cotton, etc). Purpose is to achieve the best result, strip cropping is to be done in combination with other farming practices, like good crop rotation, contour cultivation etc. There are four types of strip cropping systems. They are: (1) contour strip cropping, (2) field strip cropping, (3) buffer strip cropping and (4) wind strip cropping.

Location

This method is useful on regular slopes and with the soil of high infiltration rates.

3. Retention Ditches

Retention ditches are large ditches, designed to catch and retain all incoming runoff and hold it until it infiltrates into the ground. They are sometimes also called infiltration ditches. In semi-arid areas retention ditches are commonly used for trapping rainwater and for growing crops that have high water requirements, such as bananas. These crops can be planted in the ditch and thereby get increased supply of moisture

Location

They should be constructed on flat or gentle sloping land and soils should be permeable, deep and stable. Retention ditches are not suitable on shallow soils or in areas prone to landslides.

4. Contour Farming

Contour farming means that field activities such as ploughing, furrowing and planting are carried out along contours, and not up and down the slope. The purpose is to prevent surface runoff down slope and encourage infiltration of water into the soil. Structures and plants are established along the contour lines following the configuration on the ground.

Contour farming may involve construction of soil traps, bench terraces or bunds, or the establishment of hedgerows.

Location

Contour ploughing is successful on slopes with a gradient of less than 10%. On steeper slopes contour ploughing should be combined with other measures, such as terracing or strip cropping. The fields should have an even slope, since on very irregular slopes it is too time-consuming to follow the contours when ploughing.

5. **Contour Furrows**

Contour furrows are, small earthen banks, with a furrow on the higher side which collects runoff from the catchment area between the ridges. The catchment area is left uncultivated and clear of vegetation to maximize runoff. Crops can be planted on the sides of the furrow and on the ridges. Plants with high water requirements, such as beans and peas are usually planted on the higher side of the furrow, and cereal crops such as maize and millet are usually planted on the ridges.

Location

Contour furrows are suitable for areas with annual average rainfall amounts of 350-700mm. The topography should be even to facilitate an even distribution of the water. Contour furrows are most suitable on gentle slopes of about 0.5-3%. Soils should be fairly light. On heavier clayey soils these are less effective because of the lower infiltration rate.

6. **Broad Bed and Furrows**

The Broad Bed and Furrow system has been mainly introduced by the International Crops Research Institute for the Semi-arid Tropics (ICRISAT) in India. Broad beds of 100 cm width are prepared and 50 cm furrows are provided in between two beds. Purpose is to encourage moisture storage in the soil profile to support plants through mid-season or late-season spells of drought and to provide a better drained and more easily cultivated soil in the beds. Double cropping by means of inter-cropping or sequential cropping is also possible.

Location

The BBF system is particularly suitable for the vertisols. The technique works best on deep black soils in areas with dependable rainfall averaging 750 mm or more. The broad bed and furrow system is laid within the field boundaries. The land levels taken and it is laid using either animal drawn or tractor drawn ridgers

7. **Grass Strips**

Grass strips are cheap alternatives to terracing. Grass is planted in dense strips, up to a meter wide, along the contour. Grass strips create barriers that minimize soil erosion and runoff. Silt builds up in front of the strip, and within time benches are formed.

Location

Grass strips are suitable in areas where there is a need of fodder or mulch. If farmers do not have livestock, they have little incentive to plant grasses. Grass strips are not applicable on steep slopes and in very dry areas since grasses might not withstand drought.

8. Planting Pits

Planting pits are the simplest form of water harvesting. They have proved successful especially for growing sorghum and millet in areas with minimal rainfall. The purpose is to trap runoff, increase soil moisture status and reduce erosion.

Location

Planting pits have been proven successful in areas with annual rainfall of 200-750 mm. They are particularly useful for rehabilitating barren, crusted soils and clay slopes, where infiltration is limited and tillage is difficult. The slope should be gentle (below 2%) and soils should be fairly deep.

9. Mulching

Mulching is done by covering the soil between crop rows or around trees or vegetables with cut grass, crop residues, straw or other plant material. This practice help to retain soil moisture by limiting evaporation prevents weed growth and enhances soil structure. Mulching is used in areas subject to drought and weed infestation. The mulch layer is rougher than the surface of the soil and thus inhibits runoff. The layer of plant material protects the soil from splash erosion and limits the formation of crust.

Location

Areas with limited rainfall usually respond very well to mulching. Mulching is not applicable in wet conditions. The fields should have good drainage

10. Cover Crops

Cover crops are usually creeping legumes which cover the ground surface between widely spaced perennial crops such as fruit trees and coffee, or between rows of grain crops such as maize. Often cover crops are combined with mulching. Cover crops are grown to protect the soil from erosion and to improve soil fertility. They protect the soil from splashing raindrops and too much of heat from the sun.

Location

Cover crops are suitable in dry areas, with annual rainfall of more than 500 mm. Cover crops are good alternative source of mulch, especially useful in semi-arid lands where crop residue are important animal feed.

11. Conservation Tillage

Conservation Tillage refers to the practice in which soil manipulation is reduced to a minimum. This practice preserves soil structure and, increases soil moisture availability and reduces runoff and erosion. To reduce labour and farm power requirements, costs, energy requirement and increase crop yield due to less direct impact of raindrops on bare soil and increased soil moisture status.

Location

Conservation tillage takes various forms, depending on the prevailing soil and farming conditions. When introducing conservation tillage, it is important to focus on the needs of the specific farming conditions. Each farmer’s plot has specific soil characteristics and management needs.

12. Vegetative Barrier

Vegetative barriers inhibit surface runoff, slowing and ponding water and capturing and preventing sediment from flowing downhill (figure 3.50). Vegetative barriers have potential to not only reduce erosion but can enhance vegetated filter strips in the uptake of nutrients. Vegetative barriers are narrow strips of vegetation which are created primarily to slow runoff, capture sediment and resist gully development. A vegetative barrier reduces water velocities and establishes a broad uniform vegetative surface for the uptake of nutrients.

Location

Vegetative barriers can be used to eroding sites on areas of cropland, pastureland, feedlots, mined land, gullies, and ditches. This practice should be used in conjunction with other conservation practices in a conservation management system.

13. In situ Rain Water Conservation

(i) Ploughing and planting on flat land

The shaping of small depressions created during the ploughing operation has the objective of impeding surface runoff of the rainwater so that it remains stored in the soil and so available to the crop for a longer period.

(ii) Ridging after planting

Ridging after planting is a rainwater harvesting technique that consists of ploughing and sowing the flat area followed by ridging between the crop rows and ridging up again a second and third time according to the crop, using either animal drawn or tractor operated ridgers . When crops such as maize and sorghum are well developed, it becomes difficult to use the toolbar equipped with more than a single ridger body. In such situation use of single animal one-row ridger along the row is the solution.

(iii) Tied ridges

It consists of ploughing and ridging at 0.75 m row spacing, followed by an operation to tie the ridges with small mounds along each furrow so as to impede the runoff of the rainwater. Tying the ridges is done with an implement designed for use with animal traction and should be undertaken before planting on the ridges.

The mounds are made at intervals between two and three metres by way of controlling the implement. Care is to be taken to leave them at a height that is less than that of the main ridge to be used for planting (Figure 54). For this hoeing or weeding is done by using a ridger between the rows and making a second pass with a hand hoe between the plants.

(iv) Partial ploughing

In situ capture of rainwater through partial ploughing consists of two successive passes with a reversible animal-drawn plough, leaving a distance of 0.60 m from each second furrows. In this manner, the work time is reduced by half due to the ploughing being accomplished in strips. The unploughed land between the strips is used for harvesting the rainwater, leading it to the seed zone. Using a punch planter sowing is done in the second furrow with a punch planter into the second furrow left by the plough in each strip.

14. Stabilising stream bank by vegetation

The purpose of this is to prevent nala banks from collapsing and to maintain natural course so as to avoid the water from damaging the adjoining lands. Where the soil is more prone to collapse or where the nala bunds and changes direction and makes the bank vulnerable to damage.

15. Brush mattresses and wattling

Wattles are long bundles of plant stems, straw, or coir that are bound using twine and are anchored in shallow trenches with wooden stakes. Stakes are then partially driven into the bank on approximately three-foot centers in areas that are to be covered by the brush mattress. The brush mattress, consisting of willow branches or other appropriate woody brush, is then placed over the staked area. Finally, cross branches are placed over the mattress and are tied to the stakes using twine.