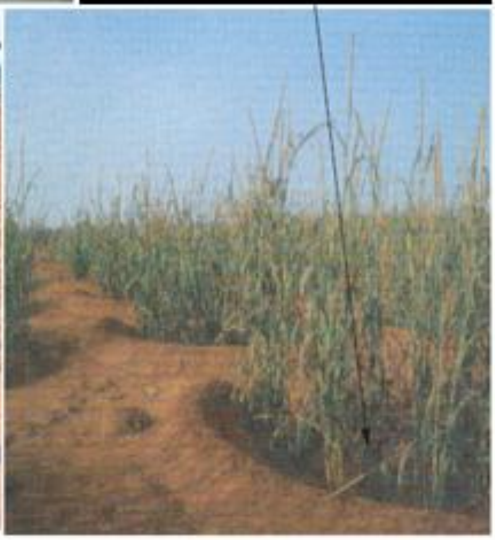
TRAINING PACKAGE ON BIOPHYSICAL SOIL AND WATER CONSERVATION MEASURES ON HILLSIDE/DEGRADED LAND

PART THREE: TECHNICAL MANUAL ON WATER HARVESTING STRUCTURES



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MODULE 1: MICRO POND

1.1 Concept of micro-pond

The micro-pond concept includes its description, purpose, time to construct, suitability and agro-ecology.

Description Of micro-pond

A micro- pond is naturally or artificially confined pool which is used to collect or harvest and store water for use during dry seasons either for irrigation, domestic use and human consumption. It has the capacity to hold up to 100 m^3 of water. Roughly this will be 500 barrels or 100000 litres. Usually, there are two types of micro- ponds: One is a watershed micro-pond in which water availability is entirely dependent on rainfall. The second one is a spring-fed micro-pond in which water supply entirely depends on springs and road side runoff.

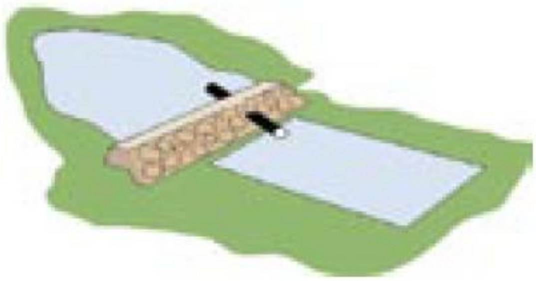


Photo 1: Rain fed pond

Purpose of constructing micro-pond

Micro-pond is constructed to collect and store surface water and/or runoff water from various sized catchments through cut-off drains, feeder roads, graded bunds, spillways.

Time to construct micro-pond

Construction of micro-ponds should be during the dry seasons before the beginning of rainfall. In addition, appropriate time or seasons to find labour force should be considered as micro-pond construction and its management is labour intensive.

Suitability and agro-ecology

Selecting a suitable site for micro-pond construction is important. A suitable site for a micro-pond is an area where a limited amount of excavation is required to contain, or hold a large volume of water. Construction of micro-pond is suitable in all agro- climatic zones except in areas with excessive dryness (below 400 mm annual rainfall) as it is not cost effective.

The following criteria can be used for micro-pond site selection.

- on open fields to collect water from graded bunds and waterways,
- at the foot of treated hillsides to increase the recharge of ground water table,
- inside large gullies,
- around homesteads,
- at a point where maximum volume of water can be collected with least digging or earth fill,
- around grazing land at about not more than 1km ,
- away from farm drainage and sewage lines in order to avoid possible pollution.

1.2 Design, Layout and Construction of micro-pond

1.2.1 Technical standards and design steps

The major issues to be considered here under technical standard are technical design and technical specifications.

Technical design:
To determine the volume of water to be stored in the pond, the volume of expected water use should be calculated. Water can be used for human consumption, animal consumption or crops. The following tables give guidelines for the calculation of the requirements.

Table 1: Human and Animal Water Consumption

Consumers / Beneficiaries	Consumption in liter / day
Human being	15-25
Cattle	20-40
Milk-cow	70-100
Camel	40-90
Donkey	10-15
Horse	30-40
Sheep	3-5
Goat	3-5
Poultry	0,20-0,30

Source: Training workshop on pond planning, design and construction presented by Hailu Hundie (PCU) and Arega Yirga, 2010, Addis Ababa.

The water Consumption (requirement) of crop depends on the crop factor (KC) which is used as a unit to know the amount of water consumption. The crop factor, Kc, mainly depends on:

- the type of crop,
- the growth stage of the crop,
- the climate.

1. Kc and the type of crop

Fully developed maize, with its large leaf area will be able to transpire more and thus use more water than the reference grass crop. Therefore, Kc, maize is higher than 1. On the other hand a fully developed cucumber will use less water than the reference grass crop. Thus Kc, cucumber is less than one.

2. Kc and the growth stage of the crop

A certain crop will use more water once it is fully developed, compared to a crop which has just recently been planted.

3. Kc and the climate

The climate influences the duration of the total growing period and the various growth stages. In a cool climate a certain crop will grow slower than in a warm climate (see table 2).

Table 2: Values of the crop factor (Kc) for various crops and growth stages

Crop	Initial Stage	Crop Dev. Stage	Mid-Season	Late Season Stage
Barley / Oats / Wheat	0,35	0,75	1,15	0,45
Bean, green	0,35	0,70	1,10	0,90
Bean, dry	0,35	0,70	1,10	0,30
Cabbage / Carrot	0,45	0,75	1,05	0,90
Cotton / Flax	0,45	0,75	1,15	0,75
Cucumber / Squash	0,45	0,70	0,90	0,75
Eggplant / Tomato	0,45	0,75	1,15	0,80
Grain, small	0,35	0,75	1,10	0,65
Lentil / Pulses	0,45	0,75	1,10	0,50
Lettuce / Spinach	0,45	0,60	1,00	0,90
Maize, sweet	0,40	0,80	1,15	1,00
Maize, grain	0,40	0,80	1,15	0,70
Melon	0,45	0,75	1,00	0,75
Millet	0,35	0,70	1,10	0,65
Onion, green	0,50	0,70	1,00	1,00
Onion, dry	0,50	0,75	1,05	0,85
Peanut / Groundnut	0,45	0,75	1,05	0,70
Pea, fresh	0,45	0,80	1,15	1,05
Pepper, fresh	0,35	0,70	1,05	0,90

Source: *Training on crop water requirement and methods of its estimation, presented by Dr (Phd) Abdi Boru, Oromia BoA, 2010, Adama*

The volume of water to be stored in the pond should be calculated not only on the bases of the volume of water t o be consumed by different consumers. In addition to that it should be also calculated on the amount of water losses due to evapo-traspiration and seepage.

The following calculation illustrates the volume of consumable water and the volume of losses separately and adds it to show the whole volume of the water.

Figurative data for capacity calculation:

- Crop data: Selected crop is sorghum, Average Kc is o.7
- Livestock data: Total livestock number (using the reservoir) 500, water consumption is 50l/day/animal.
- Population data: Number of users is 400, water consumption 40l/day/person.
- Losses data:
  - → Average reference crop evapo-transpiration during the dry period is 6mm/d, irrigation area is 2 ha, overall water application efficiency is 40%, dry period is 90 days.
  - → Seepage loss is assumed to be equal to ETo losses. Reservoir: Surface area is 1000 m2, bottom and side walls area is 1500m^2.

Computation

Irrigation water demand	Livestock water demand	Domestic water demand	Total water demand
Etcrops=Kc x Eto+0.7 x 6mm/d=4.2mm/d Etcrop(dry period)= Etcrop(day) x dry period= 4.2mm/d x 90d= 378mm Ir= 10 x Etcrop x Ca/Ef = 10 x 378 x 2/0.4= 18900m3	WL=NL x Ac x T/1000= 500 x 50 x 90/1000= 2250m3	Wd= Po x Dc x T/1000=400 x 40 x 90/1000= 1440m3	Total water demand = Ir + WL + Wd = 18,900 + 2,250 + 1,440 = 22,590m3

Where:

Etcrop = Crop water requirement in mm per unit of time,
Kc = Crop factor (crop coefficient),
Eto = Reference crop evapo-transpiration in mm per unit of time,
Ir = Irrigation water requirements in cubic meters for the whole dry period,
Ca = Area irrigated with water from the reservoir in ha,
Ef= Overall water application efficiency,
WL = Water needed for livestock during the whole dry period,
NL = Number of animals to be watered from the reservoir,
Ac = Average rate of animal water consumption in litres per day per animal,
T = Duration of the dry period in days,
Wd = Domestic water supply during dry period in cubic meters,
Po = Users of the reservoir,
Dc = Average rate of water consumption in liters per day per person.

Computation of Losses

Seepage losses	Evaporation losses	Total losses
Seepage losses assumed equal to 6mm/d. Total seepage losses = Seepage loss x Bottom and side wall areas = 6mm/d x 1500m2 = 9m3/d	ETo x Surface area of the reservoir = 6mm/d x 1000m2= 6m3/d	Total losses = (Evaporation losses + Seepage losses) x dry period = (6 + 9m3/d) x 90d = 1,350m3

Source: Natural resources management directorate, MOA, April 2011, Addis Ababa.

Required Storage Capacity = Total water demand + Losses = 22,590 + 1,350 = 23,940m3.
Where there is no such scientific data or for other technical problems, the expected water use can be calculated by asking the water users about their daily consumption.

Volume of a pond is calculated based on the shape of the pond. Usually there are two commonly used shapes in pond construction (Circular and rectangular).

a) Circular pond

Volume of a circular pond can be calculated by multiplying the average area of the pond by its depth.

- To avoid collapsing or sliding of the sides of ponds, it should have a certain permissible side slope.
- The volume of the sloping sides therefore should be deducted from the total volume of the pond.

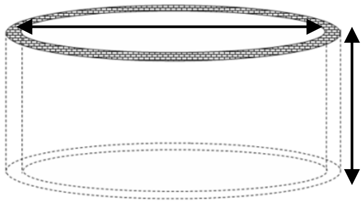
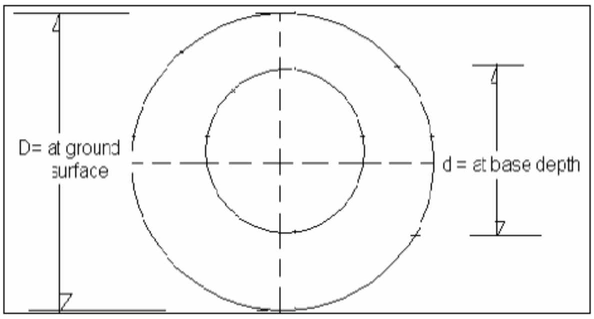


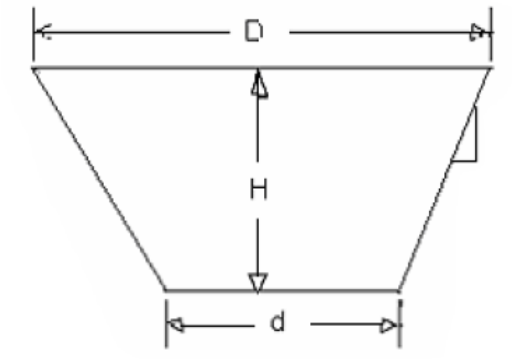
Figure 1: Circular pond

A circular micro-pond is usually 4 – 6 meters radius and 3 – 4 meters deep. The cone of the pond is truncated at its bottom, allowing for 2-3 meters diameters flat bottom. Circular pond is preferable to rectangular if the slope is steepy.

Top view of circular pond



Front view of circular pond



The volume of a circular pond can be calculated by multiplying the average area of the pond by its depth. To avoid collapsing or sliding of the sides of ponds, it should have a certain permissible side slope. The volume of the sloping sides therefore should be deducted from the total volume of the pond. Its computational formula is as follows.

I) The average area

$$A_S = \frac{\pi D^2}{4} \qquad A_b = \frac{\pi d^2}{4}$$

$\pi = 22/7 = 3.1428$

Where:

A_S = Area at the surface of the pond, m^2.
A_b = Area at the base of the pond, m^2.

$$A_{av} = \frac{A_S + A_b}{2} = \frac{\pi(D^2 + d^2)}{8}$$

Where:

Aav = Average area of the pond, m^2.

The average volume or the capacity of a pond can be calculated by using the following formula:

$$V_{av} = A_{av} \times H = (\pi (D2 + d2)/8)xH$$

Where:

V_{av} = Volume or capacity of the pond, m^3.
H = Depth of the pond, m.
D = Diameter of the pond at the surface, m.
d = Diameter of the pond at the bed of the pond, m.

b) Rectangular pond

Volume of a rectangular pond can be calculated by multiplying the average area of the pond by its depth.

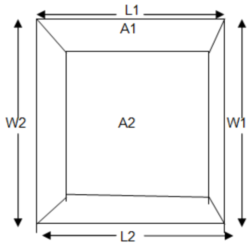
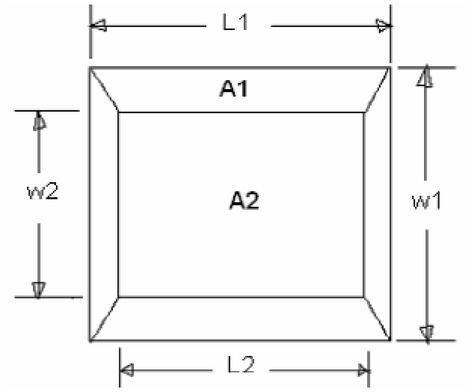


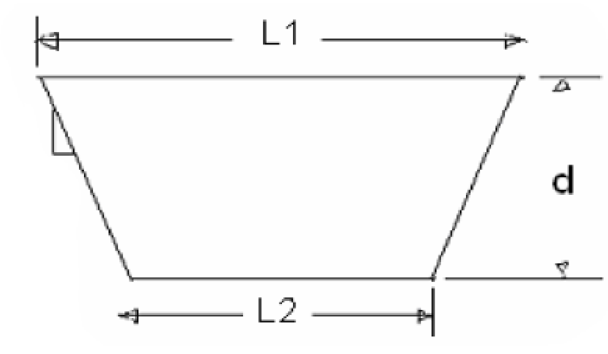
Figure 2: Rectangular pond

A Rectangular pond is rectangular in shape with the depth of 2.5 m – 3.5m. It is cheaper than circular pond and larger in size which means more capacity to store water.

Top view of Rectangular pond



Front view of Rectangular pond



The volume of a rectangular pond can be calculated by multiplying the average area of the pond by its depth.

The surface area (A1) and area at the bottom of the pond (A2) is calculated as follows:
A1 = W1 x L1
A2 =W2 x L2
Aav = (A1 + A2)/2 = **(**(W1xL1) **+** (W2 x L2)**)**/2

Where:
Aav = The average area of the rectangular pond, m2
A1 = Area of the surface of the pond, m2
A2 = Area at the base of the pond, m2
W1 = Width of the pond at the surface, m
W2 = Width of the pond at the base, m
L1 = Length of the pond at the surface, m
L2 = Length of the pond at the base, m

Volume of a rectangular pond can be calculated by using the following formula:

Vav = Aav x d = **(**(W1 L1 **+** W2 L2) x d**)**/2

Where:
Vav = Average volume or capacity of rectangular pond, m3.
d = Depth of the pond, m.

1.2.2 Layout and Construction steps of Micro Pond

The general layout

The general layout of the pond needs to be defined according to the slope layout and excavation layout. See Figure 3 and 4 below to read the layout.

- Consider point O in the two figures as a centre of the micro-pond ,
- Regarding slope layout, if the side slopes are considered to be the same in both sides, the distance of the two sides are equal (see figure 3 side AC & BD). Similarly, distances of OA & OB are as well equal,

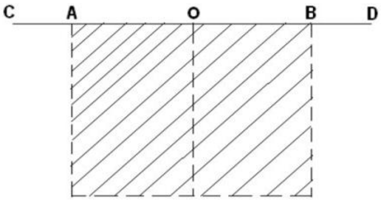


Figure 3: Slope layout (CBPWD guideline, 2005)

- Regarding excavation or digging layout, first read ''AMNB'' for digging and then shape CAM and DBN as shown in the figure 4 below.

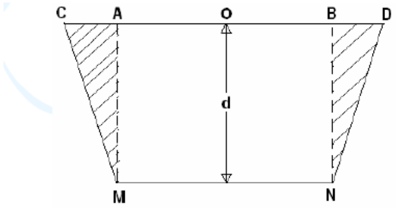


Figure 4: Excavation layout *(CBPWD guideline, 2005)*.

To know the minimum depth of a pond, the following losses must also be considered:

Climate	Rainfall, mm	Minimum Depth of Water over 25% of Pond Area, m
Humid	1000-1500	3
Sub-humid	750-1000	3,5
Semi-arid	500-750	4

Source: Training on pond planning, design and construction by Hailu Hundie & Arega Yirga, 2010, Addis Ababa.

Construction of micro pond

Site Selection:

Planning of micro-ponds follows groups and individual owners' agreement on the location, the source of runoff to exploit, the purpose, the types of crops, and the management. When we plan to construct a micro-pond it is important to discuss with the target community focusing on:

- Drying of springs and water in the wells in surrounding area
- Shortage / lack of water for domestic and livestock
- Drying of perennial grasses and other vegetation
- Where and how to get local labor and equipment.

Selecting a suitable site for micro-pond construction is important. A suitable site for a micro-pond is an area where a limited amount of excavation is required to contain or hold a large volume of water. Construction of micro-pond is suitable in all agro- climatic zones except in areas with excessive dryness (below 400 mm annual rainfall) as it is not cost effective.

The following criteria can be used for micro-pond site selection:

- On open fields to collect water from graded bunds and waterways
- At the foot of treated hillsides to increase the recharge of ground water table
- Inside large gullies (only if the gully is treated and will not deepen, widen and move on)
- Around homesteads
- At a point where maximum volume of water can be collected with least digging or earth fill
- Around grazing land at about not more than 1km
- Away from farm drainage and sewage lines in order to avoid possible pollution.

In addition to the selection of the side, other factors have to be taken into consideration. Construction of micro-ponds should be during the dry seasons before the beginning of rainfall. In addition, appropriate time or seasons to find labor force should be considered as micro-pond construction and its management is labor intensive.

Tools and Equipments:

For constructing micro-ponds the following tools and surveying materials are required:
1) Cement 2) Sand 3) Crow bars 4) Plastic cover 5) Shovels 6) Wooden poles 7) Buckets 8) Pegs 9) Strings 10) Measuring tapes 11) Pick axes 12) Wooden compactors, e t c.

Construction procedures/steps:

- Mark the pond on the ground,
- Start digging the pond,
- Keep the soil 3 m away from the edge of the pond,
- Consider point O in the figure 4 above as a centre of the pond,
- If side slopes are considered to be same in both sides the distance of points AC & BD are equal. Similarly, distances of OA & OB are as well equal (See figure 4 above).
- Start excavating or digging AMNB first and then shape CAM and DBN as shown in the figure 4 above.
- Construct the pond as the design shows in the figure 5 below.

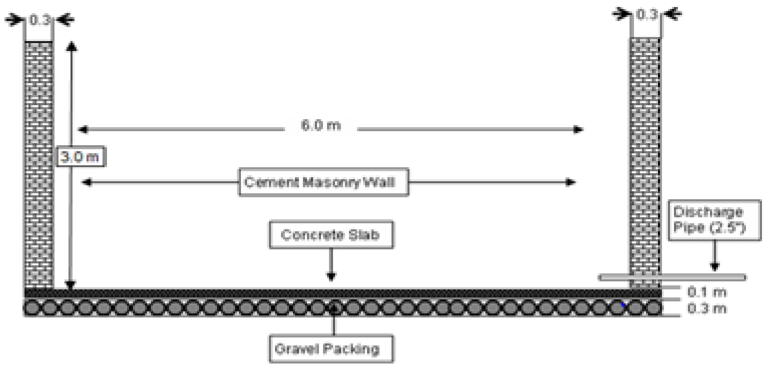


Figure 5: The design of 85 m3 storage pond (Source: Sustainable utilization of natural resources program, 2005, Tigray)

- Construct silt-trap
  Construct small silt traps before water enters the micro-pond (2m length x 2m width x 1m depth (see photo below).

Source: Sustainable utilization of natural resources program, 2005, Tigray

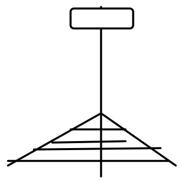
More than one silt trap may be required (especially for micro-ponds collecting water from erodible soils- check first year add one if necessary.

- Seal the pond:

Ponds can be sealed by using different sealing methods such as compaction, clay blankets and waterproof linings.

  - **Compaction:** If the material around the pond area contains a small gravel or coarse sand to fine sand, enough clay of 10 percent or more and silt compaction can be an effective sealing.
  - **Clay blankets:** If a pond area is containing high percentages of coarse grained soils, but lacking enough clay to prevent excessive seepage, it can be sealed by blanketing. Blanket the entire area over which water is to be impounded as well as the upstream slope of the embankment. The blanket should consist of a well-graded material containing at least 20 percent clay.
  - **Waterproof linings:** Using waterproof linings is another method of reducing excessive seepage in both coarse-grained and fine grained soils. Cementing, Polyethylene, vinyl, butyl-rubber membranes, and asphalt-sealed fabric liners are the commonly used waterproofing lining materials got wide acceptance as linings for ponds. Because they virtually eliminate seepage if properly applied.

- Prepare a forked stick as shown below to shake the water in the pond every day. So that the breeding of malaria mosquito will be protected.



1.3 Management and Maintenance Micro Pond

Feeling of ownership on the part of community, leadership of a Kebele leaders and frequent technical advice of DAs at site are decisive preconditions for continuous maintenance and *sustainability of the pond*. Provided this, there will be frequent information exchange among these main actors to:

- protect pond from the reach of children and animals by fencing,
- Repair broken part of the pond,
- Remove silt from reservoir/silt trap as required,
- Check and repair the sealing if there is any breach or wrinkle.

1.4 Major issues not to forget and Common mistakes

Don’t forget to:

- select a location where there is adequate surface runoff availability and non-polluted catchment,
- exchange information with the community.
- treat the upper catchment to minimize siltation of the pond

The following mistakes are often made:

- Inappropriate layout or design
- Forgetting to treat the runoff area (upper catchment)
- Forgetting to fence the pond
- Forgetting to place ladders in the pond.

REFERENCES

1. MOA, Guideline for seepage control methods in rain water harvesting structures, April 2011, Addis Ababa.
2. MORAD, Community-based Participatory Watershed Development Guideline, 2005, Addis Ababa.
3. Sustainable Land Management in Practice Guidelines and Best Practices for Sub-Saharan Africa.

MODULE 2: PERCOLATION PIT

2.1 Concept of Percolation Pit

The percolation pit concept includes its description, purpose, time to construct, suitability and agro-ecology.

Description of percolation Pit

A percolation pit is a structure that is constructed to harvest water. It is designed to allow the harvested water to "percolate" or infiltrate into the ground so that the percolated water recharges the ground water supply.

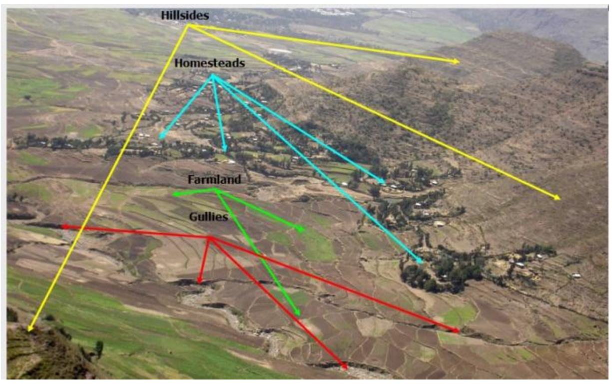
Purpose of constructing percolation Pit

Percolation pit is constructed for the following purposes:

- Recharge the ground water,
- Enhance production through improved water availability,
- Reduce runoff and subsequently erosion and land degradation.

Time to construct percolation pit

Percolation pits are constructed only during the dry season and period not interfering with agriculture.
Percolation pits are constructed only during the dry season and period not interfering with agriculture.



Source: Sustainable utilization of natural resources program, 2005, Tigray

Suitability and agro-ecology

Percolation pit could be constructed in a wide range of conditions in any topography where there is availability of adequate runoff to be diverted to the pit:

- At any marginal lands where there is no drainage problem or where the ground water table is deep.
- At abandoned quarries and depressions
- At outlets of cut-off drains/waterways
- Inside water courses (creek)
- Between check dams
- Areas where the ground is pervious.

2.2 Design, Layout and Construction of Percolation Pit

Required Size and number

The layout and design of a percolation pit needs to be defined according to the required size. The size of the percolation pit may vary depending on the geomorphologic, topographical and soil condition and the catchment area to be rescued from flooding. Different sources give slightly differing sizes depending on the situation they are dealing with. Percolation pit is constructed in the open space at required intervals.

- Size "1m x 1m x 1.5m (depth)
- Filled with broken bricks / pebbles
- Suitable for sandy sub - soil area
- One unit for 300 sq.ft area (approx.) (*Source: www.aboutrainwaterharvesting.in/rwh-methods-pitmethod.htm)*

If the open space surrounding the land is more and it is not paved, the surface run off may be recharged into ground through percolation pits. Depending on the geomorphologic, topographical and soil condition, the pits may be of the size of 1.20 m width x 1.20 m length x 2.00 m to 2.50 meter depth (Source: www.cmakarnataka.com /WCT/htm/rwh_type.htm).

Percolation pit is constructed in the open space at required intervals. Size " 1m x 1m x 1.5m (depth) and filled with broken bricks / pebbles Suitable for sandy sub - soil area. If the soil is clay, the pit has to be dug to a depth till a reasonably sandy stratum is reached. The diameter of these pits will be 25 cm (10 inches). A square / circular collection chamber with silt arrester is provided at the top. Approximately, one unit for 300 sq.ft area is recommended.

In Ethiopia bigger size is recommended than the above mentioned. The recommendation is to make the top size 3m diameter by 0.5m depth, next to that within it to make 2.5m diameter by 2m depth and within it to make 1.5m diameter by 1 depth. The detail will be illustrated latter in module 2 and 3 (Source: CBPWD guideline, 2005).

However, the recommendable size or number of percolation pits is when the pits are capable to manage storm water run- off, prevent flooding and downstream erosion *(Source: Wikipedia, the free encyclopaedia).*

The latest case practiced in Jakarta (Indonesia) in 2013 depicts the fact that the size and/number of percolation pits have to be determined on the basis of securing the given area from flooding and erosion.

Case study: Percolation pit size/number

The Jakarta Post, Jakarta |Jakarta| Sat, 26 January 2013, 8:04 AM

The Jakarta administration is set to get tough with the managements of land to ensure the land users build percolation pits as required.

Although most of land owners say they have dug the pits, the land planner suspects otherwise.

“Seeing what has happened [the floods], including those on Jan. 17, I doubt that they have [percolation pits],” she told The Jakarta Post on Friday. “The volume of water on [Sudirman] showed that the pits don’t exist.”

She added that the lack of a clear punishment in the 2005 regulation led to weak enforcement despite the importance of percolation pits.

Jakarta Governor recently made a target of digging at least 100,000 percolation pits over the next five years, making it one of breakthroughs in countering the endemic flooding and erosion problem.

He also pledged to take back the land ownership certificate from the land users who did not comply with the regulation.

The construction to of percolation pits is mandated to Construction Supervision and Regulation Agency by the regulation, stipulating that the administration, through its Construction Supervision and Regulation Agency, supervises the construction of the pits to ensure their compliance.

The environmental sustainability division head of the Jakarta Environment Management Agency (BPLHD) said percolation pits would contribute to efforts to eradicate flooding and erosion as they reduced the volume of water flowing above the ground. The Agency reported that Jakarta had 86,551 percolation pits as of December 2011, with a total capacity of 3,104,127 cubic meters.

Construction Supervision and Regulation Agency head said that his team made sure of the existence of percolation, starting from the design that developers attached when handing over the landownership certificate.
Agency said, “If we find a building without the required pit, we will not extend the land ownership certificate.

Henceforth, he said he would encourage group members to comply with the rule as the city administration was also ready to apply stricter punishments for violators.

2.2.1 Technical standards and design steps

1. Excavate a 50 cm deep pond of any shape with either sides ranging from 2.5 to10 m.
2. Inside the 0.5 m pond, excavate a pit with a diameter of 2.5 m and depth of 2 m
3. Inside the pit excavate another pit with a dia. 1.5 m to a minimum depth of 1 m or more.
4. The upper most portion of the pit is covered with an artificial filter to prevent suspended materials from entering into the recharged water.
5. The filter consists of o.4 thick coarse sand, o.5 m thick gravel (diameter 20 mm) and stones of 40 mm size starting from 1 m below the surface up to the bottom end.
6. Spacing between two pits shall be about 50 meter.

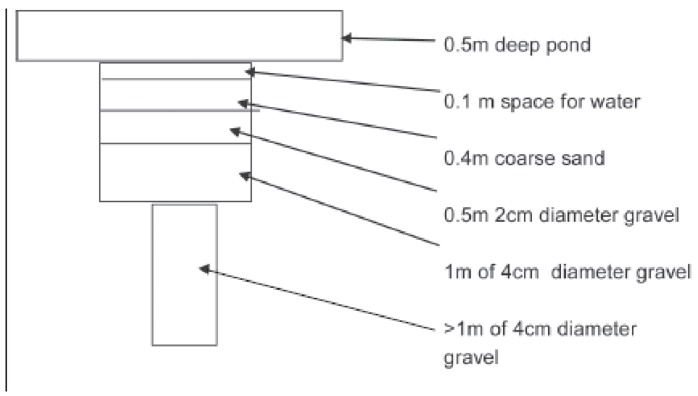


Figure 1: design of percolation pit

2.2.2 Layout and Construction steps

Layout:

The pit can be laid as a circular and the outer pond can be laid in compliance with the shape of the available land. Sketch the top 0.5m deep pond with 3m diameter and again 2m deep pit with 2.5m diameter. Then sketch the Next 1m deep pit with 1.5m diameter (see figure 2 below).

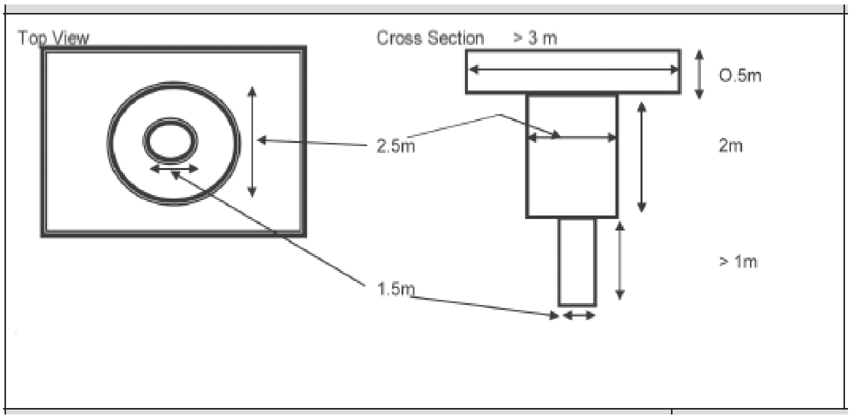


Figure 2: The Layout (Source: CBPWD guideline, 2005)

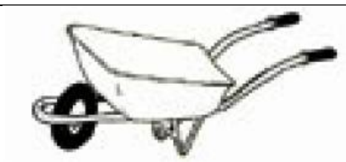
Construction steps:

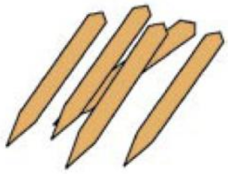
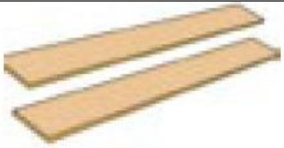
Preparation of tools required:

The following materials/tools are needed for the construction of percolation pit:

1) Shovel 2) Wooden poles 3) Bucket 4) Pegs 5) Strings 6) Measuring tapes 7) Pick axes 8) Wooden compacters, ladder, trolley, e t c. See table below.

Tools and equipment required for pond construction.

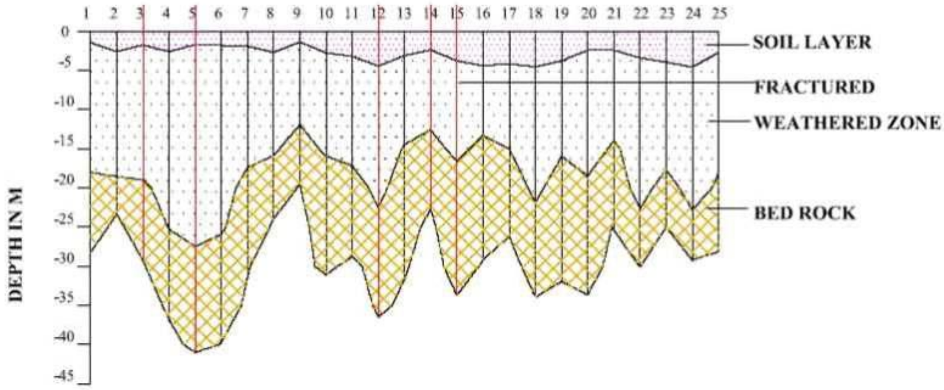
Item	Picture
Konchora to cut weeds and unnecessary things from the place of construction	
Axes to cut and/or split necessary materials for construction	
Pick axe to pick any kind of materials	
Hoes to digg	
Shovels to lift and move thesoil	
Wheel burrows to move soil	

String (for measuring and showing the lines).	
Pegs to measure the distance and/or to stretch strings and/ropes.	
Locally made equipment to move soil	
Timber 12”X1” (for pushing wheel burrows on in the bottom mud).	
compactor locally made from wood and scrape metal to compact soil	

The construction step for percolation pit follows major steps. These are:

Step 1: Select site for percolation pit

Many factors affect the suitability of a site as an infiltration facility for the disposal of percolation pit. Among these, the following are most important the depth to groundwater, surface and underlying soil type. For example the coastal areas, where there is an important layer of sand under the first layer of clay are fit to the doing of a percolation pit (sand has a high level of percolation).

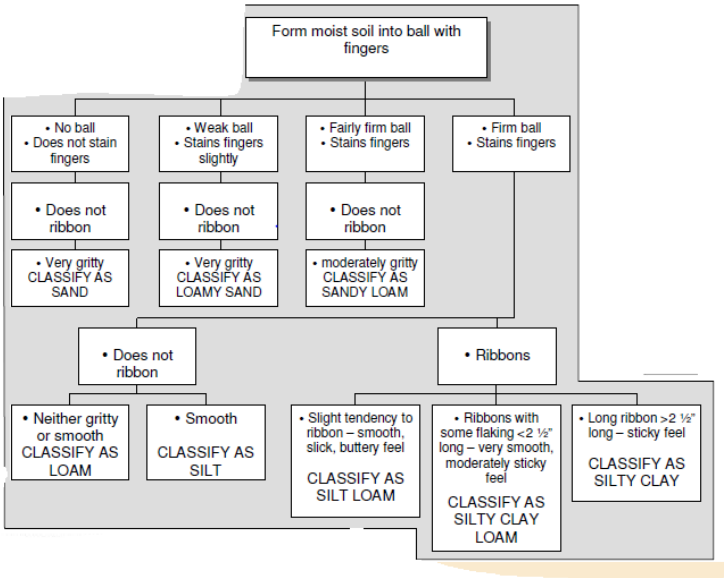


Source: National Agricultural Advisory Services (NAADS), Aquaculture technical manual vol. 1, Kampala (Uganda), 2005

Step 2: Identify permeable earth

The site should have a sufficient clean and large catchment. It should also permit fast percolation

Step 3: Test with fingers to get sandy soil



Step 4: Excavate

The excavation should reach porous soil / weathered rock / fracture. Generally it happens from 6 to 8 feet deep. The diameter of the pit will depend on the catchment area, the rate of percolation of the soil. It can vary between half meter to 3 meters.

Step 5: Fill the pit with the big jelly

You need jelly of different sizes and sand for the top of the pit. The big jelly at the bottom form big holes for the water.

Step 6: Fill the pit with the small jelly

The smaller ones on the top of it will support the layer of sand. A mesh between the sand and the jelly will prevent the sand to escape below. Instead of the sand, you can put a layer of soil (leaves or planted earth). These materials will also filter the water.

Step 7: Finish constructing percolation pit

Step 8: Adapt to Locality

If the pit aims to recharge a bore well, it should be built as close to it as possible. Ideally it should be in the valley of the surface layout.

Potential linkages with other structures:

Percolation pits are considered as an element of an integrated watershed development. They are linked with structures constructed for water use like hand-dug well and spring development. All harvesting structures and percolation pit usually go together for the maximum and efficient erosion control. For example, see the photo below how semi-circle terrace and percolation pit are linked.

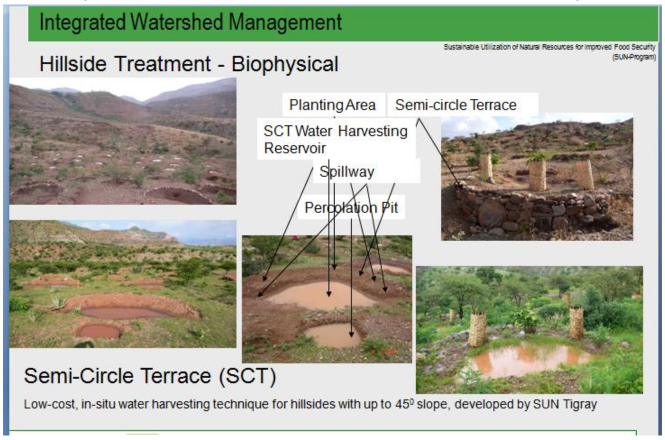


Photo: How percolation pit is linked with semi-circle terraces

As percolation pit is a structure to harvest the inflow water and let-out the outflow water it is highly connected with basins, particularly with ring-basins. (See photo below).

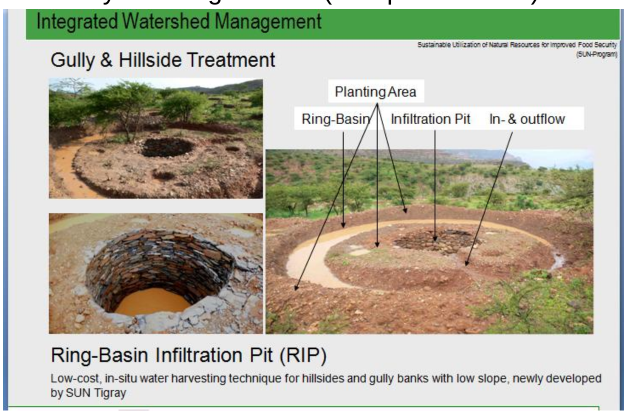


Photo : How percolation/infiltration pit is linked with ring-basin

2.3 Management and Maintenance

Percolation pits require proper regular follow-up and maintenance through user groups. The maintenance of percolation pit would include:

- Repair of breakage,
- Stabilization of embankments,
- De-siltation of pits 3 to 4 times during the rainy season, if deposition is too high (during intensive rain), and
- Gap filling & reinforcements with stones if necessary.

Work Norm**:** 1 m3 / Person/day for the first 1m depth; 0.5 m3 /PD thereafter. The work norm involves digging, disposing of spoil, and excavation of diversion. Canal Gravel and stone collection $0.5m^3$/Person/day.

2.4 Major issues not to forget and Common mistakes

Do not forget to:

- Add stones and gravels according to the construction procedures.
- Starting percolation pit construction from the top of the catchments and move down wards.
- Do not forget the removal of silt.

The following mistakes are often made:

- Inappropriate layout or design
- Forgetting to treat the runoff area (upper catchment)
- Using local stones instead of coarse sand.

References

Low-cost, in-situ water harvesting technique for hillsides with up to 45 Degree slope, developed by SUN Tigray.

Low-cost, in-situ water harvesting technique for hillsides and gully banks with low slope, developed by SUN Tigray.

MORAD, Community-based Participatory Watershed Development Guideline, 2005, Addis Ababa.

MODULE 3: HALF MOON STRUCTURE

3.1 Concept of half-moon structure

Description of half-moon structure

Half-moons are semi-circular structures made out of soil constructed along the contours. It has a rainfall multiplier system that allows cultivation of crops in low rainfall areas.

Purpose of constructing half-moon structure

The main purpose of half moon structures is for collecting and storing rainfall water meant to support the growth of trees or crops. Large half moons are suitable structures to enable cultivation of drought resistant crops in areas with very low rainfall.

Time to construct half-moon structure

Half-moon structures are mostly constructed during the dry season or after short rainy season for hard soil and when labour is available.

Suitability and agro-ecology

Half moon structures are appropriate to be constructed on degraded hillsides with slopes less than 5%. It is applied in areas with soil depth 30-50cm sandy and sandy loamy soils affected by low fertility levels and thin surface crusts that inhibit infiltration and increase runoff. It is also physical measure suitable for rangelands and degraded grazing lands in dry areas for forage crops.

3.2 Design, Layout and Construction of Half-moon Structure

3.2.1 Technical standards and Design steps

Half-moon structures are semi-circular bunds 5-15 meters large, 50-75 cm high and with a decreasing height at their tips to evacuate excess water although soils are often permeable enough. Slopes should not exceed 5% and soil depth should be not less than 30-50 cm. The run on-runoff ratio should be 1:1 to maximum 1:3 as more runoff can break the embankment. This means a 5 meter diameter half moon (has 2.5 meters width of cultivated area) will be distant from the next one 5 meters; with 1: 1 ratio, 7.5 meter with 1:2 ratio and 10 m with 1:3 ratio. Half-moons also can be placed one attached to the other (1:1 ratio) as a continuous system. However, the drier the area the higher the ratio between runoff-run on areas will be expected to take place.

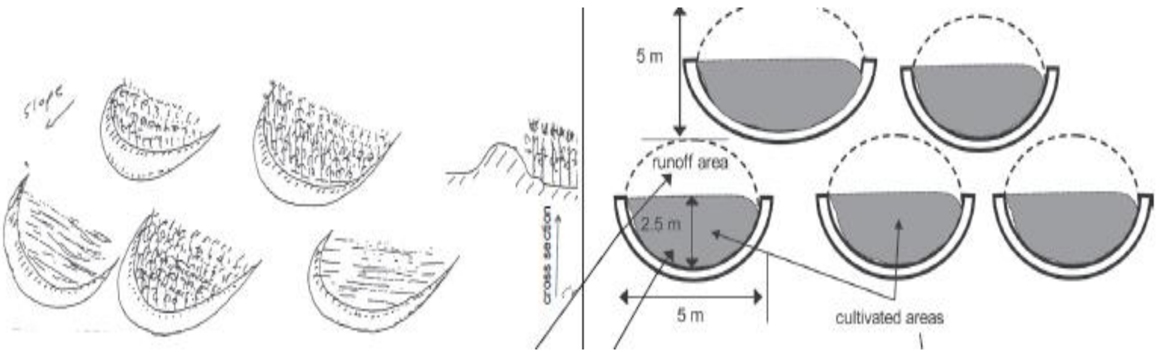


Figure 1: Half-moon structures (CBPWSD Guideline 2005)

The number of half-moons structures to be constructed can be calculated using the following formula:

$$N = \frac{A*10,000}{2D2}$$

Where,
N= No. of half-moons in a given catchments
A= Catchments area (ha),
D= Diameter of half-moons (meter)

$$\frac{C}{CA} = 1:2$$

If there is hillside terrace,

$$N = \frac{A*10,000-2000L}{2D2}$$

Where, L= the length of hillside terrace (km)
Work Norm: 4 half-moons per person per day.

Modification to Standard

If the half moon structures modified and applied correctly, it is a very effective technology measures for the reclamation and rehabilitation of shallow and crusted sandy areas. It is usually a zero-runoff system thus reduces erosion significantly.

3.2.2 Layout and Construction steps

Lay out procedures:

Step 1: Mark the first contour line using line level and put pegs.

Step 2: Mark the tips of the half-moon with pegs on the marked ground line with the string having meters (twice the radius of the half-moon). The distance to the next unit along the contour is a meter while along the slope is ---meters (depending on the slope).

Step 3: Mark the centre point of each half-moon structure with pegs at the fixed radial length. Use a piece of string and hold the string tight at the other end. The alignment of the half-moon structure is now defined by swinging the end of the string from one end to the other.

Step 4: Follow the same procedure for the next row lay out of the half-moon structure. It is important that the structures in each row are staggered in relation to the structures in the row above. The centre point of bunds, for example, in the second row should coincide with the middle of the gaps between the bunds in the first row and so forth.

Step 5: Demarcate the tie around the pit (10-15cm from pit border on both sides).

Step 6: After completing lay out, excavate a small trench inside the bunds further excavation should always be from inside the bund, as evenly as possible

Step 7: Reinforce the tips of the half-moon structure with a layer of stones for ensuring the bund tips resistant to erosion when excess water discharges around them.

Construction steps:

Half moon can be constructed of different dimensions to accommodate various needs and conditions.

- Construction start by digging a water collection ditch 1mx1mx30cm deep
- The excavated soil is piled and compacted 15cm from the border of the pit and given a half-moon shape.
- The embankment is supposed to be 30-50cm high and have a base width of 60-90cm.
- A 30cm x 30cm x 30cm pit is then dug in the lower part of the water collection pit
- They are constructed in a staggered position one from another (triangle)

Tools/equipment needed:

- A-frame used for layout of the half-moon structure.
- String and meter, shovels and pick axes are used.

3.3 Management and Maintenance of Half-moon

Follow up and repairing the damaged or broken parts of the half-moons structure whenever it is needed. It may require some maintenance in case of intensive rains during first year.
Integrated with control grazing and tree/shrubs planting on embankment such as pigeon peas, etc) plus manure application highly needed.

3.4 Major issues not to forget and Common mistakes

Don't forget to:

- Repair immediately small damages in case of intensive rains during first year of the structures establishment,
- Conduct monitoring and evaluating through field visits by DAs and community group leaders,
- Carry out controlled grazing in the newly established half moon structures.

Common mistakes
The following mistakes are often made:

- Not enough attention paid to protect from wildlife interference (porcupines, baboons, „gihe"etc)
- Semi-circle-structures is not supported by skill training.