**Recommendations - Low cost water harvesting structures**

**Low cost water harvesting structures**

**LDPE Film Lined Tank**

To increase the irrigation potential in hills, it is necessary to develop the water resources by means of small tanks (capacity up to 100 m³). The criterion for the design of tanks should be such that it not only reduces the seepage losses but it is cost effective as well. The cement tank for instance is able to check the seepage losses but the cost becomes the limiting factor in economic exploitation of water resources. On the other hand unlined tanks prone to heavy seepage losses (300-400 litre per day per m²) and may not be able to supply water for irrigation during stress. Thus, for the effective water storage, the tank should be with minimum seepage loss and cost effective.  

Low density polyethelene (LDPE) film has been successfully used to effectively control the seepage loss at much lower cost than the cement tanks. The film used should have minimum thickness of 200µ, otherwise it becomes prone to physical damage. Enhancement of effective life of plastic film and to avoid the physical damage the protection of the film is necessitated which can be realized through pitching.

**Benefits of pond lining with plastic films**

- Reduction in seepage losses to the maximum extent (95%)
- Harvesting and storing of rain water from early monsoons.
- Utilization of harvested rain-water for short during crops as well as during off season.
- Lining of ponds and reservoirs with plastic film improve water availability over a longer period of time.
- It is highly useful in porous soils where retention in ponds and water harvesting tanks is minimal.
- Economical and effective method of storing water.
- Eliminates water logging and prevents upward intrusion of salts into stored water.
- Useful for the purpose of storage of drinking water, for pisciculture and for providing supplementary irrigation.
- Prevents soil erosion.
- Technique is also suitable for lining of effluent ponds and channels to reduce soil and ground water contamination.
- It can also be used in the lining of saltpans for improving productivity as well as quality of salt.

The details of subsidy are as under:

<table>
<thead>
<tr>
<th>Item</th>
<th>Maximum permissible cost*</th>
<th>Pattern of Assistance*</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Community tanks/on farm ponds/on farm water reservoirs with use of plastic/RCC lining.</td>
<td>Rs. 15 lakh/unit in plain areas, Rs. 17.25 lakh/unit in hilly areas.</td>
<td>100% of cost for 10 ha of command area, with pond size of 100 m x 100 m x 3 m or any other smaller size on pro rata depending upon the command area, owned &amp; managed by a community/farmer group. Cost for non-lined ponds/tanks (only in black cotton soils) will be 33% less. Assistance under NHM will be restricted to the cost of plastic/RCC lining. However, for non MNREGS beneficiaries, assistance on entire cost including construction of pond/tank as well as lining can be availed under NHM.</td>
</tr>
<tr>
<td>(a) Water harvesting system for individuals – for storage of water in 20mx20mx3m ponds/dug wells @ Rs. 100/- cum</td>
<td>Rs. 1.20 lakh/unit in plain areas, Rs. 1.38 lakh/unit in hilly areas for maximum command area at 2 ha</td>
<td>50% of cost including lining (in plains) and 75% of cost i.e. Rs. 1.03 lakhs per beneficiary in hilly areas. For smaller size of the ponds/dug wells, cost will be admissible on pro rata basis. Maintenance to be ensured by the beneficiary.</td>
</tr>
</tbody>
</table>

*Subsidies are liable to be changed from time to time and please consult your local horticulture officers for latest patterns.

Layout, Shape, size and storage capacity

Shape depends on the soil type, which dictates the maximum possible slope that will stay in place without falling in. normally, the shape is kept as trapezoidal with side slopes of 1:1 to 1:2 and effective depth 1.5 to 5m. The side slopes should have a ratio of 1:1 and 1:2 for stable and unstable soils, respectively. The pond should be constructed in the form of frustum of an
inverted pyramid (Fig. 1 & 2). The size of water harvesting structures is important, but more important is its sustainability, efficiency and appropriateness. The demand dictates the required storage capacity. The catchment area and rainfall determine the supply and storage capacity are necessary for achieving higher water productivity. The basic principle for sizing any rain water system is that volume of water that can be captured and stored (the supply) must equal or exceed the volume of water required (the demand). The water storage capacity of pond (V, volume) having 1:1 side slopes can be calculated with following formula:

\[ V = \frac{H}{2}[(W-2F)(L-2F) + (L-2H-2F)(W-2H-2F)] \]

Where, \( L = \) Top length (m); \( W = \) Top width (m); \( H = \) Depth of tank (m); \( F = \) Free-board (m)

Note: \( L \) and \( H \) can be decided depending upon site conditions. However, \( H \) should not be less than 1.5 m and more than 5 m. normally, free board (F) for the small ponds may be kept between 0.1 to 0.3 m. units of measurements can be taken in feet or meters.

An alternative and simplified formula for computing the volume (V) of trapezoid shape ponds with 1:1 slope (Fig. 2) is:

\[ V = \frac{L_1 X W_1 + L_2 X W_2 + (L_1 X W_2 + L_2 X W_1)}{2} H / 3 \]

Where, \( L_1 = \) Top length, \( W_1 = \) Top width, \( L_2 = \) Bottom length, \( W_2 = \) Bottom width, \( H = \) Effective depth

The cost may vary from site to site as per head load, size of pond etc. and site conditions. A contingency, excavation provision extra rate considered for estimation are current pertaining to market rate. The details of calculating ponds of 100x100x3m and 20x20x3m is given at the end of this chapter.

Computation of requirement of material: The material for trapezoidal shaped farm pond with side slopes of 1:1 can be calculated as under:

Area of the lining sheet = \[ 2 \sqrt{2}(H+F) + 1.0 + (W-2H-2F) ] \times [ (2 \sqrt{2}(H+F)+1.0 + (L-2H-2F)] \]

Area of brick/stone pitching = \[ 2 \sqrt{2}(H+F)x (W+L-2F-2H)] + [(L-2H-2F)x (W-2H-2F)] \]

(Excluding peripheral path)

Thumb rule for computing area of the lining sheet:

Length of sheet : \[ 2 \times \text{Path width (m)} + 2 \times \text{Slanted depth (m) at corner + Bottom (floor) length (m)} + 2 \times (0.5 \text{ m) for sheet anchoring in the peripheral trench}] \]

Width of sheet : \[ 2 \times \text{Path width (m)} + 2 \times \text{slanted depth at corner (m) + Bottom (floor) width (m)} + 2\times(0.5 \text{ m) for sheet anchoring in the peripheral trench}] \]

Area of sheet = Length of sheet \times width of sheet
Approximately 4.5 m² LDPE sheet (250 micron) weighs about, 1.0 kg

Weight (kg) of black LDPE sheet = \[ \text{Area of the sheet} / 4.5 \]

Weight (kg) of cross laminated = \[ \text{Area of the sheet} \]

Silpaulin sheet (200 gsm) = 5

The thickness of LDPE sheet should be 200-250 microns (800-1000 gauge) and should conform to BIS standard 2508/1977. For large size farm ponds of capacity more than 1000 m³, 1000 gauge sheet should be used.

Construction of farm pond

The construction process includes (i) Selection of site (ii) Excavation (iii) Lining of pond with sealants.

Selection of site: The site should be selected keeping in view the following issues:

- The pond should receive sufficient runoff.
- The site should be such that higher storage-excavation ratio can be achieved.
- The site should not have hard rocks which would require blasting consequently increasing the cost of construction.
- The pond should be close to the command area to ensure ease of irrigation preferably through gravity flow.
- The site should not be very close to the existing springs, if any; otherwise excavation may disrupt the capillary lines of the spring resulting in reduced discharge.
- The pond should not be constructed over the natural water source if found during the excavation process.
- There should not be any large tree near the site.

Excavation: First of all, the pond dimensions (L,W,D and side slope) identify and then mark the top level (outer rectangle/trapezium) as well as the bottom level (inner rectangle/trapezium) length and width clearly on the ground (Fig. 3). Put pegs at the corners of both the rectangles and tie a rope to demarcate pond dimensions. Start digging the area of the inner rectangle till desired depth is achieved. Excavated soil can be kept near the pond around the periphery and used later following the principle of cut and fill ratio. Give 1:1 slope by digging the side walls of outer rectangle for better stability of walls and pitching of
stones/bricks. This is readily ascertained by joining the top corners of the outer rectangle with the adjacent and nearest bottom corners of inner rectangle with a wooden frame.

Finishing of pond bed and side walls: After excavation, the side slopes of pond are made smooth and compacted by removing angular projections, protruding stones, pebbles, roots etc. Before laying the sheet, apply thin layer of slurry of clay and cow dung or place a thin layer of used gunny bags/soft grass between the sheet and the walls of the pond to avoid damage by sharp protruding objects. Spray of Atrazine @ 0.4 g/m² is given on the side walls after applying slurry for controlling weeds. If needed, simple pipe (5 cm diameter) spillway may be provided to regulate the outflow.

Lining of pond with sealants: The ponds are located on a variety of soil types which – exhibit wide range of seepage characteristics. The pond must be lined with a suitable sealant to minimize seepage losses and to improve storage efficiency. Different sealants have been evaluated by different institutes in the state (Table 1). Both black LDPE and Silpaulin sheets were found equally good. The black LDPE sheet has been proved to be more appropriate owing to its low cost and reliability. The Silpaulin sheet is costlier than the black LDPE. In addition, Tarfelt and other sheets are also available which can be used for lining.

Joining of LDPE sheet: Generally plastic sheets are available up to 14 m width. If possible, joining of sheets should be avoided by procuring sheet of required width. If joining required, bitumen heated to 100°C is spread over 30 cm wide strip on one sheet and this painted portion of the sheet is put over the counterpart and is pressed by a smooth object. It is then allowed to cool. Sheet can also be joined/repaired with synthetic rubber adhesive.

Laying of LDPE sheet and fixing outlet pipe: The plastic sheet is spread over the dug out area after ensuring that there are no sharp stones, pebbles, etc. on the side slopes. Anchor the lining sheet edges in a small trench (0.25x0.25 m) dug around the external periphery of the pond to ensure that sheet lies smoothly on the side walls of the pond and firmly held. The trench can be approximately 0.5 m away from the external periphery of the pond. The lining sheet should fit in the pond area loosely so that it does not break when it is anchored. The sheet should not be placed on a very hot and windy day. For fixing the outlet pipe through the sheet, a hole of 5 cm diameter, slightly larger than that of outlet pipe is made in the sheet. The sheet is then embedded with pipe in the embankment by pouring additional cement concrete (1:3:6) over the surface adjacent to hole.

Stone/brick pitching: The stone/brick pitching imparts longevity to the sheet as well as pond and both are important considerations of farmers. Both black LDPE and Silpaulin sheets are UV resistant but these are damaged by sunlight if exposed for longer duration. The plastic sheet must be protected by covering with inert material such as soil, bricks, stones, etc which is not damaged by UV rays. Pitching with bricks/stones also protects the sheet from any accidental physical damage by sharp objects. The brick pitching of bottom of the pond can be avoided and sheet is covered with about 15 cm soil layer. If soil is not to be used, a toe-wall is essential to support the bricks in the side slopes. For this a trench (about 5x5 cm) is to be dug along the bottom periphery of the pond. Once the toe-wall is constructed then the brick pitching of the sides should be done from bottom to top. In areas, where bricks are not
readily available, flat stones with blunt edges can be used. Stone pitching is started by placing bigger diameter stones (about 20 cm) at the bottom of the slope. The diameter of the stones should be gradually reduced (about 10 cm) as the pitching work proceeds towards the top of the side slopes. The bricks/stones are arranged in a manner that provides grip to each other. The gap between the bricks/stones may be then filled with cement mortar (1:8) for strengthening the pond. The top 30 cm width of stone pitching is plastered with cement mortar may be provided at an interval of 0.6 m.

Silt retention trench: Construct silt retention trench (2x1 m) along the inlet channel near the pond to prevent silt getting into the pond in case of surface runoff harvesting. The trench is divided into 2-3 segments to lower down the velocity of runoff and to allow more time for the silt to settle down. The silt retention trench should also have proper LDPE sheet lining and brick pitching to avoid seepage. The runoff water is first directed to silt retention trench and the inlet channel from this trench is connected thereafter to the storage pond.

Table 1. Cost of dug out LDPE farm pond (20x20x3m with effective capacity of 650 m³) with different lining materials

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Lining material</th>
<th>Approx. cost of construction (Rs. in lakh)</th>
<th>Cost (Rs/m³ of water harvested)</th>
<th>Expected life (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Kaccha pond without sealant</td>
<td>0.31</td>
<td>48.00</td>
<td>--</td>
</tr>
<tr>
<td>2.</td>
<td>Black LDPE sheet lining</td>
<td>0.61</td>
<td>78.38</td>
<td>5-7</td>
</tr>
<tr>
<td>3.</td>
<td>Black LDPE sheet lining &amp; pitching with bricks</td>
<td>2.34</td>
<td>299.50</td>
<td>20+</td>
</tr>
<tr>
<td>4.</td>
<td>Silpaulin sheet lining (UV resistant)</td>
<td>0.70</td>
<td>82.30</td>
<td>5-7</td>
</tr>
<tr>
<td>5.</td>
<td>Silpaulin sheet lining (UV resistant) &amp; pitching with bricks</td>
<td>2.85</td>
<td>351.00</td>
<td>20+</td>
</tr>
<tr>
<td>6.</td>
<td>Masonry cement/RCC tank</td>
<td>16.00</td>
<td>2462.00</td>
<td>20+</td>
</tr>
</tbody>
</table>

Irrigation potential
Ponds of 50-200 m³ capacity can be easily constructed on individual farmer basis which are sufficient for vegetable cultivation in about one kanal area. A 100 m³ capacity pond once filled can provide five irrigations through traditional systems each of 5 cm to one kanal area (400 m²). The irrigation potential can be increased upto 5-6 times if high-tech irrigation systems like drip or sprinkler irrigation systems are to be used. It is pertinent to mention here that rooftop area of polyhouses can be effectively used for rain water harvesting. A polyhouse of 200 m³ roof top area can yield upto 160 m³ water in the area having average annual rainfall 100 cm which can fully meet the water requirement of crops grown inside the polyhouse.

Protection and maintenance

- Trespassing by animals should be avoided.
- In case the sheet is punctured or damaged, paste required size of LDPE sheet using heated bitumen at damaged portion.
- Clean the silt retention trench regularly. Inspect inlet channel and collecting area regularly. Periodically clean the pond and remove accumulated silt/algae.
- Storage of water of first 1-2 monsoon showers should be avoided for preventing quick sedimentation of siltation tank.

The dos & don’ts in LDPE farm pond

Dos

- Ensure good dressing before laying the sheet.
- Jointing of the sheet, if required, is done by heat sealing/synthetic rubber adhesive at the site itself.
- Direct the rain water to the pond through a single point.
- Recommended cement: sand ratio is 1:4 for bricks joining at the top 30 cm.
- Ensure a systematic procedural follow up and the use of right quality material and good workmanship.

Dont’s

- Don’t use hooks and also don’t drag the sheet.
- Don’t walk on the sheet while it is being laid.
- Don’t use rough tools or equipments for cleaning.
- While constructing pond, make sure there are no trees near the pond.
Cost estimate of LDPE lined farm pond size 20x20x3 m (Top Dimension)

Top length = 20 m

Bottom Length = 11 m

Top width = 20 m

Bottom width = 11 m

Length of LDPE sheet = 11+2(6.36) +1+1

Width of LDPE sheet = 11+12.72+2 = 25.72 m

= Length of sheet = 25.72 (say 26 mtr)

Area of sheet = 676 m^2 = 150 kg (Black UV 20 micron)

No. of bricks required for lining = 24x24x50 = 28,800

Cost of sheet = 150x200 = 30,000

Cost of bricks = 28,800 x 6 = 1,72,800

Cost of earth work 50% cut fill @ Rs. 80/m^3 = 781.5 x 80 = Rs. 31,260.00

2

Total cost = Rs. 2,34,060/-

Unit cost with brick lining = 2,34,060

7,81.5

= Rs. 299.5 per m^3

= 0.30 Paisa per litre or Rs. 300 per m^3

Contingency, excavation charges 10 to 15% extra (unit cost may vary as per head load at site)

Unit cost without brick lining = 61,260 =Rs. 0.078 per litre or Rs. 78.38 per m^3
Unit cost may vary as per site condition as escalation charges (The rate considered are current prevailing to market rate)