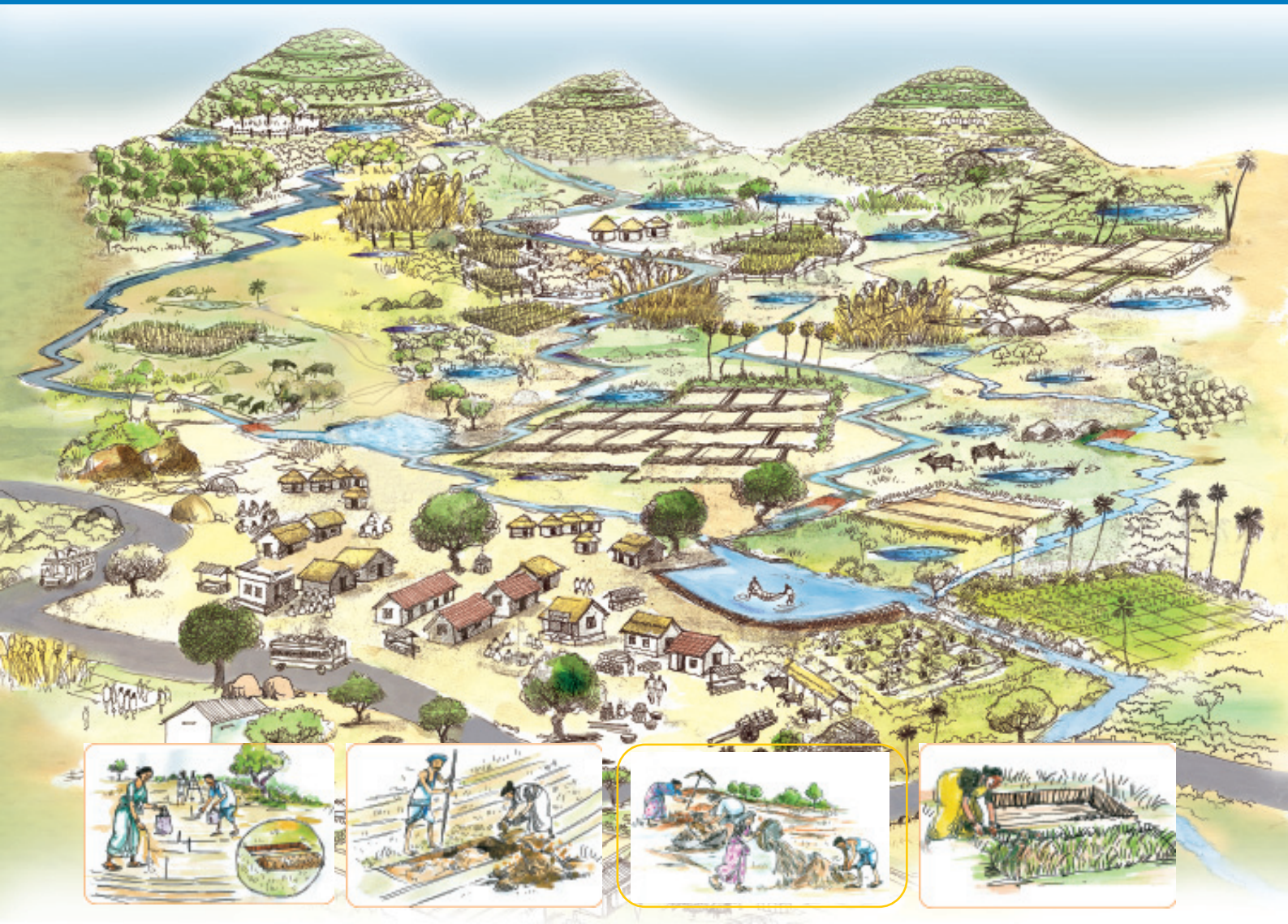
Watershed Development for Rainfed Areas under MGNREGS



A Resource Booklet for MGNREGS Functionaries:

Designed and Developed by WASSAN as part of GIZ Project
"Environmental benefits of the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA-EB)"

This booklet is a handy reference for use by cutting edge MGNREGA functionaries. It is intended to help and support them to apply the knowledge/ tools/ instruments for the creation of technically sound assets and helps in following all the steps of the process/ procedure in their proper sequence, with the recommended precautions.

Imprint details:

November, 2015

FOREWORD

I am happy that GIZ under the MORD-GIZ joint project "Environmental Benefits of MGNREGA" has simplified the SAMARTHYA and has developed four simplified technical resource booklets on themes namely, (a) Watershed Development for Rainfed Areas under MGNREGS (b) Command Area Development with MGNREGS (c) Afforestation and Tree Plantation under MGNREGS (c) Convergence of MGNREGS with Other Schemes and a Simple Mathematics Guide and Measurement.

The primary objective of these resource booklets is to demystify the technical aspects of MGNREGA works for the cutting edge functionaries like Mates. The resource booklets and the mathematics guide will go a long way for the creation of durable and sustainable assets. It will provide necessary support to the MGNREGA functionaries in following required procedures with the recommended precautions.

I am hopeful that the four simplified resource booklets and the Mathematics Guide will act as handy reference for the MGNREGA functionaries and will provide answer for all possible queries to cutting edge MGNREGA functionaries. The illustrations and sketches in the booklets will be helpful for the MGNREGA workers to understand the basics about the works under MGNREGA.

(APARAJITA SARANGI)
Joint Secretary (MGNREGA)

MESSAGE

The project on ` Environmental Benefits of MGNREGA' is a collaboration between GIZ and the Ministry of Rural Development, Government of India. It is operational in the states of Rajasthan (Bhilwara and Chittorgarh districts), Chhattisgarh (Dhamtari and Rajnandgaon districts) and Andhra Pradesh (Anantapur and Vizianagaram districts). This project is technically supporting Gram Panchayats to strengthen the mobilisation, planning processes, implementation capacities, user groups formed under MGNREGS and mechanisms for sustainable use and maintenance of assets.

To strengthen this process, we have supported the development of four booklets based on the "Samarthya" (the technical handbook for MGNREGS developed by MoRD), of which this is one. These booklets provide simplified ways of understanding and designing MGNREGS works related to natural resources management, agriculture and allied activities.

I believe that these booklets will be of immense help for the field level MGNREGA functionaries in creating durable and sustainable assets, thereby helping to mainstream environmental benefits as one of the success indicators of MGNREGA. These booklets will also be useful as resource books for the training of ground level functionaries, thus helping enhance the element of environmental benefits of MGNREGA all over the country.

I would like to express my gratitude to MORD for validating these booklets. I am hopeful that they will be disseminated widely and used across India in its various regional languages.

SABINE PREUSS (Mrs.)
Director
Natural Resource Management Programme
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

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1 Rainfed Areas and MGNREGS Works

Rainfed areas have unique set of features in terms of their layout, quality and productivity due to their type of soils, rainfall pattern and physical aspects like slope, undulation etc. Yet, these areas, entailing with different types of plants, crops, birds, animals and insects which have vast potential to produce food, fodder, timber, fuel wood etc. All of these need favourable conditions such as humus factor in the soils, moisture, water and bio mass for better sustenance and higher productivity. For integrated development of rain fed areas and drought proofing; area treatment from ridge to valley on watershed approach is the only solution. This will lead to conservation of natural resources, increasing the productivity of the land, bringing additional area under agriculture, employment generation and social upliftment of community living in the rural area.

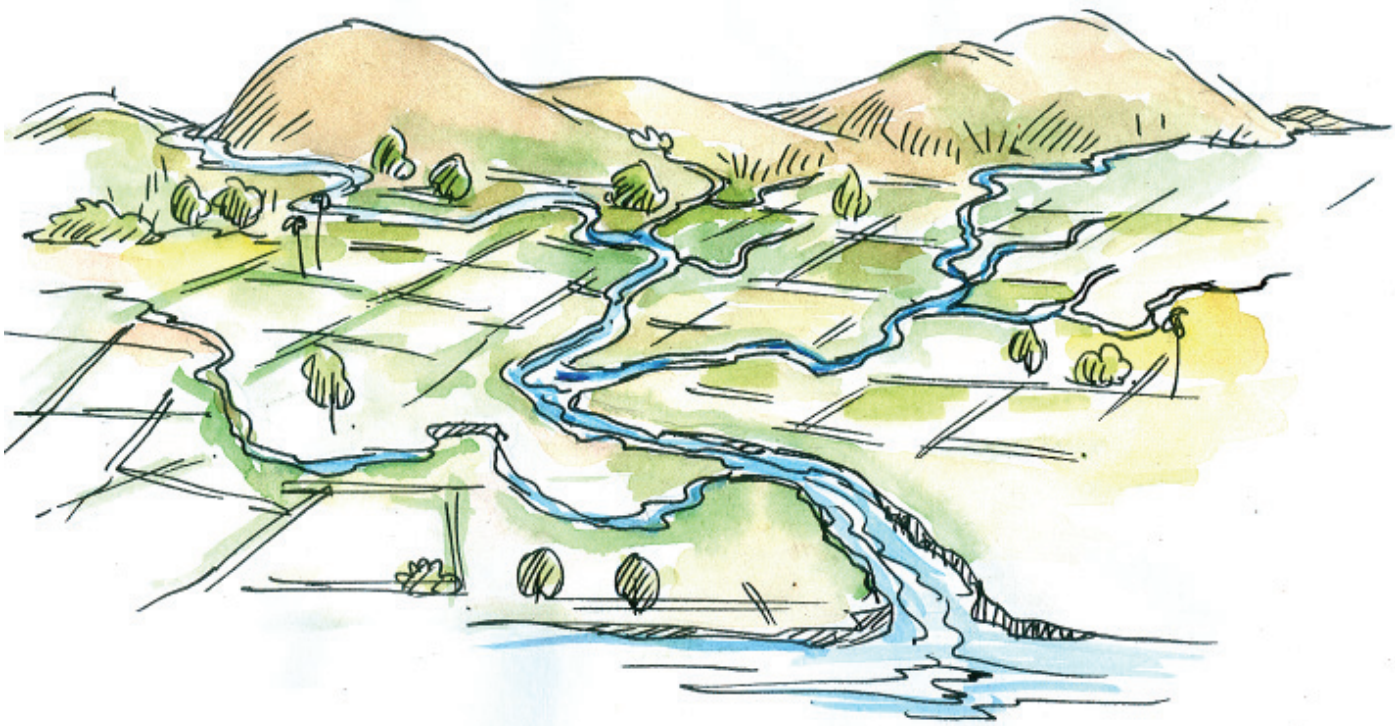
Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) is an unique scheme with two prime objectives; Ensuring minimum 100 days of wage employment to registered rural households and creation of durable assets. It provides enormous opportunities to take up diverse activities and create durable assets in rainfed areas. When such needed activities are planned on watershed basis, with ridge to valley approach, it can help in achieving the objectives of the scheme and also for optimum utilization of MGNREGA funds in rain fed areas.

What is Watershed?

Watershed is a geo-hydrological unit of an area draining to a common outlet point. The undulating land area of any region forms several such units, each of which is called watershed.

The top of a watershed from where the slopes start is called the ridge, because it is the dividing line that partitions one watershed from another. In a watershed, the slopes falling from the ridge to the beginning of the plain/arable, area called the ridge area. The channels which carry the rainwater in to the drains area called drainage lines. Gullies, streams and rivers are all drainage lines. The size of a watershed may vary from a few hectares to thousands of square kilometers.

Area before treatment of Watershed

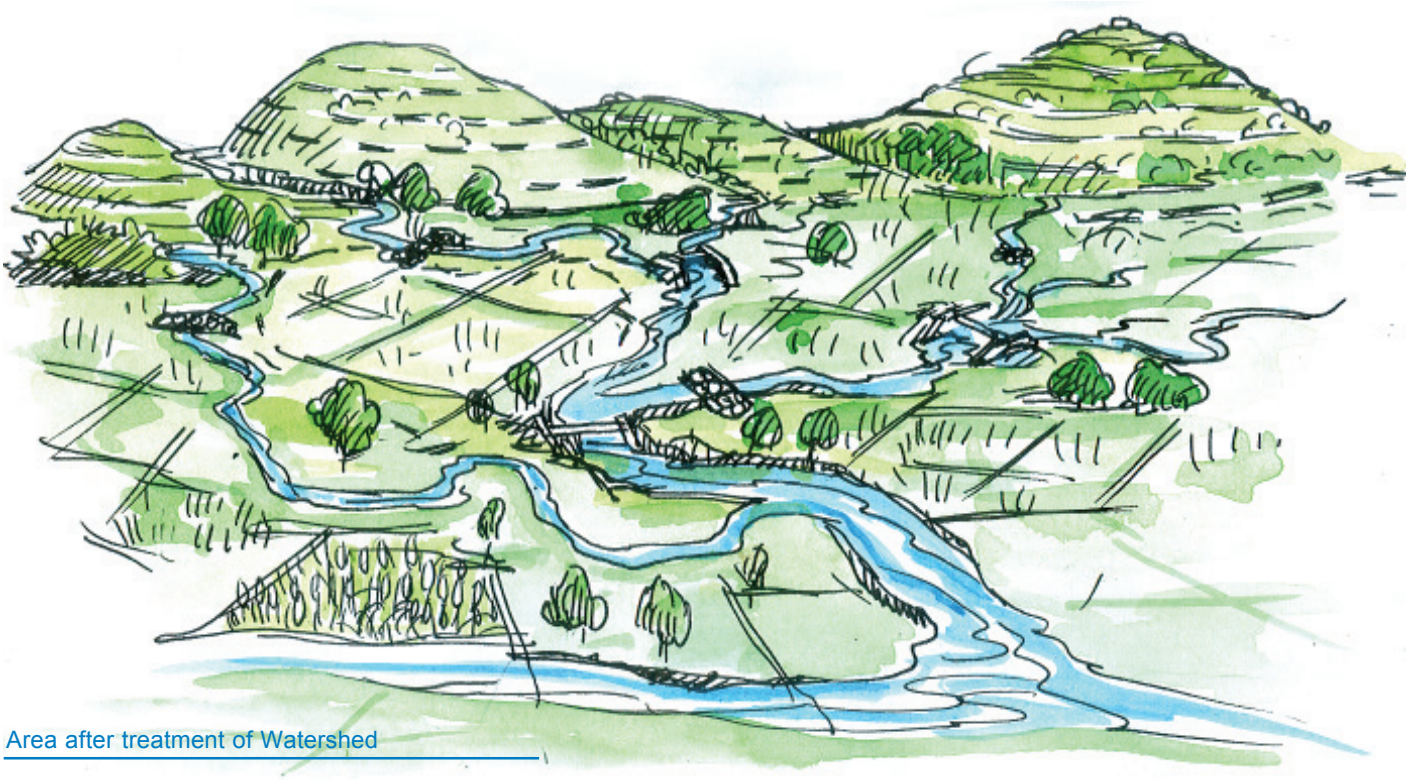


Why Watershed approach?

Most of the works permitted under Mahatma Gandhi NREGA, at Para No. 4(1) of Schedule-1, MGNREGA are such that the rain fed area can be developed to bring the area under production and to increase the productivity through watershed management works.

It has been recommended by various technical Committees and established by implementation of different Watershed Management Programmes, that for integrated development of rain fed area and drought proofing; area treatment from ridge to valley on watershed approach is the only solution. This will lead to natural resource conservation, increasing the productivity of the land, bringing additional area under agriculture, employment generation and social upliftment of community living in the rural area. Therefore, to achieve the objective of the scheme and optimum utilization of MGNREGA funds in rain fed area, the projects are to be prepared on watershed approach with ridge to valley concept.

While planning for rain fed area, the sub/ micro watershed area covering a Gram Panchayat or a village can be a unit for planning. For planning of works the revenue map of the village should be superimposed on the G.T. Sheet or Watershed Atlas of the area by enlarging or reducing the scale of the maps to bring on similar scale for superimposition. Watershed should be delineated/ marked on this superimposed map. Thereafter planning of works on watershed approach with ridge to valley concept and water budgeting should be made. Once, the planning is completed the execution of works should start from ridge to valley



Area after treatment of Watershed

Classification of watershed area for MGNREGS works

- Hilly/ high slope areas or uplands
- Waste Lands or Fallow Lands
- Agriculture fields
- Drainage lines
- Natural water bodies/ Water harvesting structures at appropriate places

How to Plan on Watershed Approach?

- Take village map covering Gram Panchayat (s) or a village (s) as an Unit
- Super impose the revenue map of the area on a Great Trignometrical (GT) map sheet or Watershed Atlas.
- Enlarge or reduce the scale of the maps to bring on similar scale for superimposing.
- Delineate/mark the watershed on this superimposed map.
- Identify the needed works through field visits and meetings with community participation on watershed approach (ridge to valley concept)
- Execute the works from ridge to valley.

Each of the above areas requires different set of development works to enhance the capacity of land and water bodies. Ground water recharge structures need to be planned to maintain water balance.

2 Permissible works for Rainfed Areas under MGNREGS on Watershed Basis

2.1. Trenches for Hilly/ High slope areas or Uplands

- Continuous Contour Trenches (CCTs)
- Staggered Contour Trenches (SgCTs)
- Water Absorption Trenches (WATs)

2.2. Land development works in Waste lands/ Permanent fallows

- Stone bund/ Stand wall terrace/ purro ricco terrace
- Diversion Drains

2.3. Works for Agriculture Fields

- Bunding: Contour bunds/ Graded Bunds
- Desilting and Silt application
- Farm pond/Dug out Pond/ Pond and Ghat

2.4. Works in Drainage lines

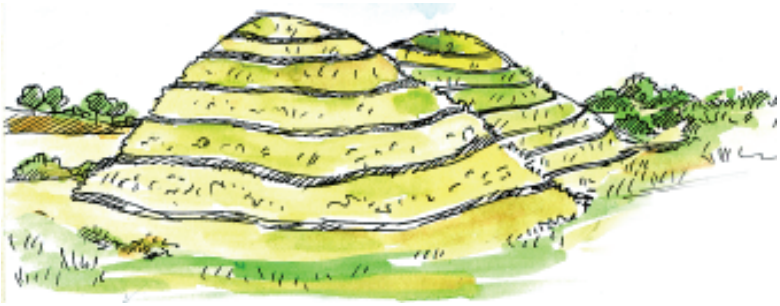
- Loose boulder check
- Gabion or Rock Fill Dam (RFD)

2.5. Water harvesting structures

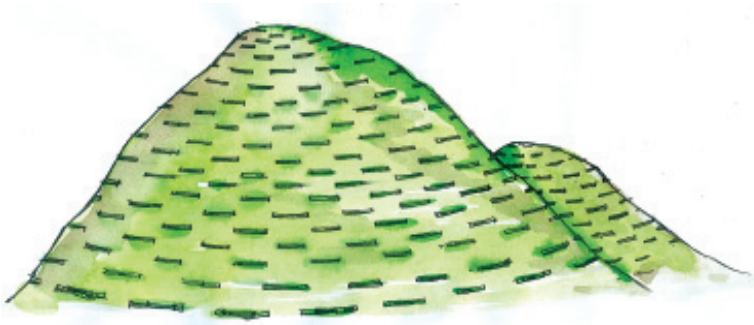
- Earthen Gully Plug
- Percolation Tank (PT)
- Check Dam/ Stop Dam

Note : Pond and Ghat work is implemented in Chhattisgarh

2.1 Trenches in Hilly/ High slope Areas or Uplands



Continuous Contour Trenches (CCT)



Straggered Contour Trenches (SgCT)

Water Absorption Trenches (WAT)

Watershed ridge areas are generally hillocks or uplands, with different slopes. These lands are with or without vegetation. Speed of rain water flow (run-off) is higher in these uplands compared to the plain and flat lands. It depends upon the slope percentage, soil type, soil depth, vegetative cover, intensity of rainfall etc. Normally soil erosion is also very high in these areas.

Soil erosion can be controlled by taking up few measures to slow down the speed of rain water, by increasing vegetative cover. Contour trenches dug across the slope will reduce the speed of the rain water flow. Plantation also helps in reducing the water speed. Thus we can control the soil erosion too.

Trenches are dug along the contour lines in the hillocks with 10% to 25% slope. The soil taken out must be deposed, on the downstream side of the trench parelally. Form the bund in shape by compacting the soil. The tenches are of three types.

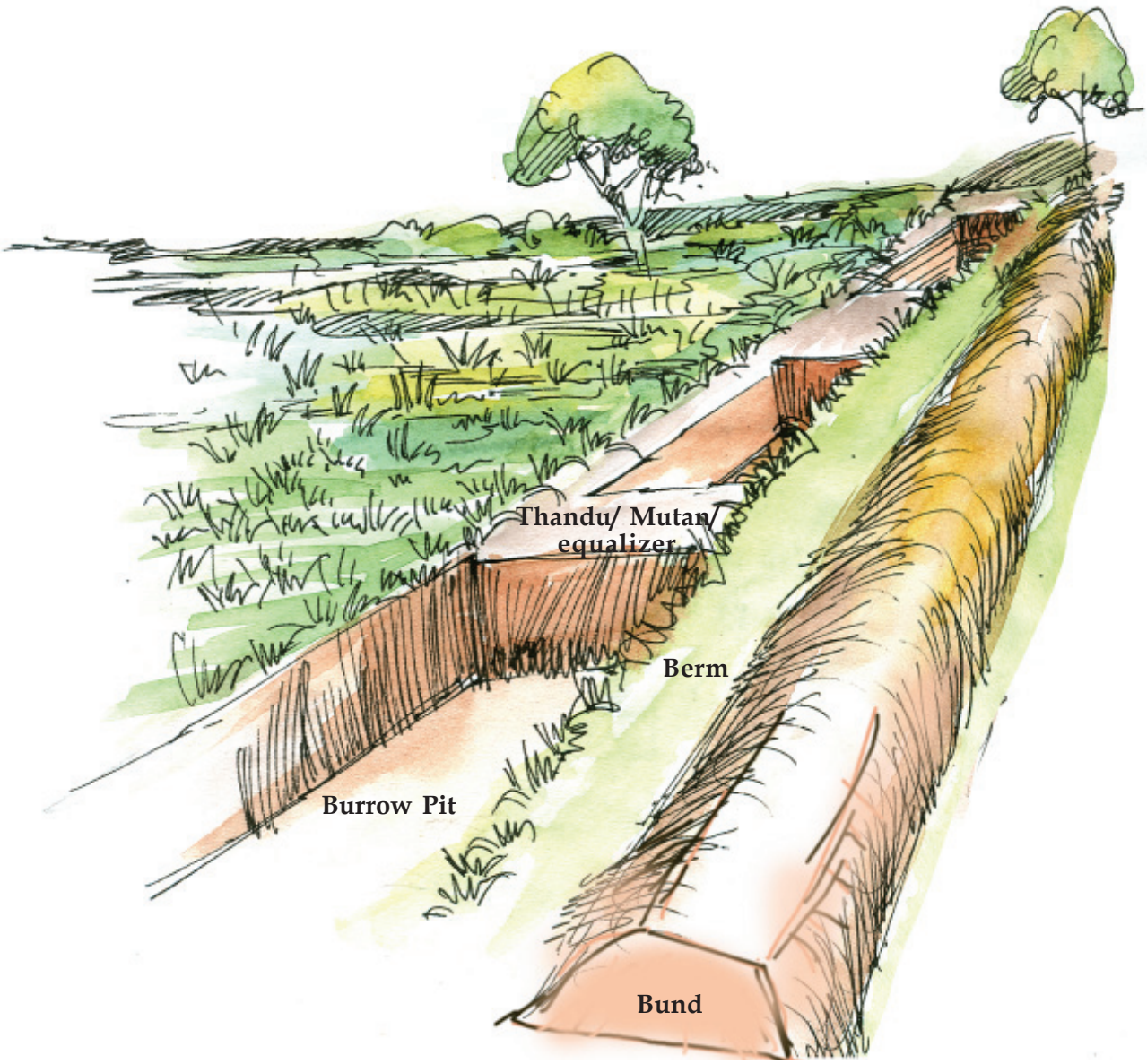
1. **Continuous Contour Trenches (CCT):** These are the trenches dug continuously without any break in length.
2. **Staggered Trenches (SgT):** These are the trenches dug in staggered manner with interspace. These trenches are directly located below one another trenche following contour lines.
3. **Water Absorption Trench (WAT):** This is also a CCTs, but generally dug at the foot of the hill. This WAT is bigger than CCT.

What is Trench?

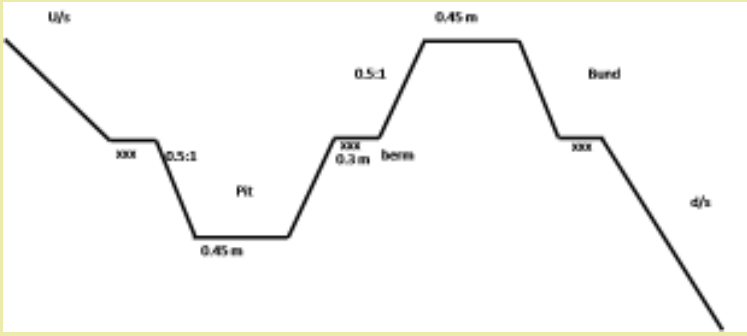
Trench is a trapezoid shaped pit dug across the slope along the contour line with specific measurements. The soil taken over from the trenches is deposited on downstream side. Flowing rain water is collected in these trenches. These trenches reduce speed of rain water and control soil erosion. The shape of the trench could be trapezoid or cuboid. The trench has following components.

Key tasks for Trenches

- Digging trench
- Depositing the soil taken out on downstream side, parallel to the trench leaving the 0.3 mtr berm
- Neat sectioning of the bund maintaining the side slope and top width



Technical Design of Trench

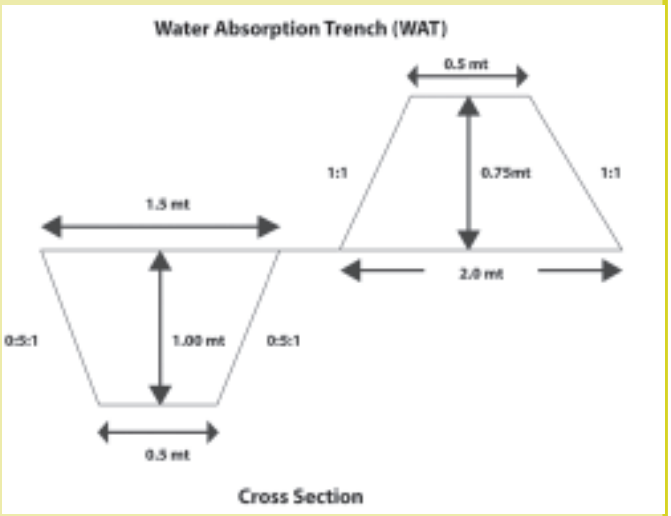


Length of CCT

Slope %	Distance between trenches (mtrs)	Total length of trenches/ Ha (mtrs)
10%	20 -15	500 to 666
10 – 15%	15 – 10	666 to 1000
15 – 20%	10 – 5	1000 to 2000

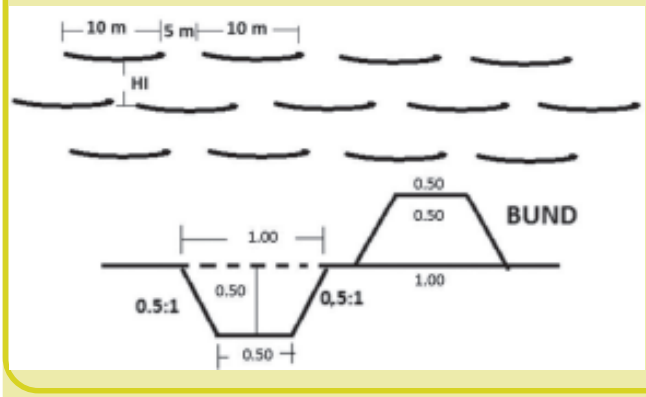
Length of the Staggered Trenches

Slope %	Distance between trenches	Total length of trenches (mtrs)	No of Trenches
10%	15	333	22
10 – 15%	12	416	35
15 – 20%	10	500	50

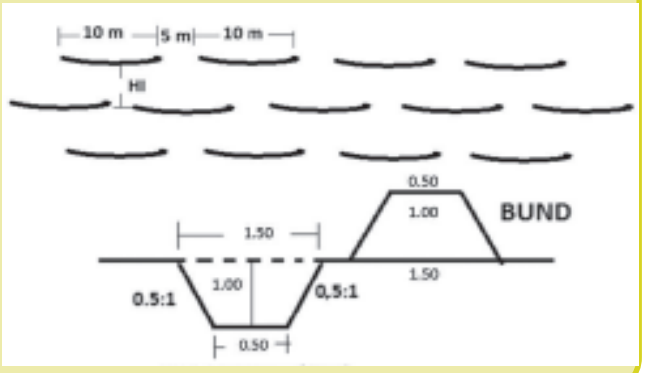


The type and specification of soil conservation measures cannot be decided without designing VI, HI, and size of trenches with respect to topography, type of soil, rainfall & catchment.

0.375 SqM Cross Section Trench



1.00 SqM Cross Section Trench



Source of designs: IWMP Technical Manual prepared by SLNA, Andhra Pradesh

Possible Benefits

Control of soil erosion, increase in vegetative cover, prevention of further formation of gullies, increased availability of bio mass, increase in humus factor in soils and soil enrichment

Steps in Execution

- Mark the contour points and draw the contour line.
- Mark the trench/digging portion, berm to leave the gap between bund and trench.
- Dig the trenches following the contour line.
- If it is continuous trench, dig the full length without any break.
- If it is staggered trench leave the gap after 5-10 mtrs, which ever is appropriate as per the design.
- Dig the trench with the given breadth and depth.
- The trench shape will be in cuboid shape, however depending upon the soil type, the side slopes can be maintained.
- Deposit the earth on downstream side parallel to the trench leaving the berm of 0.30 mtrs.
- Break clods with reverse spade or *DURMUT*. Maintain the shape, side slopes and top width using a frame/module (frame made with iron).
- Ensure that the bund is in trapezoid shape.

WAT

- Steps for digging the water absorbtion trench are similar to CCT.
- The depth and bottom width could be more than a metre and top width according to soil types and slopes.

Contour Survey

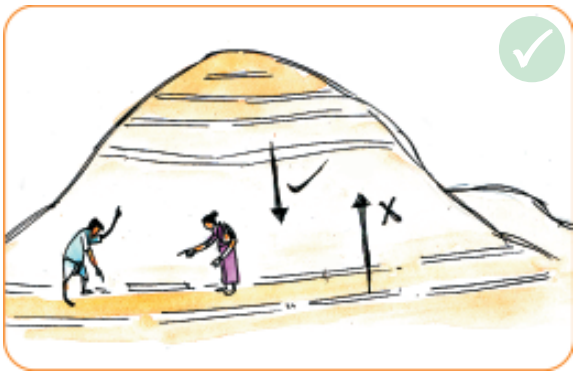
Giving Mark out/ layout

Digging Trench and keeping soil downstream side

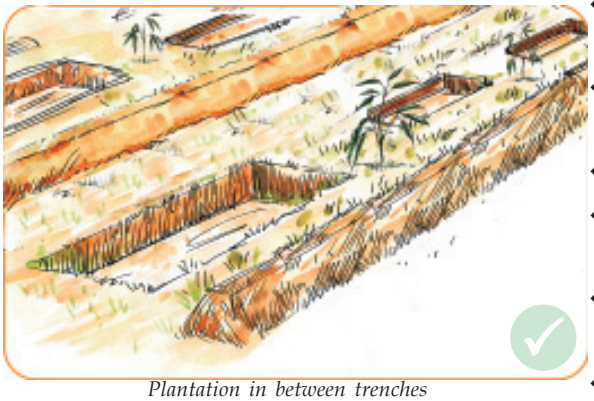
Breaking clads

For more details refer SAMARTHYA-Technical Training Manual for MGNREGA works; Pg. No.15 – 18

Dos and Don'ts



Digging trenches from ridge to valley



Plantation in between trenches

Raise local grass on the bund

Dos

- Start digging the trenches from ridge to downwards.
- Strictly follow the contours with adjustment of upto 5 mtrs upstream side but not downstream
- See that the berm is equal to the depth of the trench
- Maintain the depth of the trench evenly along the trench.
- The gap between (vertical distance) trenches depends upon the area, slope and rainfall. Hence, the distance between each trench is not same
- Provide stone outlets/ waster weirs wherever there is natural gully course or natural water ways.
- The size and length of the stone outlets depend on the gully, slope, rainfall, etc
- Raise grass on the trenches to prevent erosion
- Take up plantation in the space available between contour trenches
- Side slopes depend on type of soil. However, it will be better if at least 1:1 side slopes are maintained.
- During rainy season, locally available relevant seed can be dibbled on the bunds.

For staggered trenches

- Layout of the trenches should be zig-zag.
- Edges of the trench above should align with the centre point of the trench below.
- Maintain required gap horizontally and vertically.
- Length of staggered trenches may be 2-3 mtr and spacing between the rows may vary from 3-5 mtr.

Dont's

- Do not strip/ remove grass in the trench or on bund
- Do not dig trenches where there are natural dips.

Different Cross Sections for Trenches

Soil Depth	Bottom Width (Mtr)	Trench Depth (Mtr)	Side Slopes (HI : VI)	Top width of trench	Cross Section Area (Sqm)
Less	0.45	0.45	1:1	1.35	0.405
Medium	0.45	0.60	1:1	1.65	0.630
Medium	0.60	0.60	1:1	1.80	0.720
High	0.50	0.50	1:1	1.50	0.375
High	0.60	0.60	1:1	1.80	0.720
High	1.00	1.00	1:1	3.00	2.000

Maintenance of Trenches

- Bund is more prone to erosion than the plain surface. Therefore, raise grass on top and sides of bund to strengthens the bund and prevent erotion.
- Dibble seed of local variety plants on the bunds during rainy season
- Take up plantation in the space between the trenches to increase the impact.
- Do not strip/ remove grass in the trench or on bund
- During rainy season locally available relevant seed can be dibbled on the bunds.

FAQs

Q: How to identify and mark the contour lines?

A: By A -Frame or level Tube /Hydro marker

Q: What happens if trenches are not according to the contour lines?

A: The trenches not dug according to the contour lines may cause formation of new gullies.

Q: Why the berm is necessary?

A: To prevent the siltation of trench.

Q: Why we should maintain the depth of the trench evenly along the trench?

A: If the depth is maintained evenly, the trenches give adequate soil to farm a bund.

Q: What happens when the bund is not in trapezoid shape?

A: The life of the bund will not be longer.

Q: What to measure? Bund or Trench? And How?

A: Trench, Because earth after excavation swell and do not give correct quantity. Estimate is also prepared for earth work excavation for trenches. Hence the trench should be measured.

Q: Why not the bund is formed at upstream side?

A: Rain water flow forces the bund, bund sags down to trench and becomes flat. Finally there will be neither trench nor bund.

Q: Whether the stone outlets/ waster weirs are also part of estimates?

A: Yes

Q: Why the size of the WAT should be bigger than CCT?

A: The water flowing down from the trenches is collected finally in the WAT. WAT also acts as cattle proof trench.

Q: When the WAT is dug in between the CCTs, what measures need to be taken?

A: No special measures, but WAT also requires stone outlets at appropriate places to allow excess rain water flow safely.

Diversion Drain

It is a drain dug to divert and dispose the rain water safely without damaging agriculture fields. Generally it starts at the foot of the hill or from the place where it starts damaging the crops in the downstream.

Location

Starts from the bottom of the foothill in ridge areas and ends by joining it into natural stream course.

Technical Design

- The minimum bottom width of the drain must be 0.3 mtr.
- Upto 4 ha of catchment area, the bottom width shall be 0.3 mtr. For increase of every 2 ha thereof, the bottom width shall be increased by 0.3 mtr. Upto 6 ha, the bottom width would be 0.6 mtr, upto 8 ha - 0.90 mtr, upto 10 ha - 1.20 mtr and upto 12 ha - 1.50 mtr.
- The side slope of the diversion drain to be maintained is 1.5:1 in ordinary soils, 1:1 in hard soils and 0.5:1 in very hard soils.

Components

Drain, berm, bund

Key tasks

- Identification of area where the water flow is damaging the crops.
- Identification of area through where the water flow can be diverted
- Slope survey.
- Giving mark-out to dig the drain.
- Depositing the earth on the bank leaving the berm.

Identification of the work

- Identify the area where the rain water flow is damaging or likely to damage the arable areas.
- Identify the starting point from where the water is entering into the arable lands.
- Identify the end point where the drain or rain water flow can be joined into the natural gully/stream course.
- Identify the area through where the water flow can be diverted.
- Measure the slope.
- According to the slope, identify chainage points.
- Fix the depth of the drain at different chainage points.

Mark-out

- Clear the unwanted bushes.
- Identify bottom width portion and top width portion to dig the trench, place to deposit the earth, berm to leave.
- Fix the wooden pegs.

Steps in Execution

- Dig the bottom width portion till the depth at each chainage point.
- Then cut the earth from top width portion and maintain the slope.
- Deposit the earth leaving the berm on the specified place.
- Do sectioning to the bund duly breaking the clauds.

Dos and Don'ts

Dos

- Divert the drain with proper slope. The slope should be non-erosive, non-siltation grade.
- Oganise a meeting with the affecting and benefiting farmers to build common agreement among them for the alignment of the drain.
- The best way is to allow the diversion drain on the filled boundaries if the slope and course is as per the allowed standards and design, i.e. non-erosive and non-siltation.
- Deposit the earth on both sides of the excavated drain preferably on the downstream side.
- Leave the berm to prevent the sagging of the bund or siltation of the drain.
- Link the diversion drain to the natural gully course for safe disposal of water.
- If the slope of the diversion drain is erosive, provide stone revetment in the drainage bed.
- Grow suitable grazss on the bund to prevent erosion.

Dont's

- Do not dig the diversion drain in the cultivable fields.

Possible Outcomes

- The diversion drain collects excessive flow of rainwater.
- The diversion drain diverts rain water flow to a natural gully course and prevents soil erosion in arable lands.
- This diversion drain protects the downstream structures.
- The diversion drain discharges the water safely.
- The diversion drain protects crops from the natural gully course if it is damaging the crops in the downstream side.

Maintenance

- The flow of rain water may take further diversion and cause damage to the arable lands. Hence, keep on checking diversion drain and take corrective measures.
- Remove siltation frequently fom the drain.
- Remove the obstacles in the drain. These obstacles, if not removed may cause damage to the drain and may breach it.
- Rats, crabs and frogs may dig holes in the drain or bund. Observe these holes frequently and close them with proper impervious soils

Further Learning

Refer MGNREGS Samarthya Technical Training Manual page No: 15

FAQs

Q: Is there fixed cross section for Diversion Drain?

A: No fixed cross section. Depends upon the field conditions

Q: What is the permissible velocity in the diversion drain for different types of soils?

A: The permissible velocity for any soil should be non siltation and non erosive. If the slope and erosion is higher, grassed waterway is suitable structure*.

Q: What is the ideal slope in diversion drains

A: Usually less than 0.5%. It should be non-erosive and non-silting slope.

**For more details, refer Samarthya Technical Training Manual, Page No: 43.*

2.2 Land Development Works in Waste/ Fallow Lands

Lands in upstream with 6%-10% slope are often non arable due to several problems. Such lands are covered with bushes, stones, steep gullies; depth of soil is low and very hard. In some areas, lands with less than 6% slope are also non arable. To bring these lands into productive use, such problems should be addressed. Bush clearance and boulder removal in non-arable land are not recommended under watershed approach. In non- arable land, existing boulders conserve the soil mass and control the flow of runoff water. However, it will be better if these activities are carried out as per requirement, only for tree plantation not for crop husbandry.

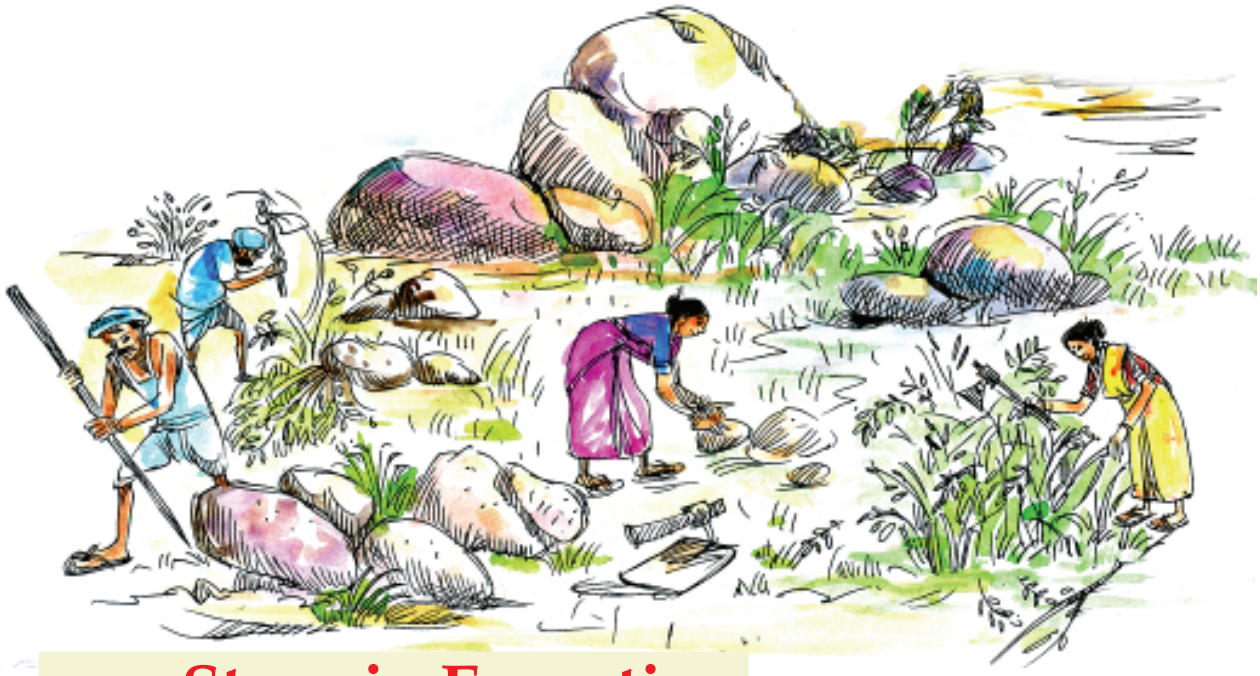
Stone bunds formed with big boulders bring waste lands into productive use.

Note: Works such as bush clearance, boulder removal, contour bunds and trenches are also discussed as part of "Afforestation and Tree plantation" and "Command area Development" as part of Samarthya Technical Training Manual. But, these works are more relevant in Water Development for Rainfed Areas.

Details of the Activities

2.2.1 Formation of stone bund

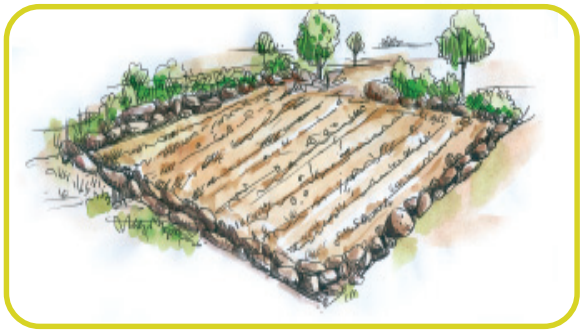
It is very difficult to till the land and sow the seed when there are big boulders in fields. Remove such boulders and construct a stone wall/ stone bund on the farm boundary or across the slope.



Steps in Execution

- Identify the boulders which can be removed manually.
- Remove the earth around the boulder
- Remove the stone using crowbars
- Transport the boulders to the farm boundaries
- Arrange the boulders in a bund shape on Contour lines/ farm boundaries

Remove the boulders using crowbars



Construct the wall with stones removed

Dos and Don'ts

Construct the wall properly

Stone walls also stop cattle

Land brought into productive use

Don't remove stones smaller than 6" size

Dos

- Use the removed stones/ boulders to make stone bunds wherever necessary
- Scrap the area upto 10 cm where bund is to be formed
- Keep the big size stones in the bottom and smaller size on the foundation
- Based on qunatum of stones, bund can be formed around the boundary, but priority must be given to contour bund

Dont's

- Do not remove small size pebbles
- Do not dump the removed stone inside field

Don't dump the stones inside the field

Possible Benefits

- Land becomes into productive use
- Increased cultivation area
- Increased yields and productivity
- Prevent cattle and wild animals
- Also act as stone outlets

2.3 Works for Agriculture fields

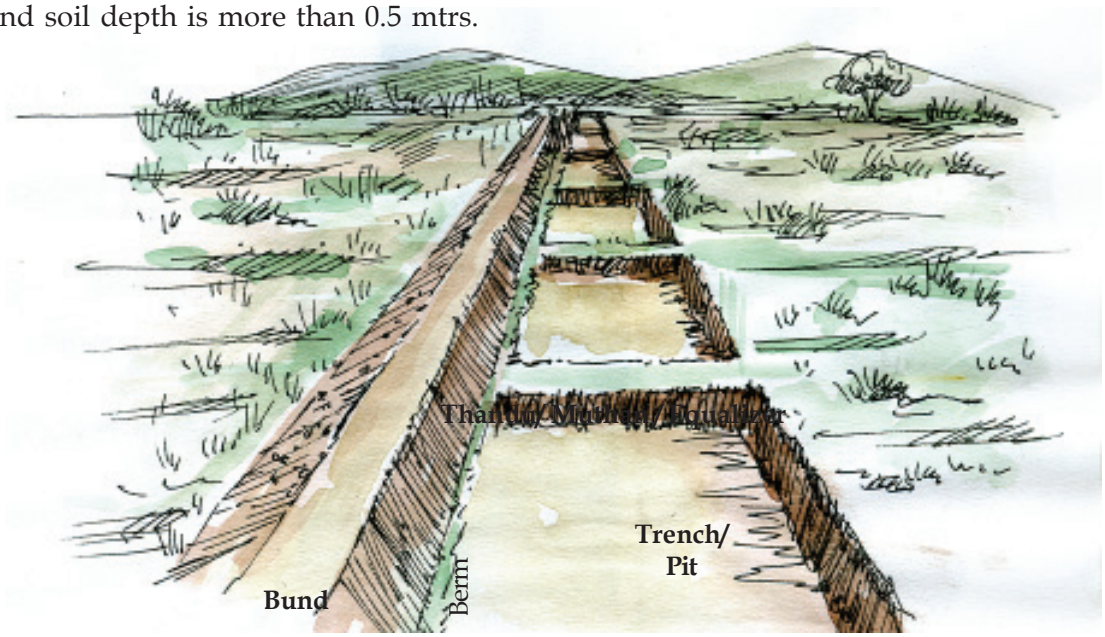
Generally agriculture takes place in lands with less than 10% slope. Productivity of these rainfed lands is less than actual potential because of many factors. Issues such as land undulation, soil erosion, low rainfall, low capacity of soil to retain the moisture etc hamper the productivity of the soil

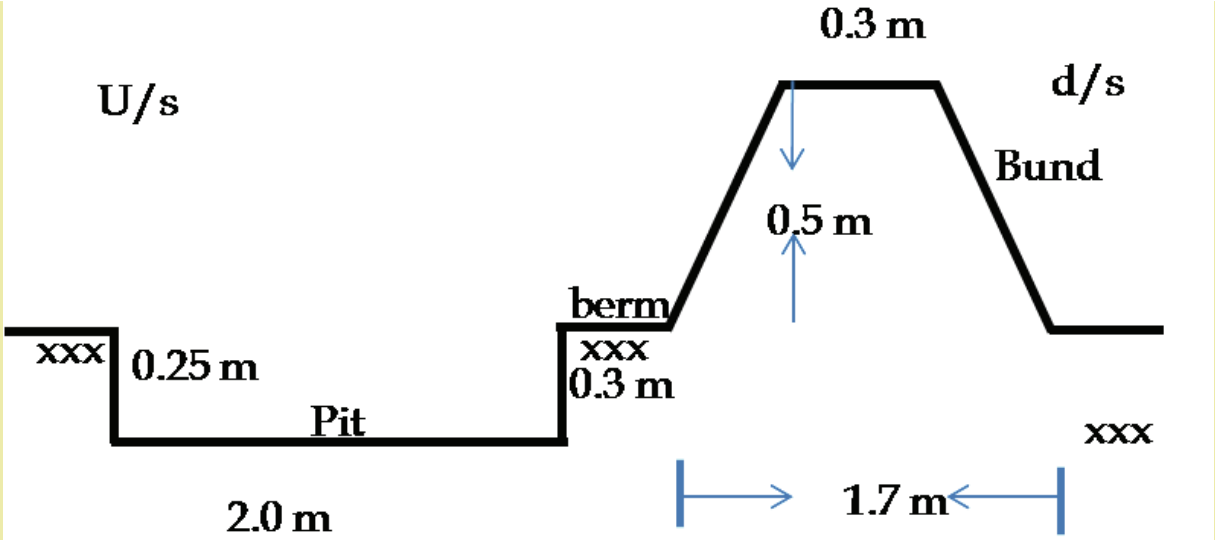
Following physical structures/interventions could bring some life into the soil and improve the productivity:

- Contour bunding/ Graded Bunding
- Silt Application
- Farm pond
- Diversion drains in water logged areas.

2.3. 1 Contour bunding

Earthen bunds are formed along the contours across the slope. Contour bunds control soil erosion in the fields. Trenches dug for these bunds hold water and increase moisture. These bunds are taken up in agriculture fields where the slope is upto 10% and soil depth is more than 0.5 mtrs.

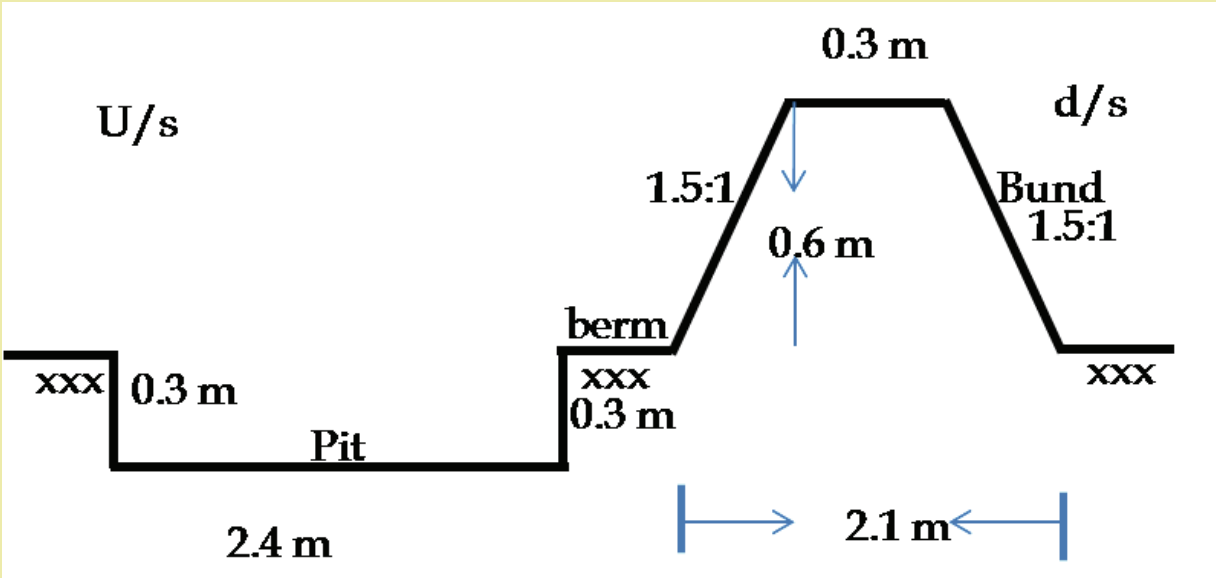




Soil Depth	Pit Depth (Mtr)	Pit width (Mtr)	Height of the bund (Mtr)	Top width of Bund (Mtr)	Bottom width of Bund (Mtr)	Side Slopes	Cross section Area (SqM)
Less	0.25	2.50	0.50	0.30	1.70	1.4 : 1	0.50
Medium	0.30	2.40	0.60	0.30	2.10	1.5 : 1	0.72

Vertical Interval (VI), Horizontal Interval (HI), size of bunds & waste weir depends upon topography, type of soil, rainfall & catchment.

For more designs, refer Page 25 in SAMARTHYA technical training manual



Key tasks

- Earth work excavation for digging the borrow pit leaving thandus
- Formation of bund by depositing the excavated earth on donwnstream side leaving the berm of atleast 0.30m
- Neat sectioning of the bund, maintaining the slopes on both sides and top width of the bund

Possible Benefits

- Reduces the speed of water flow and controls soil erosion
- Stabilizes the gullies (about to form as drainages) and makes it level over a period of time.
- Helps the crops to retain the moisture for longer duration.
- Helps in retaining the fertilizers and manures applied in the field itself.

Steps in Execution

- Mark the contour points and draw the contour line
- Mark the trench /digging portion, berm (to leave the gap between bund and trench) and bund
- Dig the burrow pit for trench following the contour line
- Strip/ scrap the trench portion and remove the grass/weed. Do not mix this with the earth for bund
- Deposit the earth on downstream side parallel to the trench leaving the berm of 0.30 mtrs
- Break clods with reverse spade or wooden stick. Maintain the shape of side slopes and top width using a frame/module (frame made with iron)
- Ensure that the bund is in trapezium shape

Contour survey

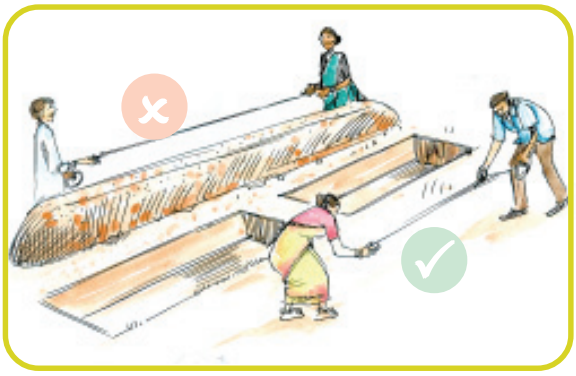
Giving mark out/ layout

Digging trench and keeping soil on downstream side

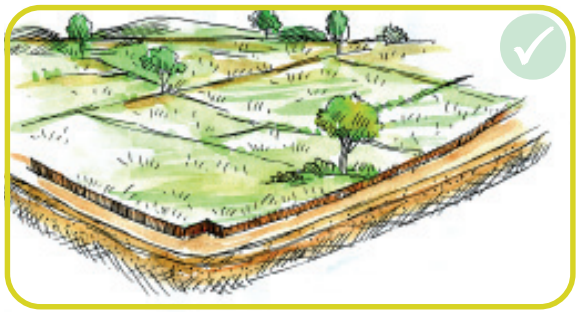
Checking the section of the bund with a template

Breaking clods

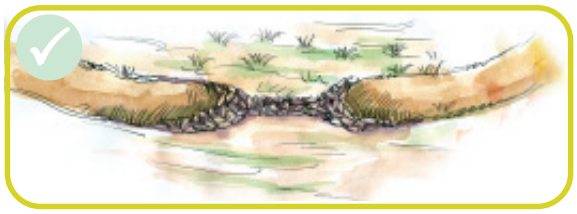
Dos and Don'ts



Measure the trench not the bund



Additional earthwork where bunds are joined



Provide waste weirs-pukka/ loose boulders

Maintenance

- Broadcast fodder seed on the bunds so that bund erosion is reduced
- Construct pakka waste weir/ outlet or repair them on regular basis as and when required.

Dos

- Separate the task of consolidation and sectioning.
- Show the place to deposit the excavated earth to form the bund at the time of marking itself so that the space for berm is left. If it is not done, bund slides down into the borrow pit. This reduces water holding capacity of the pit.
- Ensure each bund to have a proper outlet to drain out the excess water.
- Place the earth in layers with 0.23 mtrs (9 inches) thickness and tamp it by wooden *Rammer.*
- Deposit the excavated earth on the downstream, not on the upstream side.
- Take measurements of the borrow pit, not to the bund.
- Extend the bund laterally (in L shape) across the slope so that it is safe and holds water flow.
- For joining the bunds, additional earth work may be provided.
- Broadcast stylohamato or local grass seed on the bunds

Dont's

- Unless sectioning is not done, payment should not be made. This would ensure the task completion by the labour

For further details: Refer MGNREGS Samarthya booklet pages 21 to 30

FAQs

Q: What will happen if the bunds are farmed along the slope?

A: The borrow pit will form unwanted gullies

Q: What if farmers do not want to loose the area?

A: The depth of the borrow pit can be increased. However, the depth depends upon the soil type.

Q: Instead of 2.1 mtrs width of the trench, can it be reduced to 1 mtr and increase the depth?

A: Yes, this depends upon the soil type

Q: Can the earthen bund be formed around the boundary?

A: Not required in the context of soil moisture conservation. However, proper care must be taken to minimize possibility of gully formation by proper outlets.

Q: What happens if waste weir or outlets are not constructed?

A: If there is no outlet/ waste weir, the water flow may breachout the bund. This causes more damage to all the bunds down the line. If the water is stagnated for larger time it damages crop and also the soil. Hence, proper drainage facility is required. Waste weir perfoms this.

Q: Whether waste weir should be pucca?

A: Depending upon the need, it could be constructed with brick/ stone masonry, or loose boulder check. Samarthya Technical Training manual allows pucca waste weir.

Q: What are the other types of surplusing arrangements?

A: Open type surplusing arrangements such as Pipe outlet can be provided.

For more details refer SAMARTHYA-Technical Training Manual for MGNREGA works: Pg. No 22-26 & 47-48 .

2.3.2 Removing silt and applying in fields

Poor quality of soils with low fertility is one of the reasons for low productivity in rainfed areas. Situation is much worse in uplands of these areas, as quality of soils and fertility is further low. Water harvesting structures (especially irrigation tanks) in middle and lower reaches are filled with silt due to soil erosion in the upper reaches. Desiltation increases the capacity of these structures to retain more water. Application of removed silt in the fields increases soil fertility.

Key Tasks

- Digging silt from water bodies such as tanks, check dams etc.
- Transportation of silt to the fields
- Application of the silt in the fields

Possible Benefits

- Capacity of water harvesting structures is increased
- Soil becomes fertile
- Water is available to cattle even during summer in the pits excavated for desilting in the tanks.
- Crop productivity will be increased.
- Application of the silt can help in modifying the nature of the soils.

Steps in Execution

- Identify eligible farmers under MGNREGA
- Identify the water harvesting structures/irrigation tanks to remove the silt
- Remove silt from the tanks as per the measurements
- While recording the measurements, first take pre-measurements of the existing pits. Otherwise, it is very difficult to measure the actual work done. Take the pre-measurements and deduct it from final measurement to calculate the net work done.
- Ensure that the silt is spread evenly in the farmers' field.

FAQs

Q: Who are the beneficiaries?

A: SC/STs, small and marginal farmers, beneficiares of land reforms and IAY. Refer MGNREGA act.

Q: What if other farmers come forward to bear the cost of transportation?

A: Deselting can be done

Q: What happens, if farmers do not spread the silt in their fields?

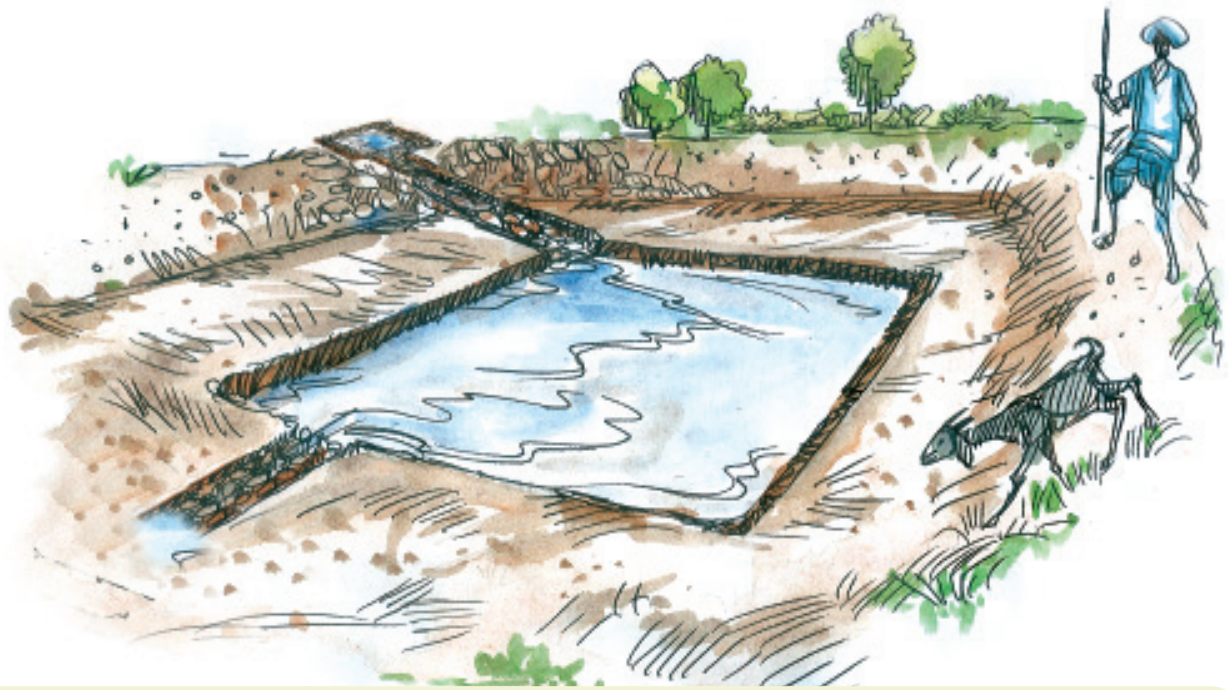
A: Dump of silt will not have any use to the field.

2.3.3 Farm Pond

A pond dug in the farmers' fields or near drainage to harvest the water to make it available for life saving/ critical/ protective irrigation.

Components in the Pond

Main pond, silt trap, inlet, outlet, key trench, revetment, toe wall, apron/pitching



Key Tasks

Earth work for

- Main pond
- Silt trap
- Inlet
- Outlet
- Key trench

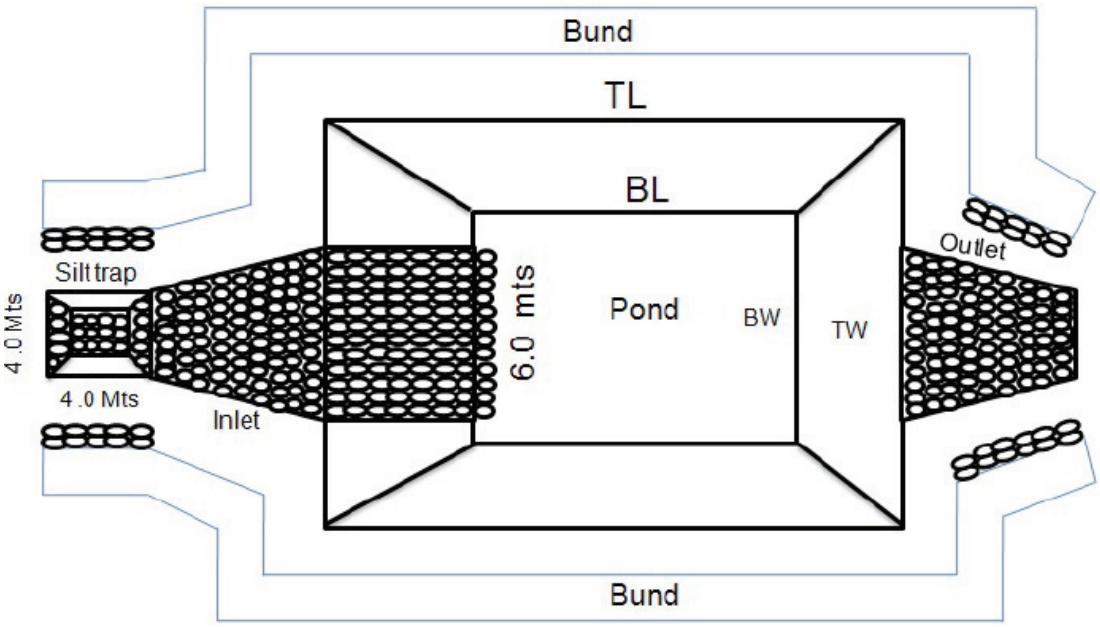
Stone work for

- Inlet (pitching/Revetment)
- Inlet slope portion
- Outlet (Pitching/Revetment)
- Outlet slope portion
- Main pond (Pitching/Revetment)
- Main pond slope portion
- Toe wall in key trench

Possible Benefits

- Harvesting rain water
- Recharge of bore wells and wells nearby
- Critical/ life saving/ supportive irrigation to horticulture and agriculture crops
- Water availability for livestock

Technical Design



Cross Section of Pond

Size of the Pond:

Depends upon the willingness of farmer, soil type and use of pond water.

Side slopes of the Pond:

In red soils 3 : 1 on upstream side, 1 : 1 on downstream side.

In Black cotton soils 3 : 1 on upstream side, 1.5 : 1 on downstream side.

Silt Trap:

Size of the silt trap : 4m x 4m

Side slopes 1 : 1 on both sides.

Inlet/Outlet:

Inlet and outlet depends upon the topography, catchment and rainfall.

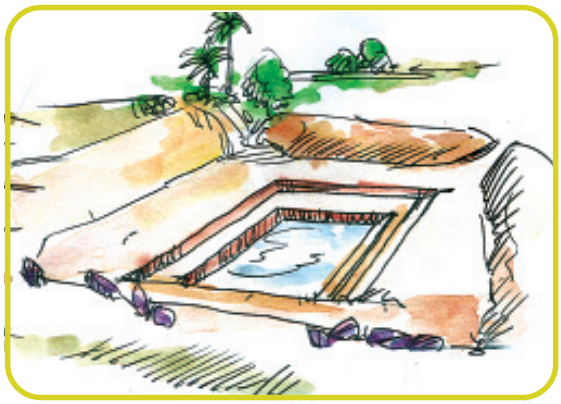
Source of the design: IWMP Technical Manual developed by SLNA, Andhra Pradesh.

Steps in Execution

Markout/ layout for farmpond

Digging farmpond and keeping the soil with proper berm

Constructing stone revitment



Another model of farm pond

- **Earth work for main pond**
  - Dig the pond as per top measurements
  - Deposit the earth leaving at least 1 mtr berm around the pond
  - Dig the pond next levels leaving the gap of 0.5 mtr at every level
- **Earth work for silt trap:** Dig the pit as per the measurements (2m * 2m * 1 m)
- **Earth work for inlet:** Dig the pit as per specifications (2m * 2m * 0.3 m)
- **Earth work for outlet:** Dig the pit as per specifications (2m * 2m * 0.3 m)
- **Earth work for key trench:** Dig the trench in the pond upstream side with 0.45m or 0.5 m width and 0.3 m depth
- **Stone work for inlet (Sides and bed):** Lay stones in the inlet
- **Stone work for outlet (Sides and bed):** Lay stones in the outlet
- **Stone work for toe wall in key trench:** Construct stone wall in the key trench
- **Stone work for Main pond slope portion:** Provide revetment to the slope portion on upstream side. Construct from bottom to upwards making the toe wall in key trench as foundation.
  - On the top of the sloped portion, fix 2 pegs in the edges and 2-3 in between.
  - Fix pegs in the bed of the pond perpendicular to the pegs above
  - Tie the pegs with ropes to maintain equal thickness of 0.225 mtr for each line of revetment
  - Construct the revetment using the key trench wall as foundation/base to it
  - As the construction progresses, shift the rope upwards parallel to the ground to maintain the shape
- **Stone work for Main pond (Pitching):** Lay stones in the bed of main pond

Dos and Don'ts

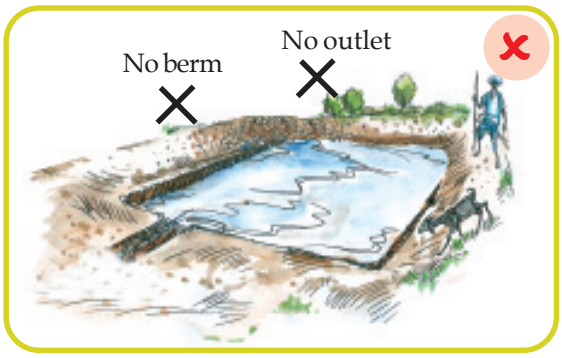
Dos

- Minimum berm of 1 mtr should be maintained between the pond and bund
- Elevation of outlet should be lower than the elevation of inlet; otherwise, water will not flow out properly. If water did not exit, it may breach the bund.
- Bund must be in trapezoid shape.
- Earth should be compacted in layers while forming the bund

Campact the earth on the bund in layers

Dont's

- Pond should not be located at higher elevation than the stream, if the source of the pond is water flowing in the drains
- The excavated earth shall not be deposited in the stream course or across the inlet or outlet portions
- Inlet should not be constructed in such a way that it should not divert the entire drainage course.



Don't construct Farm pond without proper berm, inlet and outlet

Maintenance

- Remove the silt regularly in the silt trap and pond
- Farmers should repair the revetment portions
- Clear bushes and obstacles in the inlet and outlet

FAQs

Q: How to identify best location for farm pond?

A: Where adequate space is available, where water can be stored

Q: How can we improve the productive usage of farm pond?

A: By using water for life saving irrigation, by taking up fish production

Q: How to ensure the water flow into the pond?

A: Proper inlet without any obstracles, construct pond in appropriate place, with adequate catchment.

Q: What happens if stonework/ revetment is not done?

A: The sides sag down to the pit. The water flow erodes the sides.

Q: Is it compulsory to make cement coating for the pond bed? If it is not done, what happens?

A: Not compulsory. If farmer wants to use water for irrigation, the pit bed must be impervious. Cement coating or cement lining will not allow water percolate down.

Q: Can a small farmer with a little cultivable area can afford to have a pond?

A: Depends upon the willingness of farmer. But 5% of the total area can be allotted for farm pond, by which the total productivity of farm will be increased.

2.4 Works across Drainage Lines

Gullies are formed due to undulation, continuous erosion and slopes. If these drainages are not treated properly they further get widened and deepened. Stone structures constructed across the gullies help to slow down the speed of flow of water. Silt is deposited at these structures and water flows down passing through the voids with less speed. These structures can recharge ground water, store water at certain locations of drainage line and protect the banks.

There are two types of stone structures constructed across the drainages to control soil erosion and slow down the speed of the water. The design and type of structure depends upon the zone of the drainage line viz: upper, middle and lower zone.

Loose Boulder Check/ Structure (LBC/ LBS)

Gabion/ Rock Fill Dam (RFD)

Survey and Planning

A detailed drainage line survey is needed for the planning and design of drainage line treatment measures. It is carried out in order to prepare longitudinal section (L-Section), plan and cross-section (at every 30 mt.). From the L-Section, channel gradient (or bed slope) and points of sudden drop (or fall) can be located to plan the location of treatment measures and their types. Plan of a drainage line depicts its configuration. Cross-section will provide width of the drainage line and its depth for planning and designing treatment measures.

From the L-Section, drainage line can be divided into the (a) upper, (b) middle, and (c) lower reaches depending upon the slope ranges or variations. This helps in planning different types of drainage line treatment measures.

2.4.1 Loose Boulder Check/ Structure

Loose Boulder Check is a stone structure constructed across the drainage with dry stone packing. Generally these are constructed in the beginning of gullies, with a catchment area of 2 ha to 50 ha. Loose Boulder Check is also called as loose boulder structure or stone check or boulder check.

Key Tasks

Earth work excavation for

- Foundation
- Core Wall
- Side cutting

Stone work for

- Foundation
- Main dam/Body wall
- Core Wall from bottom till the free board level

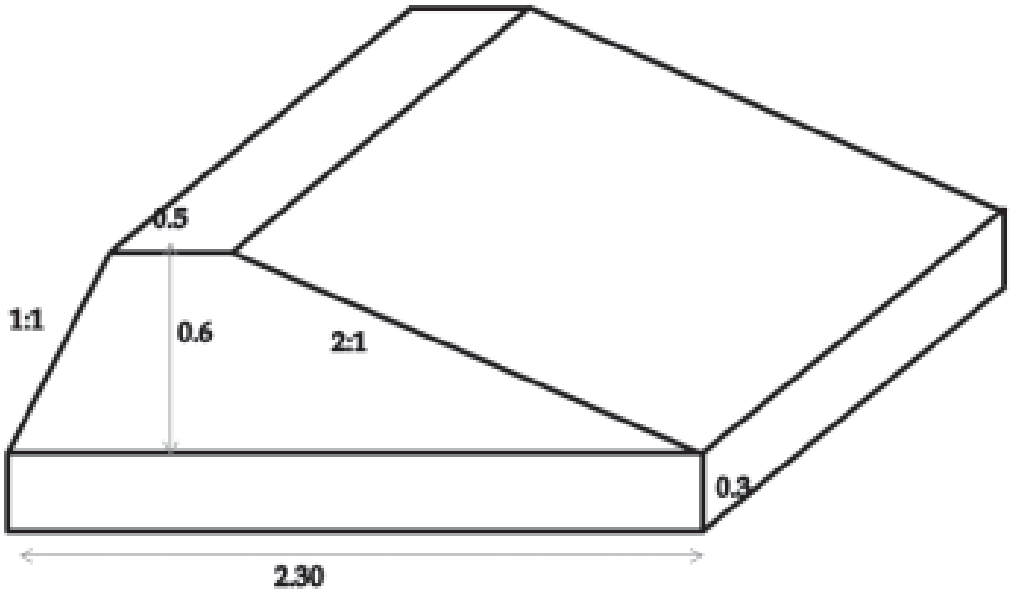
Components of LBC

Foundation, main dam

Location

Place	In the beginning of gullies and across the gully where depth is upto 1.5 mtr and width is upto 5 mtrs
Catchment	2 to 50 hectares
Gully width	2 to 6 mtrs
Gully depth	1 to 1.5 mtrs
Size of stone	Min 0.225 mtrs
Gully Order	1st Order

Technical Design



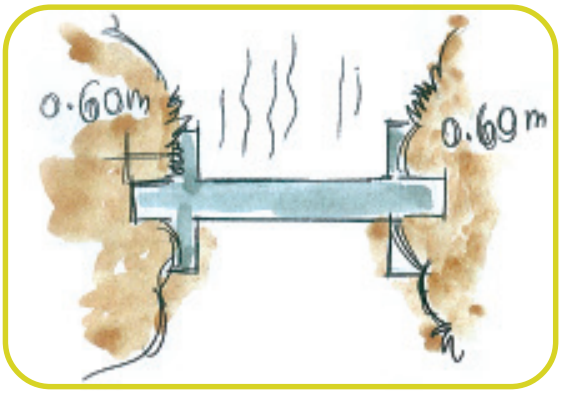
Cross Section of Loose Boulder Check (LBC)

Key points related to design

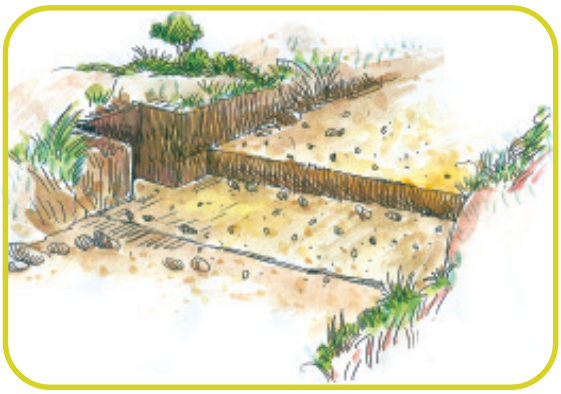
- Length of the body wall is equal to the width of the gully
- Depth of the gully is total height of the structure plus free board
- *Height of the core wall: foundation + height of the main dam + height of free board + height of the wall above free board*
- Constructing the LBC without apron is also in practice. However apron protects the wall/ dam.
- Maximum height of the LBC/ LBS is 1 mtr.
- Upstream side slope is 1 : 1
- Downstream side slope varies from 2 : 1 to 4 : 1 depending upon the volume and velocity of run off.
- The top width is 0.5 mtr, it may vary from 0.4 to 0.6 mtr depending upon the stone size.
- It is advisable to allow maximum water flow by constructing the boulder check with a dip in the middle.
- If dip is not provided, the sides of the boulder check should be embedded upto 0.5 m on both embankments

Steps in Execution

Measuring the gully width



Plan/Lay out of Gabion - Earth Work



Head Wall Extention to embankment

Earth work for

- ***Foundation of body wall:*** Cut the sides where the structure has to be constructed in the drainage. Excavate the earth for foundation as per the specification with the depth of 0.30 mtrs
- ***Core wall***: Cut the earth in the sides. The length of the core wall is equal to the top width of the main dam. The depth is upto the foundation level. Width of core wall is 0.45 mtrs.
- ***Side cutting***: Cut both sides downstream to prevent sagging.

Stone work for

- ***Foundation of body wall upto Ground Level:*** Fill the foundation dug with 0.225 mtr size boulders.
- ***Foundation of body wall above Ground Level:*** Fix the pegs and tie the ropes to maintain side slopes and top width and construct the body wall above ground level
- ***Core walls:*** Construct the core walls upto the total depth of the drain (upto top level) completely.

Loose Boulder Check (5 mtr length and 0.60 mtr height)

a. ***Length of main dam*** = *2 to 6 mtr, equal to width of the gully*

b. ***Foundation for main dam/head wall :*** *0.3 mtrs depth*

c. ***Height above the ground:*** *0.6 to 1 mtr*

d. **Side slopes:** 1:1 on u/s side and 2 : 1 to 4 : 1 on d/s side. If height is 0.60 mtr, u/s side width is 1 * 0.60 mtr = 0.60 mtr and d/s side width is 2 * 0.60 mtr = 0.90 mtr

e. **Free board**: Above the dam. Minimum 0.30 mtrs

f. **Top width :** 0.4 to 0.6 mtr, Generally 0.5 mtrs

g. **Bottom width:** (u/s side slope * height)+ (top width) + (d/s side slope * Height). (Eg: (1 * 0.60 mtrs) + (0.50 mtrs) + (2 * 0.60 mtrs) = 2.8 mtrs)

i. **Core walls/Key trench: Extension of main wall into sides, on both sides**

- **Height:** Depth of the main dam below ground + height of the dam + free board above dam. (Eg: 0.30 mtrs + 0.60 mtrs+ 0.30 mtrs = 1.20 mtrs)
- **Length:** 0.60 mtrs in to the gully sides on both sides
- **Breadth:** Extension equal to the top width of the main wall i.e. 0.45 mtr

j. The distances between each LBC depends upon the height of the boulder check and slope of the drainage. Examples are provided on 49-50 of Samarthya Technical Training Manual.

Maintenance

Repair the structures at regular intervals

Dos and Don'ts

Dos

- Provide adequate free board.
- The top of the check in the middle should have atleast 0.30 mtr
- Upstream side slope should be 1 : 1
- Downstream side slope should be atleast 2 : 1 to 4 : 1 depending upon the slope of drainage bed and volume of water flow.
- The larger stone must be placed on the outer portion of the check.
- Prefer using angular shape boulders.

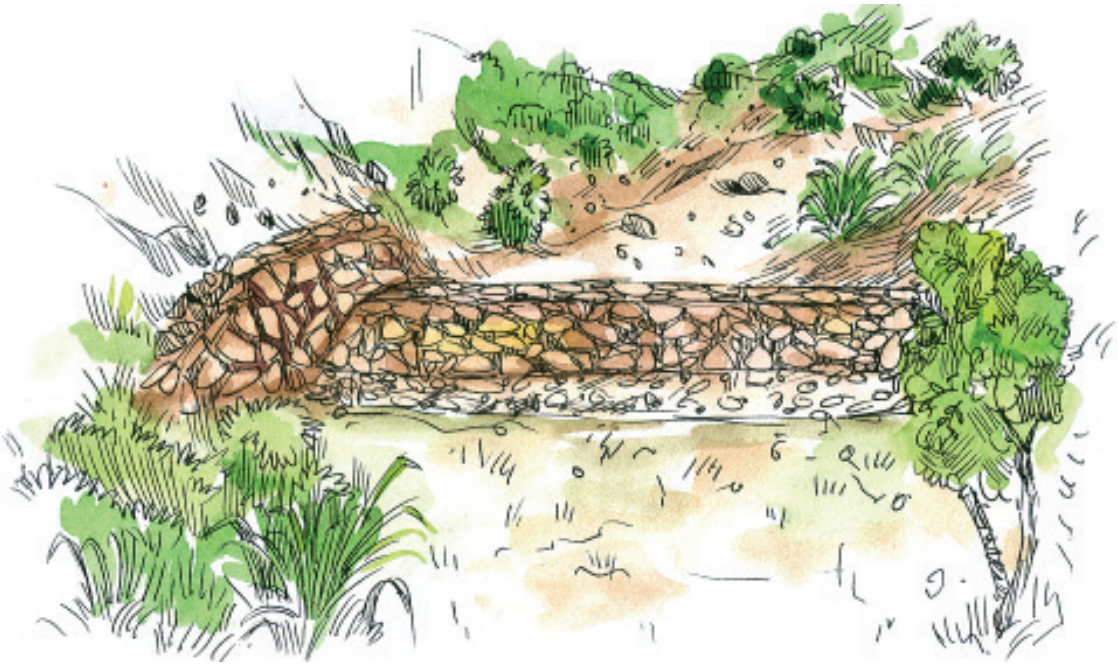
Dont's

- Do not use stones of less than 9″ size.

For more details refer SAMARTHYA-Technical Training Manual for MGNREGA works; Pg. No 47-56

2.4.2 Gabion/ Rock Fill Dam (RFD)

Gabion/ Rock Fill Dam is basically an extended structure of Loose Boulder check, with dry stone packing and wire brush. It is a stone structure constructed across the drainage, mainly in the middle reaches of active gullies, where erosion is high. It is constructed across the gully where depth is 1-2 mtrs and width is upto 6-10 mtrs. It will have a catchment of 50-500 hectares. In many parts of the country these structures are constructed without wire mesh. Such structures are called RFDs. But wired gabions are durable.



Earth work excavation for

- Foundation
- Apron
- Key trench/ Core Wall/ Head Wall Extension
- Toe wall (optional)

Stone work for

- Foundation
- Head/Body wall
- Key trench/ Head wall extn.
- Side Walls
- Apron
- Toe wall (optional)

Location

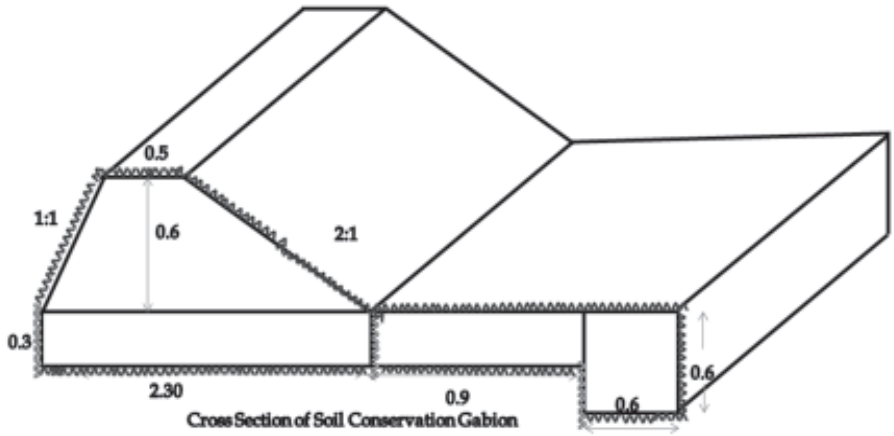
Place	Middle reaches of active gullies, where erosion is high
Catchment	50 to 500 ha
Gully width	5 to 10 mtrs
Gully depth	1.5 to 6 mtrs
Size of stone	Min 0.225 mtrs
Gully Order	1st and 2nd Order

Components

Foundation, main dam, apron, Key trench/ Core Wall, toe wall/Retaining wall

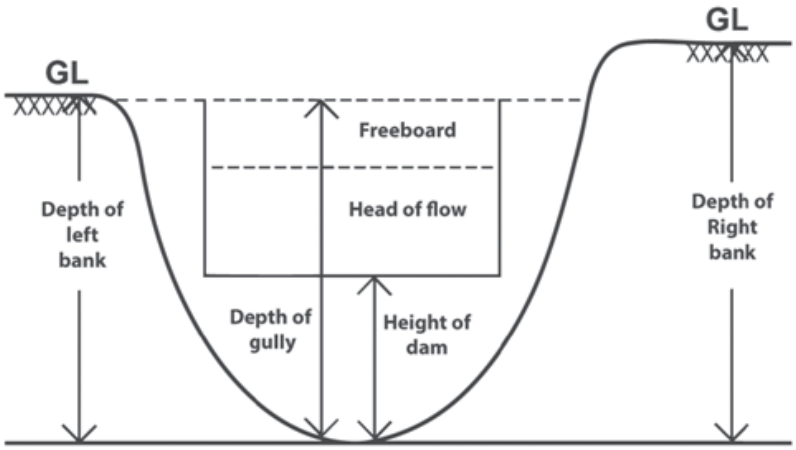
Technical Design

Execution of Gabion/RFD is similar to Loose Boulder Check. It has additional tasks.



Cross Section of Soil Conservation Gabion

Hydraulic Features identification in gully



Height of the structure HS=Depth of gully - (Head of flow + Free board)

Possible Benefits

- Slows down the speed of the water.
- Reduces soil erosion.
- Prevents further widening and deepening of gully.
- Traps silt and reduces the siltation in water harvesting structures in lower reaches.
- Reduces pressure on water harvesting structures down the line
- Wire mesh keeps the bond of stones and solidifies.

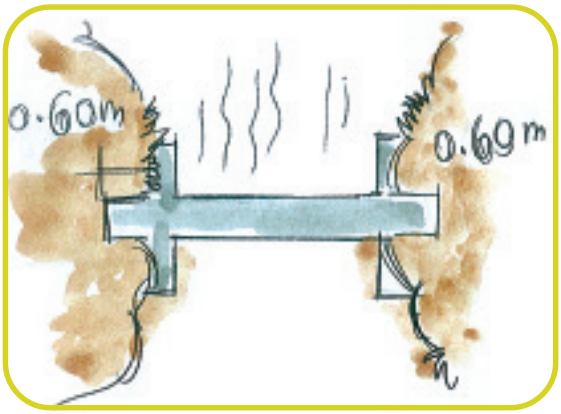
Key points related to design

- Length of the dam is the width of the gully
- Depth of the gully is total height of the structure plus free board
- Height of the core wall is *foundation + height of the main dam + height of free board + height of the wall above free board*

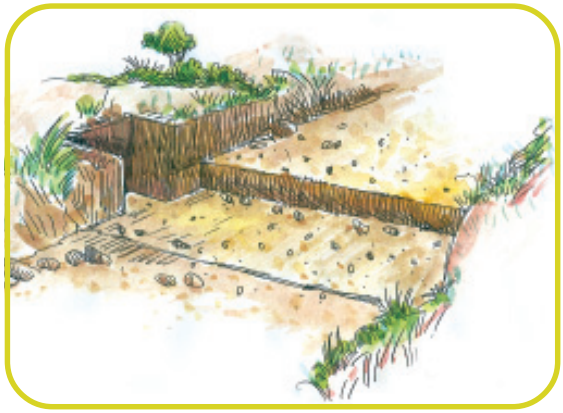
Source of Designs: IWMP Technical Manual prepared by SLNA, Government of Andhra Pradesh

Steps in Execution

Site Selection



Layout/ plan



Earthwork for gabion

Earth work for

- ***Foundation of body wall/ Head wall:*** Cut the sides where the structure has to be constructed in the drainage. Excavate the earth for foundation as per the specification with the depth of 0.30 mtr
- ***Apron:*** Excavate the apron for a depth of 0.30 mtr
- ***Retaining wall/ Toewall*** : Excavate the retaining wall for a depth of 0.60 mtr and height of 0.60 mtr for the entire length of the dam
- ***Core wall/Head wall extn.*** : Cut the earth in the sides. The length of the core wall is equal to the top width of the headwall. The depth is upto the foundation level. Width of core wall is 0.45 mtr
- ***Side cutting***: Cut both sides downstream to prevent sagging

Stone work for

- ***Foundation of body wall/ Head wall upto Ground Level:*** Fill the foundation dug with boulders of 0.225 mtrs size.
- ***Body wall/ Head wall above Ground Level***: Fix the pegs and tie the ropes to maintain side slopes and top width and construct the body wall above ground level
- ***Core walls/ Head wall extn. :*** Construct the core walls upto the total depth of the drain (upto top level) completely
- ***Apron***: As per specification
- ***Side Walls***: As per specification
- ***Toe wall/ Retaining Wall***: As per specification

Maintenance

- Repair the structures at regular intervals

Important Calculations

Rock Fill Dam (*of 10mtr length and 0.60 mtr height*)

a. **Length of main dam:** 5 to 10 mtrs, equal to width of the gully

b. **Foundation** for main dam/head wall : 3 mtrs depth

c. **Height** above the ground : 0.45 to 0.60 mtrs

d. **Side slopes**

- u/s side 0.5: 1 to 1:1
- d/s side and 1.5:1 to 2: 1
- If height is 0.60 mtr for u/s side, slope is 0.5:1, then u/s side width is 0.5 * 0.60 mtr = 0.30 mtr.
- If d/s side slope is 2:1, then D/s side width is 2 * 0.60 mtr = 1.20 mtr

e. **Free board**: Above the dam. Minimum 0.30 mtrs

f. **Top width** : 0.45 to 0.60 mtr

g. **Bottom width:** Depends on the side slopes. If u/s side slope is 0.5:1 and d/s side slope is 2:1 and height is 0.60 mtr then bottom width= (u/s side slope * height)+ (top width) + (d/s side slope * Height).

(Eg: = (0.5 * 0.60 mtr) + (0.45 mtr) + (2* 0.60 mtr) = 1.95 mtrs))

h. **Apron**

- Depth : 0.30 mtrs
- Width : 1.5 * height of the main wall = 1.5 * 0.60 mtrs = 0.90 mtrs
- Length is equal to the length of main wall

i. **Retaining wall**

- Depth/height is 2 times than the apron depth = 2 * 0.30 mtrs = 0.60 mtrs
- Breadth is same as depth/height of the retaining wall = 0.60 mtrs
- Length is equal to the length of the main wall

j. **Core walls: On both sides**

- **Height:** Depth of the main dam below ground + height of the dam + free board above dam. (Eg: 0.30 mtrs + 0.60 mtrs + 0.30 mtrs = 1.20 mtrs)
- **Length:** 0.60 mtr in to the gully sides on both sides
- **Breadth:** Equal to the top width of the main wall i.e. 0.45 mtrs

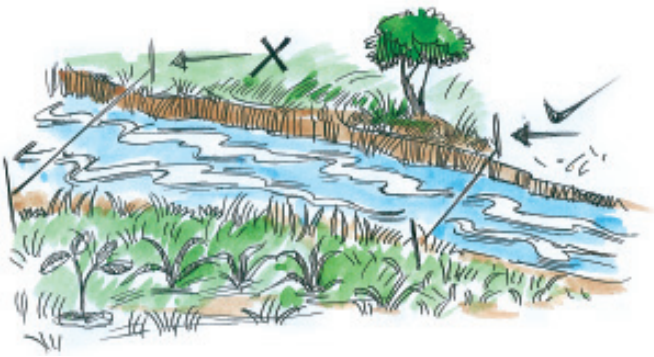
k. **Side cutting :** to prevent sagging on d/s side of the structure on both sides.

- **Length :** From the beginning of the dam to the retaining wall = bottom width of the main dam + width of apron + width of retaining wall = 1.95 mtr + 0.90 mtr + 0.60 mtr = 3.45 mtrs.
- Breadth of the cutting is upto the length of the core wall, i.e. 0.60 mtrs
- Depth of the side cutting is equal to the height of core wall.

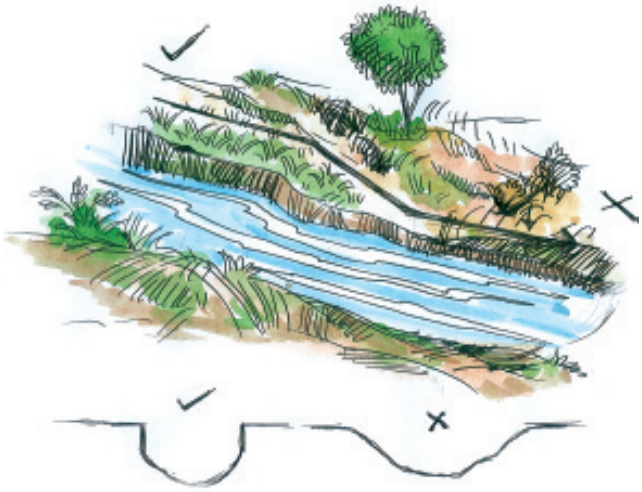
Dos and Don'ts

If Gully depth is < 1m, construct LBC

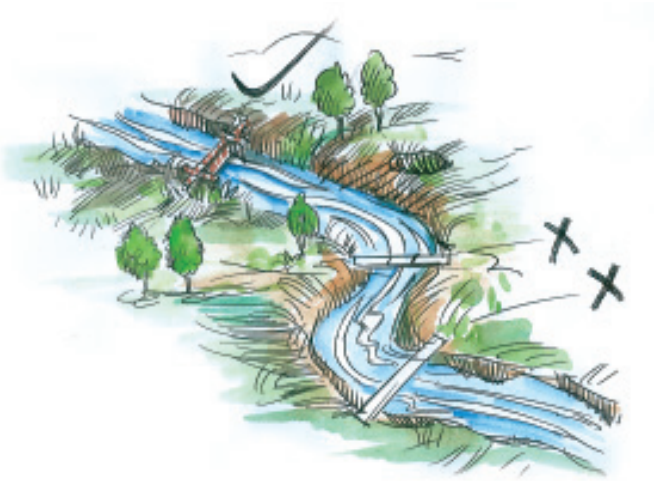
If Gully depth is > 1m, construct Gabion/ RFD



Don't construct structure where Gully width is high



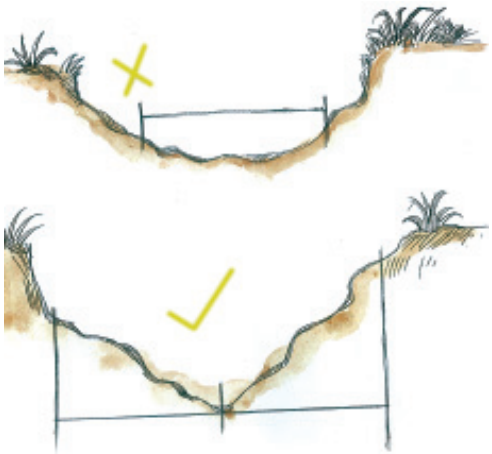
Don't construct structure where Gully Depth is high



Don't construct structure at gully curves

If constructed, it will be breached out

Don't construct structure where Gully erosion is high

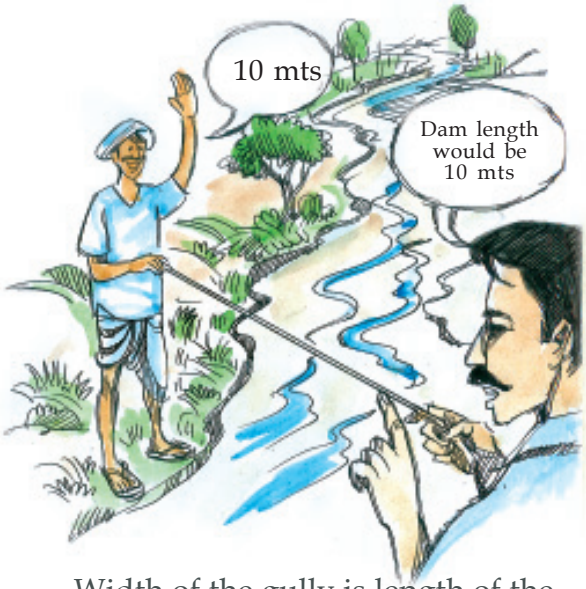


Don't construct structure without foundation

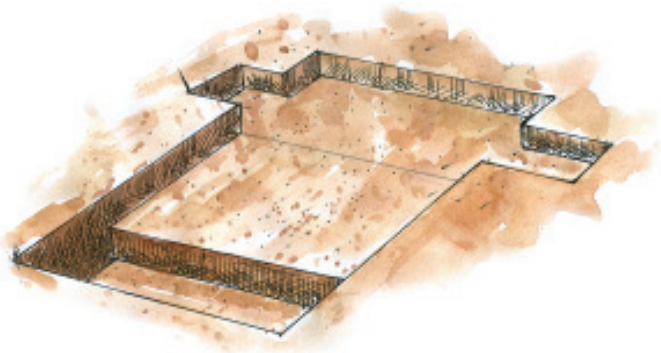
Remove bushes at work site

Take average depth

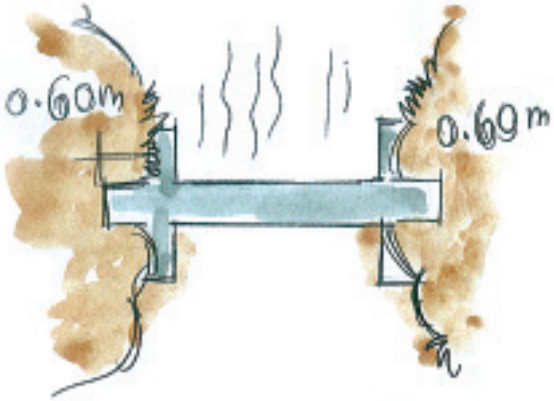
Measuring width of the gully



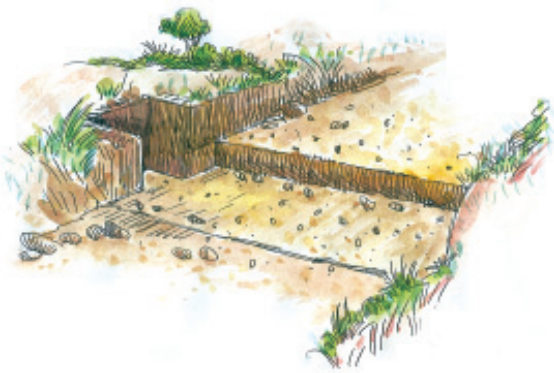
Width of the gully is length of the structure



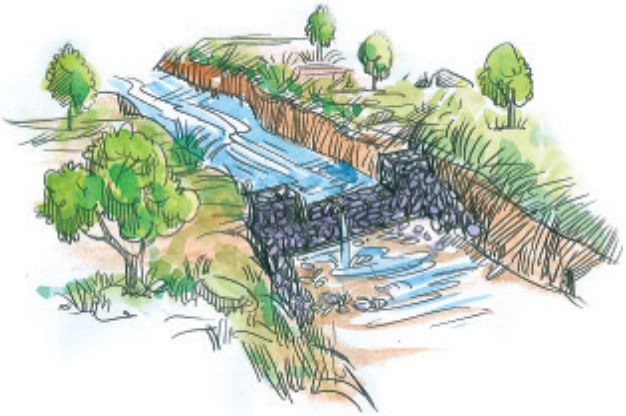
Complete earth work for all parts of the structure



Entrench core walls into enbankment

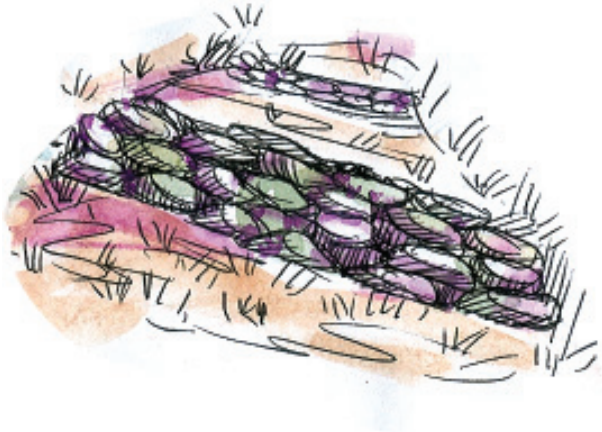


Earthwork for core walls

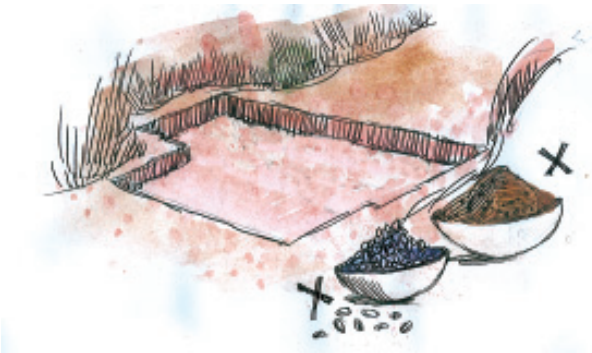


Leave adequate free board to allow eccess flow of water

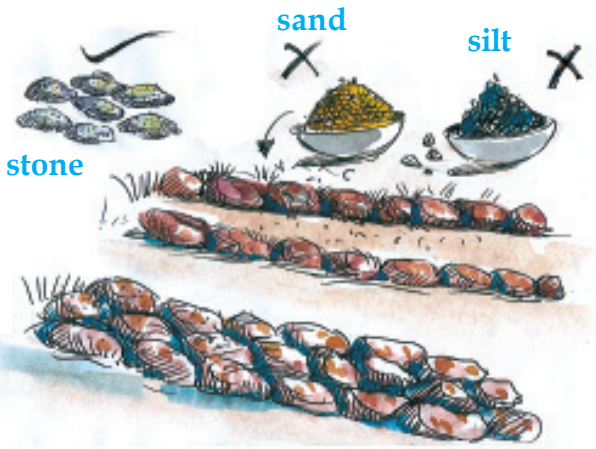
Structure with free board



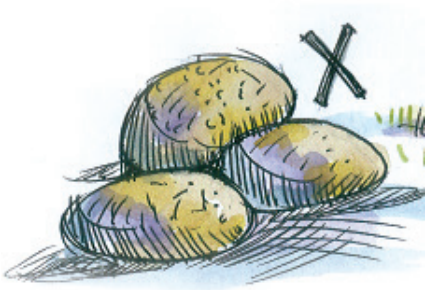
Structure with out free board is wrong



Don't use small pebbles, sand and silt to fill foundation



Use suitable size stones only



Don't round shaped stones

Use stones with angular shape

Gully Order

Gully Order	Definition	Depth of the Gully	Width of the gully
1st Order	This is the beginning of the gully	0.30 mtr to 0.50 mtr	0.30 mtr to 1.20 mtr
2nd Order	2nd order gully forms If the two 1st order gullies join together	0.50 mtr to 1.20 mtr	0.60 mtr to 6.00 mtr
3rd Order	3rd order gully forms If the two 2nd order gullies join together	0.60 mtr to 6.00 mtr	1.20 mtr to 12.00 mtr

Most frequently used terms

- **Upstream Side (U/s):** Direction towards upper side from the location of structure. Water comes from this side.
- **Downstream side (D/s):** Direction towards downwards from the location of structure. Water flows to this side.
- **Ratio** mentioned in base and height or depth (Horizontal Interval : Vertical Interval).
- **Catchment area:** The entire area above the structure/location from where water comes.
- **Main Wall:** The other terms are main dam, body wall, head wall. This is the main dam and first part of the structure. Earth work is excavated to construct this body wall. The shape of the pit is cuboid.
- **Core walls:** The head wall/main dam is extended on both sides to prevent erosion or sagging of sides due to force of water. Core walls are extended into sides.
- **Apron:** Apron is constructed as a support to the main dam. This apron protects the main dam from the force of water that spills over the dam. Otherwise, the stones may be detached by force of water flow.
- **Retaining Wall:** It is also called as toe wall. Retaining wall functions like a toe in the human body to keep the structure straight. Retaining wall protects the apron from the force of flow of water
- **Side walls:** To protect embankment/sides from scouring
- **Embankment:** Both sides of the drainage at the structure to hold it. This is also called as sides or flanks.

- **Sagging:** If proper foundation is not provided to a structure, the water passes under the structure and sinks it. Stones in the structure become loose and get dislocated. Because of dislocation or loosening of the stones, the structure sinks down.
- **Scouring:** Erosion of the bund slopes or stream slopes.
- **Free Board:** If the height of the structure is equal to the depth of the gully, there will not be space for the water to spill over. This damages the sides and structure. Therefore certain gap has to be maintained on the dam in the stream. This gap/space is called free board. This height of the free board depends upon on the catchment area, rainfall, slope, vegetation, soil types and speed of the water

FAQs

Q: What are the common problems in constructing LBCs and Gabion/ RFDs? How they can be addressed?

A: Availability of stone, selection of site, soil types etc. are the common problems. The difference between LBC and Gabion in terms of site selection, design are explained in detail in the previous page.

Q: How these structures could be maintained? Whose responsibility?

A: By repairing as and when required. Gram Panchayat and local farmers.

Q: How to identify best locations for taking up these structures?

A: Refer Illustrations as explained under "dos and Don'ts" in previous pages.

Q: What is the ideal distance between two structures?

A: Depends upon the slope. Refer Page No. 49-50, Samarthya Technical Training Manual.

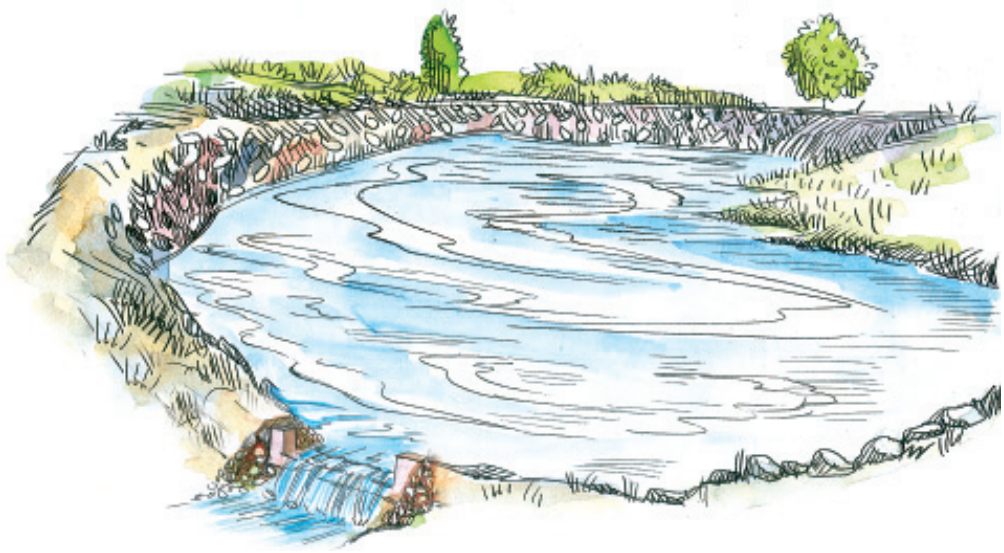
2.5 Water Harvesting Structures

Gullies are formed due to undulation, continuous erosion and slopes. Down the line, these gullies become bigger, deeper and wider. Such places are suitable to construct little bigger water harvesting structures.

These water harvesting structures can be classified as:

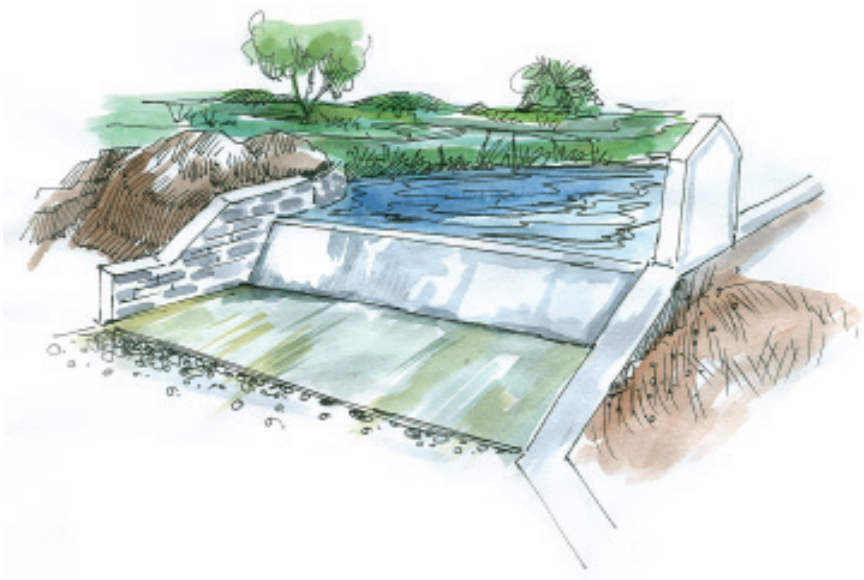
Earthen Dams

Earthen Gully Plug, Mini Percolation Tank (MPT) and Percolation Tank (PT)



Cement concrete structures

Check dam and Stop Dam



2.5.1 Earthen Dams

Earthen Gully Plug

Introduction

Earthen Gully Plug is constructed with soil across the gully at suitable site to stabilize the gully

Technical Design

Earthen Gully Plug and Percolation Tank cannot be constructed without working out Horizontal Interval (HI) and Vertical Interval (VI) based on L-Section of the drainage line and Hydrologic; Hydraulic and Structural design with regard to topography, catchment & rainfall.

Top width	:	0.6 mtr
Side slopes on both sides	:	2:1
Height	:	1 to 3 mtr
Stone Rivitment	:	On u/s side upto Full Supply Level (FSL) in the gully

For more details refer SAMARTHYA-Technical Training Manual for MGNREGA works

Location

- In the upper catchment areas where there is scope for water storage
- Where suitable soil is available for embankment
- Where the depth of the gully is less than 2 mtr
- Where the gully bed slope is less than 10%
- Where the site has facility for side spill way

Components

- Cleaning the site
- Earth work for foundation of the earthen dam equal to top width of the bund.
- Embankment with impervious soil
- Side spillway
- Stone revetment on u/s side

Steps in Execution

- Clean/clear the site
- Earth work for foundation in the gully upto 0.3 mtr
- Fill the foundation trench with impervious soil and compact it
- Construct the bund as per specifications by compacting the earth in 9" layers
- Provide side spillway at suitable place to allow the excess/surplus water flow
- Provide Stone revetment on u/s side
- Plant grass on d/s side and on top of the bund

Benefits

- It harvests water
- Prevents soil eroion
- Prevents gully erosion by slowing down the speed of the water
- Recharges ground water

Dos and Don'ts

Dos

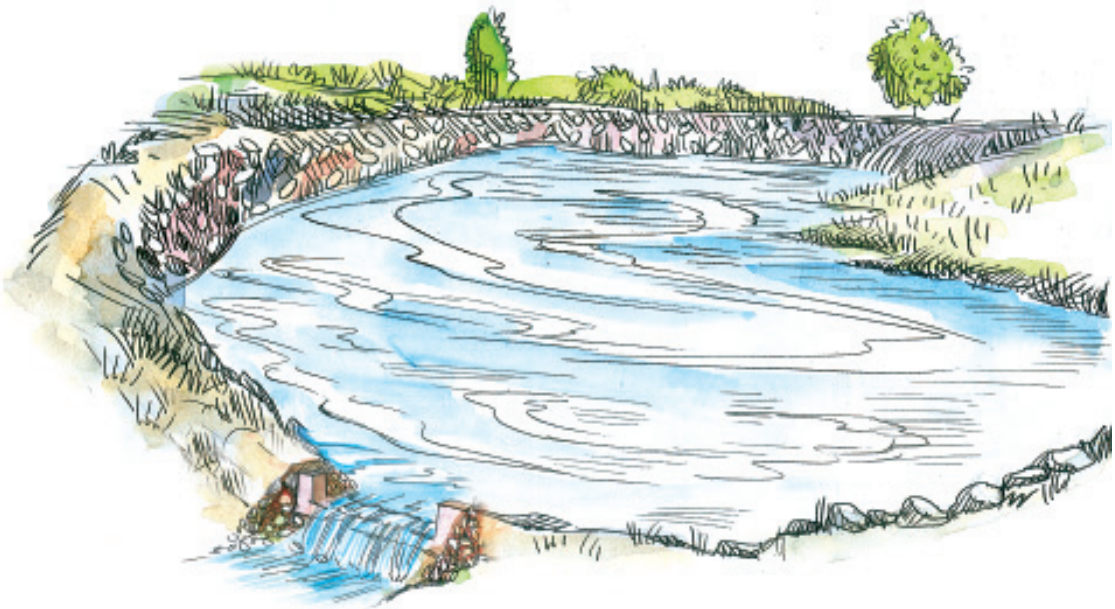
- Provide surplus/ waste weir to allow the excess flow of water
- Construct the earthen bund with impervious soil
- Provide key trench by digging proper foundation.

Dont's

- Do not construct the bund without proper side slopes on both sides.
- Do not construct to the height by which the back waters spread in to farmers' fields. Farmers may cut the bund to protect their crops from the damage.

Mini Percolation Tank (MPT) and Percolation Tank (PT)

The purpose of these structures is to harvest water and allow it to percolate down to the ground so as to enable recharge of ground water. Hence percolation tanks are to be constructed where soil is suitable for percolation of water. Broadly these structures are similar in nature with little variations in terms of location and some structural elements.



Location

- Across the 1st, 2nd, 3rd order gully
- Slope of the gully bed must be less than 1%
- Where the catchment area is 10-50 acres
- Area should be feasible for water harvesting
- Where > 0.50 acr of water spread area is available

Components

Key trench, Bund, surplus weir, nosing

Key Tasks

- Foundation for bund
- Earth work for Key trench/ Core wall
- Filling the Key trench/ core wall with impervious soil
- Construction of bund
- Compacting with roller and water
- Construction of surplus weir
- Earthwork for Toe wall
- Construction of Toe wall with stone
- Stone revetment to the bund.

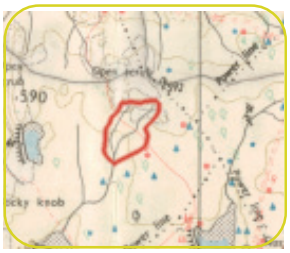
Steps in Execution

Marking

- Identify the location on the topo-sheet
- Measure the catchment area
- Clear the jungle where the bund is to be formed
- Take chainage points
- Identify the height, width of the bund to be constructed at different points
- Identify the location for surplus weir
- Give marking as per the required measurements
- Fix pegs in the gully as per the bottom width design
- Fix pegs on the sides marking the top width that is to be maintained
- Tie the ropes with the pegs horizontally and vertically from top width to bottom width to maintain the side slopes

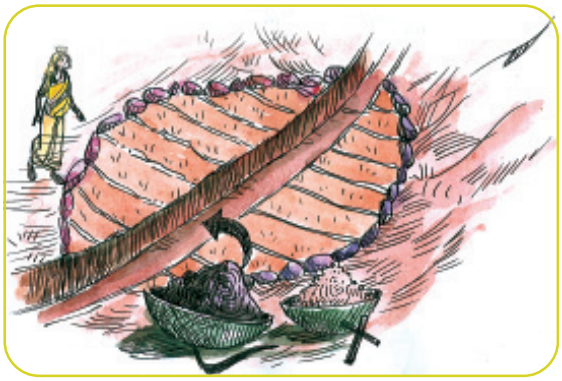
Physical Execution

- Foundation for bund: Remove earth upto the depth of 0.225 mtrs at bund formation portion and keep it aside
- Dig the key trench and fill it with impervious soil in layers by compacting and applying water
- Form the bund by compacting the earth in layers at every 0.225 mtrs
- Construct the surplus weir (*similar to check dam. Please refer to "check dam" Page No: 66 for more details*)
- Nosing – Revetment on both sides to surplus weir
- Earth work for toe wall with 0.45m * 0.45 m size along the bund in u/s side.
- Stone work for toe wall
- Revetment to the bund

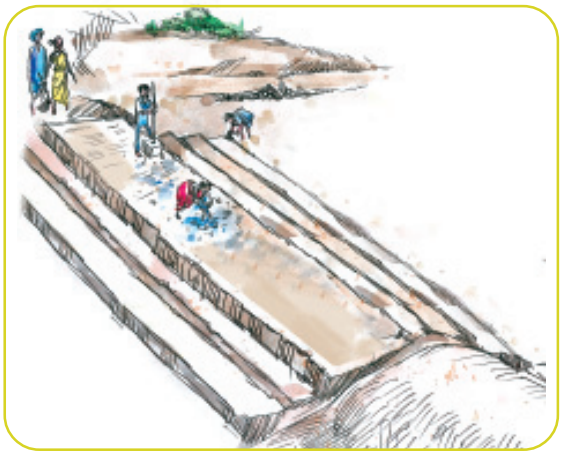


Calculate the catchment area using topo sheet

Marking/ Lay out



Fill key trench with impervious soil



Compact the earth in layers with water

Possible outcomes

- Harvesting of rain water (*with a low cost structure*)
- Controlling the speed and flow of the rain water
- Increase in ground water levels and also in nearby wells
- Availability of water for livestock and birds.
- Water for critical irrigation for horticulture and agriculture.

Compact the bund using roller

Design

- Height of the bund should be according to the depth of the gully
- Top width of the bund should be minimum 1.50 mtr
- Need to excavate the earth in the upstream side to form the bund
- Side slopes are 1.5:1, accordingly bottom width should be calculated
- The side slope depends upon angle of repose of the soil
- Need to excavate the earth in the upstream side to form the bund
- Minimum height of the free board is 1.00 mtr for surplus weir
- Stone revetment on u/s and d/s on both sides of weir (nosing)
- Use the stripped earth to cover top of the bund

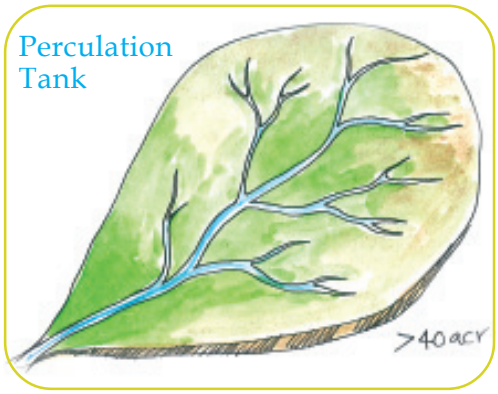
Dos and Don'ts

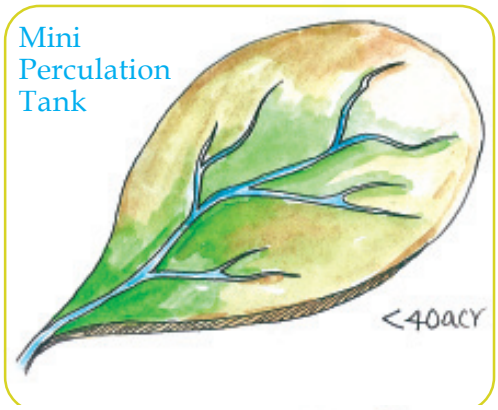
Dos

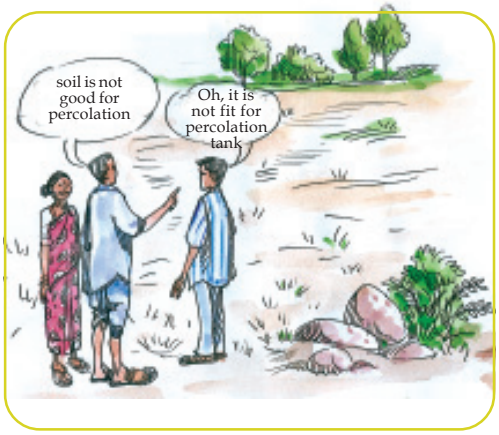
- Take up the structure where gully is stretched.
- Minimum top width of the bund should be 2.00 mtrs.
- Compact the earth at every 0.225 mtr layers with specified roller (2 ton roller).
- Take weekly measurement for earth work done.

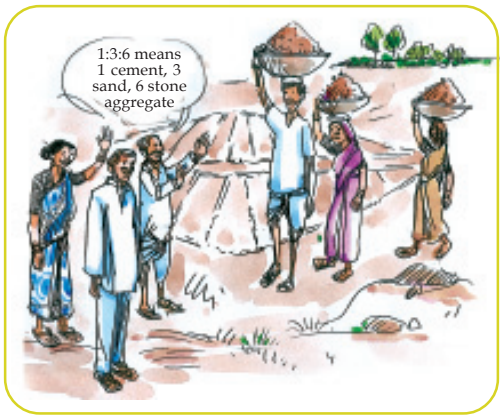
Dont's

- Do not construct percolation tank in locations where water cannot be percolated (*soils like saline, black cotton)*
- Do not construct percolation tank where the gully has sharp curves
- Do not construct the bund without key trench
- Do not use sandy or red soils for key trench. Use black cotton or saline soil
- Do not put the earth without compacting and do not compact the earth without using water to maintain the optimum moisture content
- Do not construct mini percolation tanks in bigger size drainages/streams
- Do not form the bund without foundation
- Do not leave clads without breaking them.









FAQs

Q: From which side the chainage points should be identified?

A: Facing towards the upstream side, take the points from left hand side.

Q: Why scratching the earth or foundation to the bund is required?

A: The top soil is loose and will allow the seepage, which later breaches/damages the bund

Q: Why to keep the 0.225 mtrs depth earth aside?

A: Because the top soil is not good for formation of bund, it may cause seapage and damage the bund. The top soil can be used to spread on the bund for faster growth of grass on the bund

Q: Why the earth should be excavated in the upstream area for formation of bund?

A: The pit dug by excavating the earth to form the bund will also harvest and store water. This increases the water retention capacity of the structure.

Q: What is the need for compacting the earth at every 0.225 mtrs?

A: Bund becomes stronger with it. If the earth is not compacted, water may be leaked and cause breaches in the bund.

Q: Why the minimum distance of 5 times to height of the bund, between bund and pit is required?

A: If the pit is closer to the bund, seepage may damage the bund

Q: How much free board is required in the gully for the bund?

A: Free board is not required for the bund in the gully, because, we don't allow water to spill over the bund. However surplus weir is required.

Q: Why nosing is important?

A: Nosing is provided to the suprlus weir on both sides on up stream and down stream prevents sagging of bund.

Q: Why breaking the clads is compulsory?

A: The clads in the bund form voids and allow the seepage/leakage of water. Hence, they must be smashed and broken.

Q: Why the slope of the gully bed should be less than 1%?

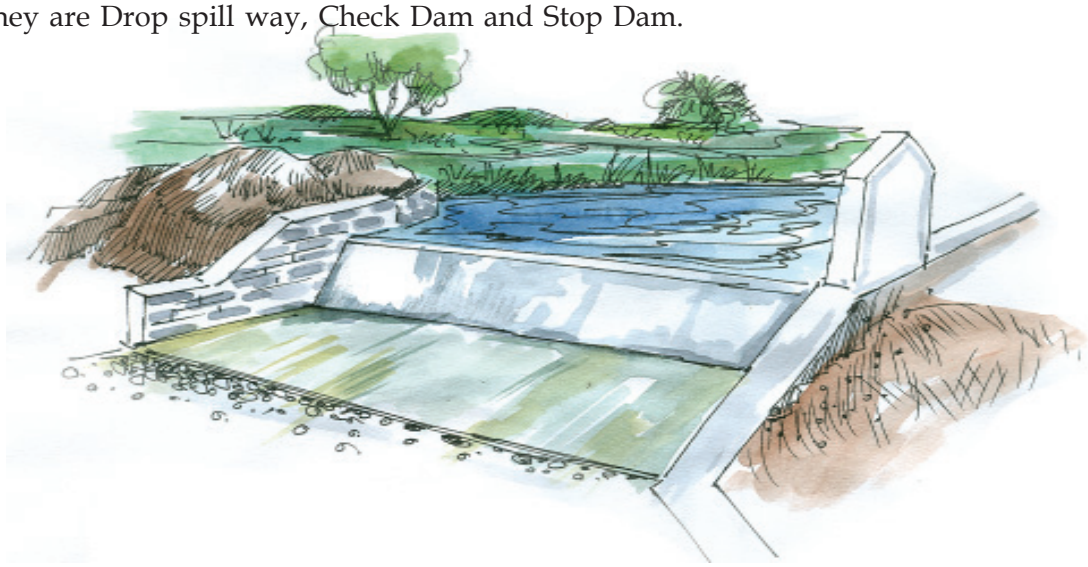
A: If the slope of the gully bed is more, the speed of the rain water flow will be higher. If the speed is high, the pressure on the bund will be very high.

For more details refer SAMARTHYA-Technical Training Manual for MGNREGA works; Pg. No 56-70

2.5.2 Cement Concrete Water Harvesting Structures

Check Dam or Drop Spill Way

These are masonry structures constructed with cement concrete across the gullies, basically to harvest water. Three types of structures are prominent in this category. They are Drop spill way, Check Dam and Stop Dam.



Location

- Across the 1st, 2nd, 3rd order gullies
- Where the flanks are strong
- Where the depth of the gully is minimum 1.20 mtrs – 1.50 mtrs
- Where the width of the gully is less and there is space available to store water
- The slope of the gully bed must be less than 1%

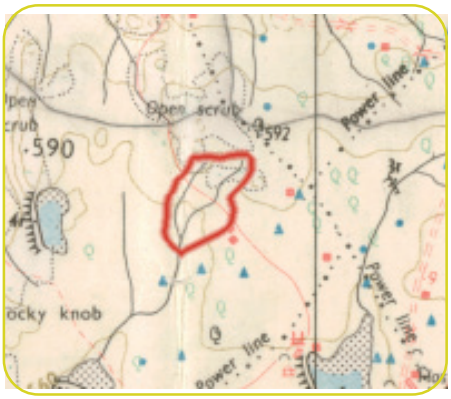
Components

Body wall, Apron, U/s Cut-off, D/s Cut-off, Talus, Toe wall, Wearing Coat/ plastering.

Key Tasks

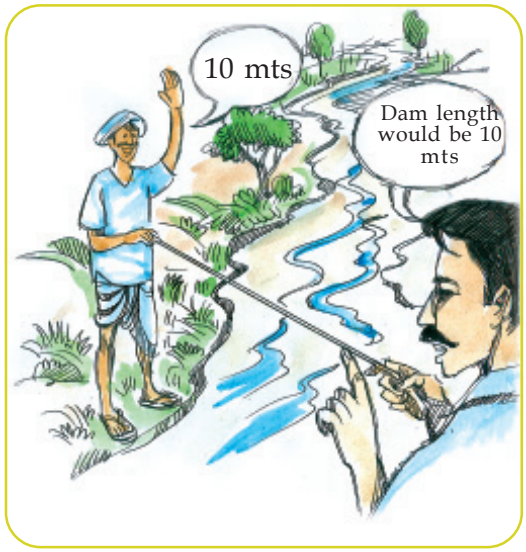
- Calculating the distance from work site to the place where different materials are available, to measure the lead
- Clearing the jungle at site.
- Foundation for main dam, Cut-off walls on upper and down stream sides, side walls, key walls
- Filling up the upper and down stream cut off trenches, foundations of body wall, side walls and key walls with 1:5:10 cement concrete
- Construction of body wall, side walls, key walls with 1:3:6
- Construction of cushion wall, toe wall
- Wearing coat with 1:2.5:5 cement concrete with 0.10 mtrs height on body wall and cushion wall
- Stone pitching to apron
- Stone revetment to the sides in u/s side upto minimum of 2 mtr length on each side
- Curing with water upto minimum of 21 days

Steps in Execution



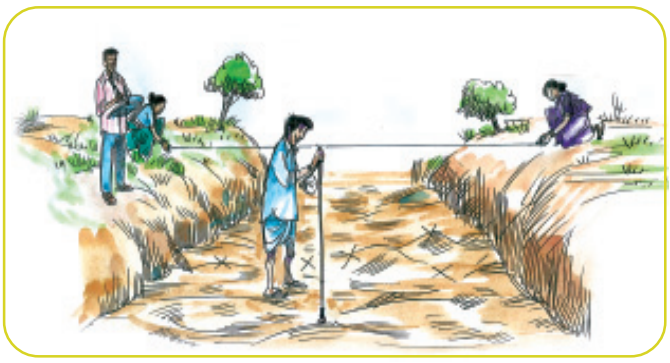
Marking

- Identify the location on the topo sheet
- Measure the catchment area and calculate discharge
- Conduct longitudinal survey of the gully for L-Section and Hydrologic; Hydralic and Structural design with regard to topography, catchment and rainfall
- Measure width and depth of the gully at every 10 mtrs in the (width of) gully and also of flanks
- Fix the height of the dam, leaving minimum freeboard of 0.30 mtrs height
- Consider minimum head of flow height as 0.45 mtrs
- Give marking as per the specified measurements
- Fix pegs in the gully as per the bottom width design



Site selection

Site clearance

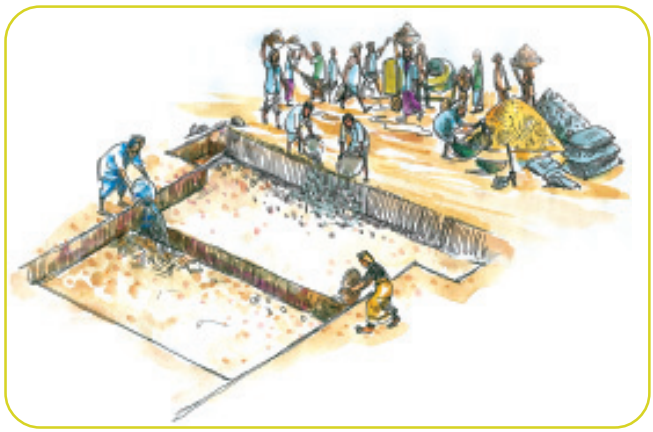


Measure the average depth

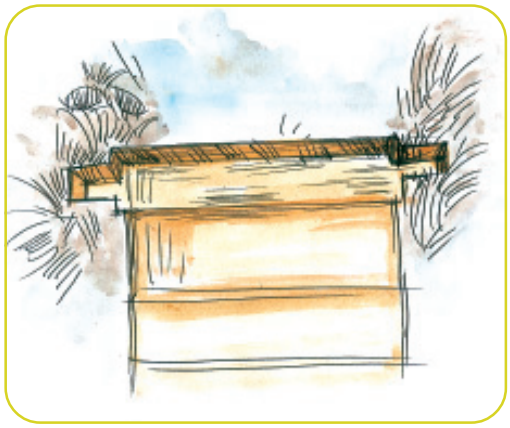
Measure width of the drainage

Physical Execution

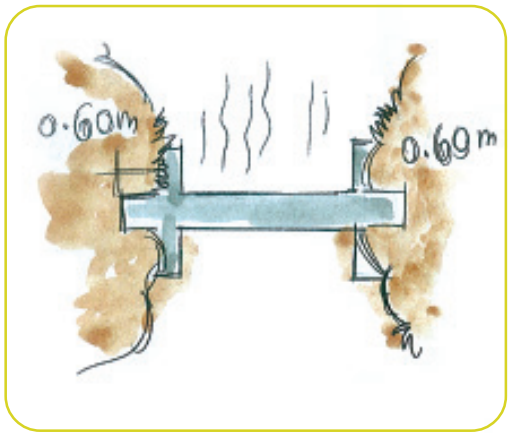
- Dig the foundation for body wall, side walls, Cut-off walls, cushion wall and toe wall
- Construction of body wall, side walls, key walls, cushion wall and toe wall, each with 1:3:6 cement concrete.
- Wearing coat with 1:2.5:5 cement concrete with 0.1m height on apron, cushion wall, body wall
- Stone pitching to apron with 0.225 m size stone
- Curing upto 21 days
- Ensure that the minimum distance between 2 check dams 400-500 m.



Filling the foundation with cement concrete



Complete earthwork



Head wall extension into embankment

Maintanance

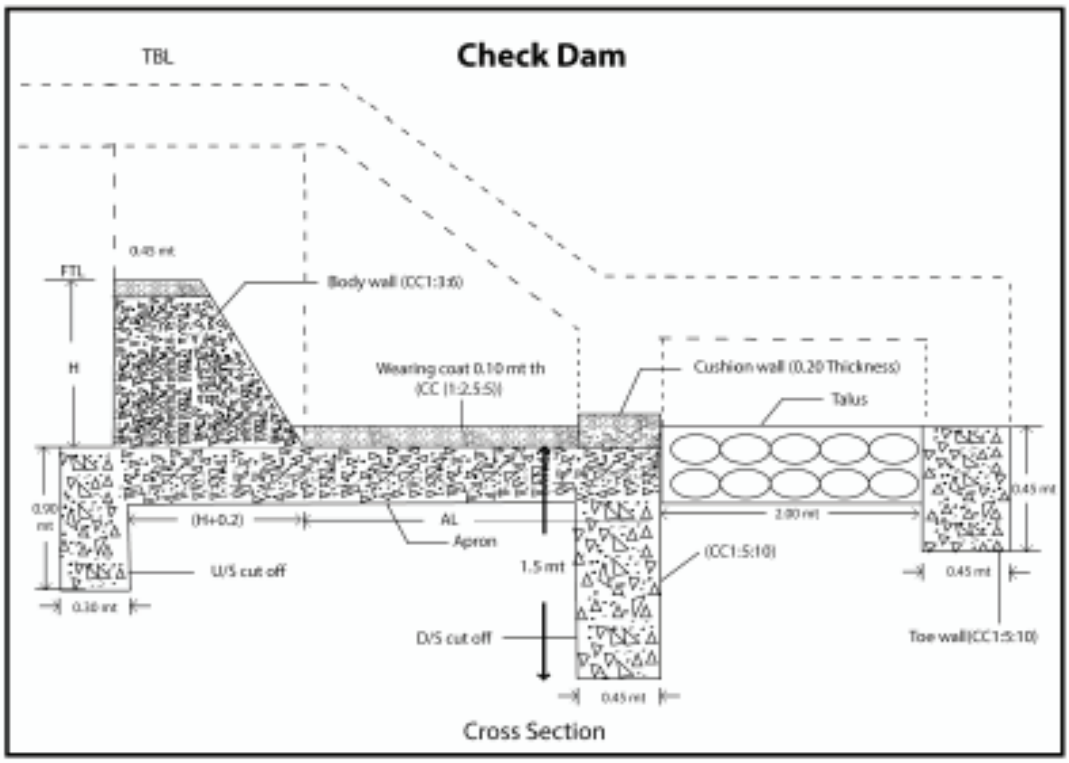
- Check and set the stones in apron right.
- If required, extend the revetment in upstream side to protect the sides.
- Desilt the dam as and when required to protect the water harvesting capacity of the structure.

Possible outcomes

- Harvesting rain water for productive use
- Controlling the speed of the rain water flow
- Preventing the gully erosion, further deepening and widening of the gully.
- Increase in ground water levels and also in nearby wells
- Availability of water for livestock and birds.
- Water for critical irrigation to horticulture and agriculture

Design

- Length of the check dam = width of the gully
- Height of the body wall according to the depth of the gully, catchment area and rainfall. For more details refer Samarthya Technical Training Manual for MGNREGA page no: 64-65.
- Height of the dam = Depth of the gully at lowest point – Head of Flow – Free board
- Minimum free board is 0.3 m
- Top width of the body wall is 0.45 mtrs



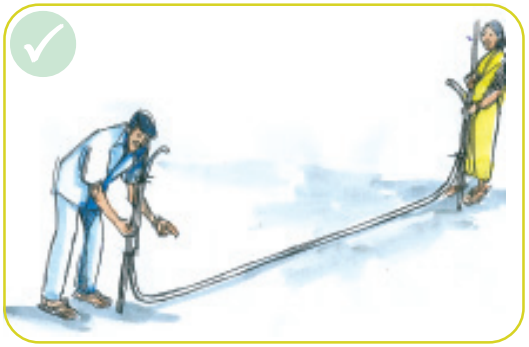
Source of Design: IWMP Technical Manual developed by SLNA, Government of Andhra Pradesh

Dos and Don'ts

Dos

- Gully must be stretched and the foundation should be parallel to the ground.
- Core walls should be entrenched into sides as much as possible
- Cement concrete should be in ratio of 1:3:6 for up stream and downs stream cut-offs body wall, apron, side walls and key walls.
- Thickness of cement concrete should be 0.30 mtr.
- Minimum gap of 3 days must be maintained for constructing body wall after construction of concrete bed.
- Concrete bed must be cured well with water, use wibrator.
- Cement concrete for Body wall is 1:3:6 ratio, use machine to mix the concrete.
- The size of stone aggregate in the cement concrete must be 40 mm (60% of total aggregate) and 20 mm (40% of total aggregate)
- Pitching must be parallel to the apron and toe wall
- Pack the apron using smaller size stones in between the 0.225 m size stone to increase the bond
- Display the board with all the details of check dam.

1 : 3 : 6 Cement : Aggregate : Sand

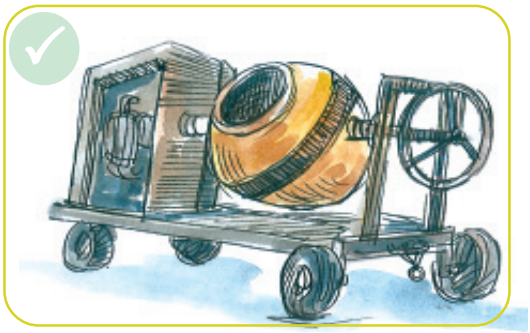


Measuring the bed slope

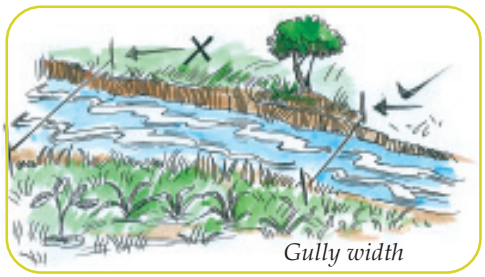
Minimum water curing - 21 days

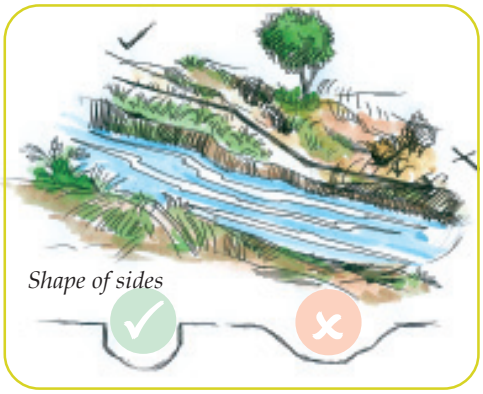
Work display board

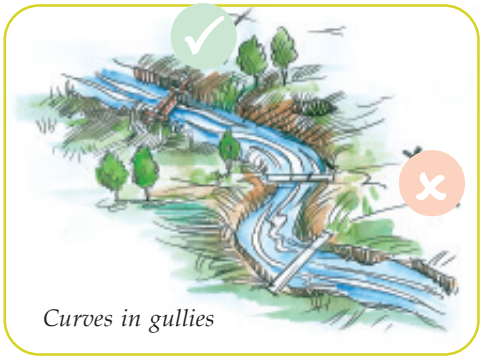
Vibrater on cement concrete



Use Concrete Mixing Machine

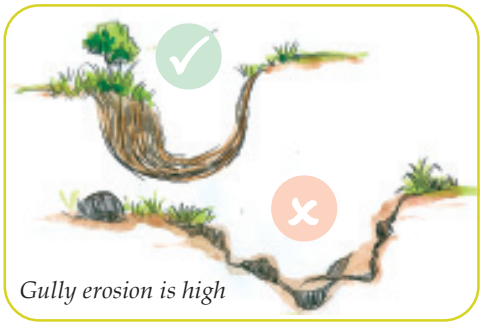


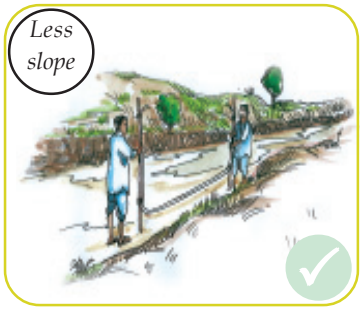




Dont's

- Do not construct where the water cannot be percolated (eg: saline or block cotton soils)
- Do not construct the check dam without treating the upper reaches with appropriate structures
- Do not widen the gully for constructing the check dam.
- Do not construct the dam where the gully has sharp curves
- Do not construct the dam if the flanks are not strong
- Do not put concrete without completion of earth work for all parts of the structure.
- Do not use pebbles in cement concrete and do not use sand mixed with soil/earth.
- Do not use the aggregate of sizes other than prescribed and do not make artificial flanks
- Do not leave the earth excavated for foundations in the gully. Transport it to the sides in such a manner that it will not sag down to the gully.





FAQs

Q: Depth of the foundation is 0.3 mtrs. Drainage is like a bowl, from which point the 0.3 m depth should be dug?

A: Identify the point where depth of the gully is high. Dig 0.3 mtr depth from the deeper point of gully. The foundation should be parallel to the ground. Therefore, depth near sides could be deeper.

Q: Why to keep aside the earth excavated for foundations?

A: Because the water flow should not be disturbed and the gully should not be silted.

Environmental Benefits of Watershed works in Rainfed Areas

Population growth demands more food production and irrigated areas are saturated to their capacity. Rainfed areas are potential to address this gap. The development of rainfed areas contribute to economic development of small and marginal farmers, development of small holdings. Beside food security they also provide environmental benefits

Research says it takes more than 500 years for formation of an inch of soil. Watershed development works control soil erosion, conserve soil and soil moisture. This soil is important for germination and survival of several plant species. Indigenous species also are part of this. The fertile soil has more capacity to hold and retain moisture content and preserve humus factor in soils. The works proposed in this resource booklet have potential to enhance the soil fertility.

The drainage line control works prevent soil erosion and further formation of gullies and waste lands. The control measures taken up help in slowing down the flow of rain water. This increases duration of water flow on the surface and thereby increases infiltration into the ground. The improved ground water level recharges open wells and tube wells. It results in availability of more water for irrigation. It enhances production and provides food and income security to the farmers.

The water harvesting structures harvest water and keep it available for crops, livestock and even birds. The crops can get lifesaving irrigation to secure the yields and income to the farmers. It also contributes in increase of level of water table in open wells and tube wells.

Development of waste lands into productive lands increases availability of land for cultivation. MGNREGS helps in realizing the fullest potential of each type of land. It enhances production of crops that give food, cash, fodder, etc. Rainfed agriculture entertains least inputs and suitable for millets and many other traditional crops. The improved rainfed lands can conserve diversity of crops, agriculture systems.

Benefits in nutshell...

- Brings effective land use system
- Converts majority of non-arable area into arable area and increases availability of land for cultivation and other productive uses.
- Controls soil erosion, conserves soil, soil moisture
- Enhances favourable micro climate for healthy plant growth, with increased soil moisture and space for rooting
- Treatment of upper catchments prevents the pressure on lower catchment and strengthens the capacity of NRM structures in downstream such as tanks to function to their fullest capacity

  (*Eg: prevents siltation, reduces pressure from speed of water)*
- Revives small holding agriculture
- Increases food production, provides food security
- Revives traditional crops
- Increases fodder production
- Strengthens livestock based livelihoods
- Provides water for agriculture, livestock, fisheries, animals and birds.
- Enhances the chance of ground water recharge – open wells, tube wells
- Revival of stream flows, spring flows and traditional irrigation systems
- Revives traditional water bodies and creates new water harvesting structures
- Enhances water productivity
- Availability of harvested water reduces pressure on ground water
- Reduces requirement of manures and fertilizers
- Strengthens resilience of eco system in the context of climate change
- Reversal to the ecological loss or environment damage

- Environmental security besides food security, fodder security, water security and income security
- Strengthens the network of biological system
- Enhances functional diversity and responsive diversity of species in a eco system

References

- Samarthya Technical Training Manual for MGNREGA developed by MoRD, GoI
- NREGS manual developed by APARD, Hyderabad
- IWMP Watershed manual developed by SLNA, Andhra Pradesh