UNIT 4 NON-ARABLE LANDS

Structure

4.0 Objectives
4.1 Introduction
4.2 Slope Stabilization Measures
  4.2.1 Diversion Drain
  4.2.2 Contour Trenching
  4.2.3 Crib Structures
  4.2.4 Contour Wattling
  4.2.5 Retaining Walls
4.3 Drainage Line Treatment
  4.3.1 Temporary Structures
  4.3.2 Permanent Structures
4.4 Vegetative Measures for Wind Erosion Control
  4.4.1 Shelterbelts
  4.4.2 Plantations
4.5 Let Us Sum Up
4.6 Keywords
4.7 Suggested Reading
4.8 Model Answers to Check Your Progress

4.0 OBJECTIVES

After going through this unit, you should be able to:

- acquaint with the slope stabilization measures for erosion control in non-arable lands;
- describe drainage line treatment for erosion control in non-arable lands; and
- explain the vegetative measures for wind erosion control.

4.1 INTRODUCTION

In the previous unit, various biological and engineering measures were explained for soil and water conservation on arable lands.

Non-arable lands are those lands which are not suitable for growing agricultural crops due to natural limitations like slope steepness, erosion hazards, stoniness, rockiness, shallow soils, wetness, flooding, extremes of climate or manmade activities such as road construction and mining. Such lands cover an area of about 107 m ha in India out of its total geographical area 328 m ha. These lands contribute a considerable amount of runoff and soil erosion and consequently lead to severe degradation problems. Formations of gullies, landslides/slips, stream bank erosion etc. are some of the erosion hazards observed on such lands. Slope stabilization measures and drainage...
line treatment are the main conservation measures for erosion control on non-arable lands.

In the next unit, concept and importance of water harvesting systems including rooftop water harvesting and traditional water harvesting systems will be discussed. Water harvesting structures and their design and concept, importance and methods of groundwater recharge will also be dealt with.

## 4.2 SLOPE STABILIZATION MEASURES

### 4.2.1 Diversion Drain

A drain transports concentrated runoff down the slope by diverting it to a stabilized outlet, thereby reducing erosion over the disturbed slope. It is provided on the top of an arable land to intercept the uncontrolled flow of runoff water from the upper catchment area and conduct it safely into a natural or protected watercourse. It performs the following functions:

- Conveys excess runoff water safely away from an unstable area.
- Conveys the runoff safely into a natural waterway or grassed watercourse.
- Reduces the length of slope and in turn the concentration of runoff.
- Diverts the water away from the active gullies, land slides and mine spoil areas.
- Safeguards areas located at the bottom of slopes by diverting excess runoff coming from the up-hills.

**Advantages**

- Protects the area from soil erosion by fast flowing runoff.
- Collects water into the farm ponds or other storage structures for runoff recycling.
- Easy construction and materials reusable.

**Points to remember**

- Bed slope (grade) of the drain should be non-erosive and non-silting;
- Gradient of diversion drain should preferably be kept within 0.5 %; and
- Diversion drain should be built when the watershed area is under grass cover.

### 4.2.2 Contour Trenching

Contour trenching implies excavating a trench along the contour. The excavated soil is heaped on downstream side of the trench in the form of a bund. It is adopted in semi-arid or arid regions with high rainfall intensities and relatively higher soil permeability. It is also practiced for development of orchards on sloping lands and denuded slopes where revegetation is planned. Contour trenches are also used both on hill slopes and barren waste lands for soil and moisture conservation as well as for revegetation purposes.
It performs the following functions:

- Promotes absorption and storage of water in the soil profile to sustain vegetative growth.
- Moderates flash floods and improves groundwater recharge.
- Controls erosion on slopes where plant cover has deteriorated and re-vegetation is required.

**Types of trenches**

Contour trenches are broadly classified into two groups.

(i) **Continuous Contour Trenches (CCT)**

These trenches 10 to 20 m long across the slope have no break in trench length. The cross-section of the trench generally varies from 30 cm x 30 cm to 45 cm x 45 cm. Trenches are constructed for moisture conservation in low rainfall areas receiving storms of mild intensities. Equalizers of 20 - 25 cm width and suitable height are placed at regular intervals to avoid concentration of flow and prevent breaching of the trenches (Fig. 4.1).

(ii) **Staggered Contour Trenches (SCT)**

In medium rainfall areas with highly dissected topography, staggered contour trenches are adopted (Fig. 4.1). The length of the trenches is kept short i.e. 2 - 3 m and the spacing between the rows from 3 - 5 m. The chances of breaches of SCTs are less as compared to CCTs.

<table>
<thead>
<tr>
<th>Continuous</th>
<th>Staggered</th>
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<tbody>
<tr>
<td><img src="image1" alt="Continuous Trench" /></td>
<td><img src="image2" alt="Staggered Trench" /></td>
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**Fig. 4.1: Layout of staggered and continuous trenches**

**4.2.3 Crib Structures**

Steep slopes (more than 40%) can be stabilized by constructing log wood crib structures filled with stone/brushwood (Fig.4.2). Crib can be made with Eucalyptus poles of 2 to 3 m in length and 8 to 12 cm in diameter. These poles are joined together with the help of 20 to 25 cm long nails. Poles are buried to a depth of 50 to 75 cm and are erected in two lines, 1 m apart line to line and pole to pole. The height of the structure is kept 1.5 to 2 m above the ground depending upon the land slope. Horizontal braces of eucalyptus poles are fitted at 45 cm centre to centre.
4.2.4 Contour Wattling

Long and steep slopes of deep gullies, landslides, roadsides and mine spoils are very unstable due to the presence of large quantities of loose friable material. Wattling is used for mechanical stabilization and revegetation of such steep slopes. It is aimed at retaining the flowing debris but headwater flows safely through the structure.

It is a technique of breaking length of slope into shorter portions in which wattles are constructed at a vertical interval of 5 to 7 m up to 33% slope and 3 m up to 66% slope. The brushwood is woven as mats in between the standing and half-buried posts to create a semi-permeable barrier (Fig. 4.3). Wattling is not possible on very loose or powdery rock as the posts cannot stand firm. It is not effective on slopes steeper than 66%.
4.2.5 Retaining Walls

Retaining walls are needed to stabilize steep hill slopes and provide stability to river banks. Such situations are often encountered in stabilization of debris cones, foot of landslides and control of torrent banks. The forces acting on a retaining wall are: i) weight of the wall acting from its centre of gravity downwards, \( W \) and ii) horizontal earth pressure acting outwards, \( P \) (Fig. 4.4). The resultant of these two forces should be within the middle one-third of the base width for the stability of the structure. Gabion retaining walls are mostly constructed in soil conservation works as besides low cost, they are ideal for unstable foundations. A general thumb rule method for calculating the bottom width of gabion walls up to 6 m height is to take base width as two-third the height of the wall. The width is reduced in steps as the wall goes up. For example, a wall of 3 m height would require a bottom width of 2 m, reduced in steps to 1 m at the top. Where there is surcharge, a 2 m top width may be adopted. Following points need to be considered for construction of gabion retaining walls:

- Gabion retaining walls can be built safely up to a height of 3-4 m.
- As a thumb rule, the bottom width of wall is kept 2/3 rd of the height.
- When there is no surcharge, the width is reduced in steps to 1 m at the top. In case of surcharge, 2 m top width is desirable.
- Minimum bottom and top widths for low height of walls are kept as 1 m.
- Walls can be made either with the steps or the vertical side facing the surcharge (sloping side). The stepping is generally done for about 1/3rd of box width for 1 m of height.

![Fig. 4.4: A typical gabion retaining wall](image-url)
Check Your Progress 1

Note: a) Use the space below for your answers.

b) Compare your answers with those given at the end of the unit.

1) What do you mean by diversion drains and contour trenches?

2) Explain the soil conservation measures applicable in the steeply sloping areas.

3) What are retaining walls? Explain their function?

4) State the suitability and functionality of contour wattling.

4.3 DRAINAGE LINE TREATMENT

Drainage channels/gullies convey runoff and sediment in a watershed from the upper reaches to the outlet. Steep bed gradient (slope) of a channel causes high runoff velocities with associated heavy sediment flow. Hence, channel gradient needs to be reduced in order to bring the runoff velocities within permissible limits. Drainage line protection structures generally comprise of check dams.

Functions of check dams

- Help in reducing the steep gradient of the gully when constructed in series across the bed slope.
Soil and Water Conservation Measures

- Reduce the erosive velocity of flow and silt carrying capacity of the stream.
- Provide scope for percolation and groundwater recharge through reduced velocity.
- Promote vegetation growth by deposition of silt and conservation of moisture in the gully.

**Components of check dam**

- Spillway adequate to carry a selected designed flow.
- A key that anchors the structure into the bottom and sides of the gully.
- An apron that absorbs the impact of water falling from spillway to prevent undercutting of the structure.

On the basis of functions, drainage line treatment measures are classified as temporary, semi-permanent, and permanent structures.

### 4.3.1 Temporary Structures

They are constructed to support the growth of natural or planted vegetation, have low heads and control the flow in small streams. Temporary structures are constructed in the upper areas where first order (small) channels/gullies exist and where runoff concentration is less. They are used to trap fine soil and runoff to improve moisture for proper growth of vegetation in the upstream areas and prevent channel erosion in the downstream side. Their life span is short (3-5 years only) by which time the vegetation gets established.

**Advantages**

- Economically cheaper.
- Require high skilled manpower for construction.
- Constructed with locally available materials such as earth, wood stalk etc.
- Have less chances of failure than large ones due to low flows.

**Types of structures:** Following two types of temporary structures are used for gully control.

#### (i) Brushwood check dams

Brushwood check dams are constructed in small gullies (1.2 to 2.1 m deep) where wooden posts are abundantly available. They can be categorised as single row- post check dam and double row- post check dam. Wooden posts of about 10-15 cm diameter and 0.6-0.9 m spacing are driven in a single row into the bed and banks of the gully to a depth of about 0.75 - 0.9 m below the ground surface (Fig. 4.5). Two rows of wooden posts are used in case of double row- post brush dam. Posts of self sprouting species such as willow are preferred for this purpose. A 15 cm thick layer of litter is placed on the floor of the gully between the posts extending upstream to the proposed base.
of the dam and downstream end of the apron. Green branches of the trees are placed on the top of the litter lengthwise along the gully with butt ends facing upstream, the longer ones at the bottom and shorter on the top till the required height of the dam is attained. Cross poles are fixed on upstream side of the structure and brush is tied to the structure with galvanized iron wire.

![Cross-section diagram of a single row brush dam]

**Fig. 4.5: Single row brush dam**

(ii) **Loose stone/dry stone masonry check dams**

Loose stone/dry stone masonry check dams can be used in upper reaches of drainage lines where good size stones are available in adequate quantities such as in the hilly regions (Figs. 4.6 and 4.7). They have a relatively longer life and require less maintenance. These structures are effective for checking runoff velocity in steep and broad gullies.
Design specifications of stone check dams are as follows:

- **Top width**: 0.5 m
- **Side slopes**: 0.5 H: 1 V
- **Depth of foundation**: 0.3 - 0.5 m
- **Height above ground level**: 0.5 - 1.0 m
- **Keying into stable portions of banks**: 0.3 - 0.6 m
(iii) Earthen gully plug

An earthen gully plug is constructed across the gully at a suitable location using local soil. It is constructed in the upper catchment areas where there is scope for water storage, suitable soil for the embankment is available, depth of gully is less than 2 m and its bed slope is less than 10%. The site should have facility for side spillway.

Limitations

- availability of local materials has to be ensured; and
- chances of failure are more due to piping.

The general design specifications of earthen gully plugs are given below (Fig.4.8).

Top width : 0.6 m
Side slopes on u/s and d/s sides: 2 H: 1V
Maximum height : 3.0 m
Minimum height : 1.0 m
Stone-pitching : up to full supply level (FSL) of water on upstream

4.3.2 Permanent Structures

They are constructed in second and third order (main) gullies/channels for grade stabilisation. Their life ranges between 10 and 25 years (Fig.4.9). These structures are commonly used for drainage line treatment in relatively bigger streams. Cross barriers have been found more suitable in main drainage channels of the mine spoil areas for debris collection and grade stabilization. Cross barriers differ from check dams as no particular weir opening is provided and runoff can pass through almost the entire width of these structures. This reduces the risk of erosion on downstream side by runoff flowing through the structure. Runoff water is not stored against them.
Types of structures: Three basic types of permanent structures or spillways employed in gully control are:

i) Drop spillway

ii) Chute spillway

iii) Drop inlet spillway

Location of gully control structures

The suitable location for these spillways in a typical gully reach is shown in Fig. 4.10. Chute spillways are located at the gully head to convey the water safely to the gully bed. The drop spillways are built along gully bed to act as control points so that gully bed is not eroded below the level of the structure. The drop inlet spillways are used in a gully for storage of water.

Basic components of soil conservation structures

Most of the gully control structures comprise of four components, viz. embankment, spillway inlet, conduit and spillway outlet.
Embankment

The embankment of drop spillway or chute spillway usually extends from the spillway to a high ground. It checks and diverts the water to pass through the spillway. In case of an earthen dam constructed for a farm pond, the embankment impounds the water as well as directs the stream flow to pass through the spillway.

Spillway inlet

Water enters the structure through the inlet, which may be in the form of a box or weir in a wall. Vertical walls, known as cut off walls, extend down into the soil under the inlet in order to prevent water seepage under the structure. Similar walls, extending from the inlet to prevent seepage around the ends of the structure are known as head wall extensions. These walls also protect against burrowing rodents.

Conduit

The conduit receives water from the inlet and conducts it through the structure. It restricts the water to a definite channel. The conduit may be closed in the form of a box or it may be open as in a rectangular channel. Cut off walls or anti seep collars are usually constructed as accessories of the conduit to prevent seepage adjacent to it and to ensure greater stability of the structure.

Spillway outlet

The outlet discharges the water into the channel below it at a safe velocity. It provides apron for dissipation of kinetic energy of the flowing water within the confines of the structure in a manner and to a degree that will protect both the structure and the downstream channel from damage.

Wing walls

These are vertical walls or toe walls extending from the outlet back into the channel banks to protect the structure against the swirling effect of the turbulent water as it enters the channel. These walls similar in construction to cut off walls at the inlet end are built around the apron to prevent under cutting.

(i) Drop spillway

Drop spillway is a weir structure. Flow passes through the weir opening, drops to an approximately level apron or stilling basin and then passes into the downstream channel. The different components of the drop spillway are: (1) head wall and head wall extensions, (2) side walls, (3) wing walls, (4) apron, (5) longitudinal sills, (6) end sill and (7) cut off walls (Fig. 4.11). It is an efficient structure for controlling low heads, normally up to 3 metres. It performs following functions.

- Stabilizes gullies and ravines.
- Acts as erosion control structure for stabilization of land slides and mined areas.
- Protects fields, roads and hutments etc. from gullies.
- Controls grade for stabilizing channels and waterways.
Soil and Water
Conservation Measures

- Functions as reservoir spillway where the total drop is relatively low (< 3m).
- Controls irrigation water.

Advantages

- Less likelihood of serious structural damage than for other types of structures.
- Rectangular weir less likely to be clogged by debris than the openings of other structures of comparable discharge capacities.
- Relatively easy to construct.

Limitations

- Costlier than other types of structures where the required discharge capacity is less than 3 m³/sec and the total head or drop is more than 3 metres.
- Generally not used where temporary spillway storage is required to obtain a large reduction in discharge.
- Stable grade below the structure essential.

(ii) 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 (Fig. 4.12). An earthen embankment is required to direct the discharge through the spillway. Thus, a drop inlet conveys a portion of the runoff through or under an embankment without erosion. Vegetative or earthen spillways around one or both ends of the embankment should also be used in conjunction with drop inlet spillway. The riser of a drop inlet spillway may be of plain concrete,
masonry or pipe. The barrel may be of reinforced concrete, concrete or clay tile, or smooth metal pipe having watertight joints. In India, RCC pipes are generally used.

It is a very efficient structure for controlling relatively high heads usually above 3 metres and well adapted to sites where an appreciable amount of temporary storage above the inlet is needed. It may also be used in conjunction with relatively low heads as in the case of drop inlet on a road culvert in passing surface water through a spoil bank along a drainage ditch.

It performs the following functions:

- Principal spillway for farm ponds and reservoirs
- Grade stabilization
- Principal spillway for debris basins
- Flood prevention structure
- Roadway structure
- Surface water inlet for drainage or irrigation.

**Advantages**

- Requires less material than a drop spillway for the same head;
- Design discharge capacity of the structure can be considerably reduced where an appreciable amount of storage is available above the inlet; and
- Most efficient structure for flood prevention and channel grade stabilization.

**Limitations**

- Small drop inlets are susceptible to be choked by debris; and
- Limited to locations where satisfactory earthen embankments can be constructed.
(iii) Chute spillway

It is an open channel like structure in which flow is carried down the steep slope at super-critical velocities (Fig. 4.13). It usually consists of an inlet, vertical curve section, steep channel and an outlet. The major part of the drop in water surface takes place in the channel. Flow passes through the inlet down to the tapering channel and to the floor of the outlet. It is adopted for sites where construction of check dams is not possible particularly for gully heads up to 5 to 6 metres and can also be constructed in combination with check dams and other retention type structures. It performs the following functions.

- Controls the gradient in natural or artificial channels.
- Conveys runoff from upstream areas into the gully bed safely without erosion.
- Serves as a spillway for flood protection, water conservation and sediment collection structure.

![Fig. 4.13: Components of a chute spillway](image)

**Advantages**

Chute structure requires less construction material than the drop structure of the same capacity and hence more economical for high heads.

**Limitations**

- Considerable danger of undermining of the structure by the rodents.
- Seepage tends to weaken the foundation in poorly drained locations. In such locations, if the construction of chute structure is very essential, provision to control the seepage is essential.
- Does not provide for any storage of water upstream of the structure.
**Check Your Progress 2**

**Note:** a) Use the space below for your answers.

b) Compare your answers with those given at the end of the unit.

1) Differentiate between temporary and permanent gully control structures.

2) What do you mean by drainage line treatment?

3) Describe in brief the brushwood and loose stone check dams.

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### 4.4 VEGETATIVE MEASURES FOR WIND EROSION CONTROL

Temporary or permanent vegetative measures retard wind velocity near the surface and are generally the most effective means of controlling wind erosion. The temporary measures are essentially crop management practices to provide a cover to the soil. Close growing crops provide a good protection. The permanent vegetative measures consist of planted trees, shrubs and grasses in the form of farm or block forestry or shelterbelts or in combination of these in order to protect the area from wind erosion.

#### 4.4.1 Shelterbelt

A shelterbelt usually consists of shrubs and trees planted in lines across the direction of damaging winds to reduce wind erosion or frost damage to crops. Shelterbelt is installed by more than two rows of trees, usually at right angle to the direction of prevailing winds (Fig. 4.14). The rows of belt can be developed by using shrubs and trees. It is mainly intended for conservation of soil moisture and for the protection of field crops against severe wind erosion.

Considering all the parameters related to climatic conditions, topography and local habitat of vegetation of the region, site for shelterbelt is selected and
the planting programme is designed. Slowing the wind with a layered defence is the best approach, but this is more costly in both space and time. A front of shrubs followed by open crowned trees with a light under-storey of shrubs several metres deep will give the best defence. In such cases, the wind is slowed all the way through the shelterbelt and little eddying occurs on leeward side.

Fig. 4.14: Shelterbelt for controlling wind erosion

Shelterbelt is more effective for reducing the impact of wind velocity than the other practices. The trees planted in shelterbelt provide fodder, fuel and timber and also protect the orchards and crops from hot and cold winds. Besides, it moderates the local micro climatic conditions of the adjoining area. However, it affects the crop yields of the adjoining fields through shade and light effect of tree canopy, root competition and by harbouring bird population.

4.4.2 Plantations

Growing of vegetative barriers around farms, ponds and either sides of road is an age old practice to protect them from devastating winds and other calamities. Most of the trees, shrubs and grasses planted across the prevailing winds called windbreak reduce the wind velocity and its ill-effects. A windbreak usually consisting of shrubs and trees is a smaller barrier than a shelterbelt. Thus the protection provided by the windbreak is not of rectangular shape but tends to be narrowed towards the outer limit. In addition to providing protection to the soil from wind, windbreaks have other commercial values. The tree branches and leaves may be used as fodder and fuel. The hedgerows are planted such that they conform to the standards of windbreak and preferably established from native trees or shrubs of some economic value. These trees are periodically pruned to prevent shading of the field crops. Alternate blocks are made by respective field crops and trees in a strip manner perpendicular to the prevailing wind direction are categorized as block plantation. Block plantation is an effective vegetative measure to protect crops from areas affected by wind erosion. These multi-storeyed blocks possessing ground storey as grasses, middle storey as shrubs and top storey as trees act as windbreaks and protect the area from further desertification. Such a plantation facilitates nutrient recycling, suppresses weed growth, decreases runoff, and reduces soil erosion. The prunings can be used as fodder for livestock, or as green manure, or sometimes as vegetative mulches.
Check Your Progress 3

Note: a) Use the space below for your answers.
    b) Compare your answers with those given at the end of the unit.

1) What do you understand by a shelter belt?

2) What are the advantages of a block plantation?

4.5 LET US SUM UP

- Non-arable or non-agricultural lands are generally those lands which are not suitable for growing agricultural crops due to one or more of natural limitations like slope steepness, erosion hazards, stoniness, rockiness, shallow soils, wetness, flooding, extremes of climate or manmade activities such as road construction and mining.

- Formation of gullies, landslides/slips, stream bank erosion etc. generally occurs on such lands.

- Man made activities like road construction and mining on steep slopes render large areas as denuded and unfit for cultivation.

- In spite of all these limitations, such lands can be utilised for our production systems and other allied enterprises by applying appropriate technologies developed at various research organizations.

- The rainfed agriculture is not remunerative and sustainable due to inadequate and erratic rainfall distribution resulting in scarcity of water leading to very low productivity.

- The rainfed agriculture can be made viable by harvesting rainwater and introducing integrated farming systems.

4.6 KEYWORDS

Check Dams: These dams are smaller in size than the conventional dams. The check dam is constructed in the gully section to control the runoff and impound water in the upstream side for various uses.
Contour Trenching: Refers to excavating a trench along the contour.

Drainage: Removal of excess surface water either from the soil surface or from saturated profile to create favourable conditions for plant growth.

Semi-permanent Gabion Check Dams: These structures are commonly used for drainage line treatment in relatively bigger streams. Cross barriers have been found more suitable in main drainage channels of the mine spoil areas for debris collection and grade stabilization.

Spillway: It is an outlet provided in the water bodies for safe disposal of excess runoff from unforeseen events.

4.7 SUGGESTED READING


Check Your Progress 1

1) Diversion drains are made across the slope to convey excess runoff water safely away from an unstable area. They convey the runoff safely into a natural waterway or grassed watercourse by reducing the length of slope and in turn the concentration of runoff. Therefore, they are provided on the top of an arable land to intercept the uncontrolled flow of runoff water from the upper catchment area and conduct it safely into a natural or protected watercourse. Contour trenching is a measure where trenches of a particular size are excavated along a contour either in a staggered or continuous manner depending upon the purpose and prevailing conditions.

2) Following are the soil conservation measures applicable in the steeply sloping areas.
   - Diversion Drain;
   - Contour Trenching;
   - Crib Structures;
   - Contour Wattling; and
   - Retaining Walls.

3) Retaining walls are employed for stabilizing the precipitous hill slopes and provide stability to river banks. They are constructed by masonry, brick or gabion works. Among these, Gabion retaining walls are mostly preferred in soil conservation works as besides low cost, they are ideal for unstable foundations. Analysis of forces, which are acting on a retaining wall, is most important to assess the stability and functionality of the structure. The forces acting on the structure are: i) weight of the wall acting from its centre of gravity downwards and ii) horizontal earth pressure acting outwards. The resultant of these two forces should be within the middle one third of the base width to ensure stability of the structure.

4) Wattling is used for mechanical stabilization and revegetation of long, steep and unstable slopes of deep gullies, landslides, roadsides and minespoils. It is aimed at retaining the flowing debris through headwater flows safely through the structure. The brushwood is woven as mats in between the standing and half-buried posts to create a semi-permeable barrier as a wattle.

Check Your Progress 2

1) Temporary gully control structures are constructed to support the growth of natural or planted vegetation. They have low heads and control the flow in small streams by trapping fine soil and runoff to improve moisture for proper growth of vegetation in the upstream areas and preventing channel erosion in the downstream side. Temporary structures are constructed in the upper areas where first order (small) channels/gullies exist. They can be constructed with locally available materials such as earth, wood stalk etc.
Permanent gully control structures are recommended where the volume and peak rate of runoff to be handled is very large and cannot be controlled by vegetative measures and simple field structures. Besides, high degree of safety against the loss of life and property is warranted. These structures are constructed with permanent materials so that they help in stabilizing the gully and store water where necessary.

2) Steep bed gradient (slope) of a channel causes high runoff velocity with associated heavy sediment flow and results in deepening and widening of drainage system. Hence, channel gradient needs to be reduced in order to bring the runoff velocity within permissible limits by drainage line protection structures generally comprising of check dams. Check dams when constructed in series across the bed slope help in reducing the steep gradient of the gully. On the basis of functions, drainage line treatment measures are classified as temporary, semi-permanent and permanent structures.

3) Brushwood check dams are constructed in small gullies (1.2 to 2.1m deep) where wooden posts are abundantly available. They can be categorised as single row-post and double row-post check dam. Posts of self sprouting species such as willow are preferred for this purpose. Green branches of the trees are placed on the top of the litter lengthwise along the gully with butt ends facing upstream, the longer ones at the bottom and shorter on the top till the required height of the dam is attained. Cross poles are fixed on upstream side of the structure and brush is tied to the structure with galvanized iron wire.

Loose stone/dry stone masonry check dams can be used in upper reaches of drainage lines where good size stones are available in adequate quantities such as in the hilly regions. They have a relatively longer life and require less maintenance. These structures are effective for checking runoff velocity in steep and broad gullies.

Check Your Progress 3

1) Shelterbelt is installed by more than two rows of trees, usually at right angle to the direction of prevailing winds. The rows of belt can be developed by using shrubs and trees. It is mainly intended for conservation of soil moisture and for the protection of field crops against severe wind erosion. It is more effective for reducing the impact of wind velocity than the other practices. The trees planted in shelterbelt provide fodder, fuel and timber, and also protect the orchards and crops from hot and cold winds. Besides, it moderates the local micro climatic conditions of the adjoining area. However, it affects the crop yields of the adjoining fields through shade and light effects of tree canopy, root competition and by harbouring bird population.

2) Block plantation is an effective vegetative measure to protect crops in areas affected by wind erosion. These multi storeyed blocks possessing ground storey as grasses, middle storey as shrubs and top storey as trees act as windbreaks and protect the area from further desertification. Such a plantation facilitates nutrient recycling, suppresses weed growth, decreases runoff and reduces soil erosion. The pruning can be used as fodder for livestock, or as green manure, or sometimes as vegetative mulches.