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DUGOUT POND FOR DEEP BLACK SOILS IN DECCAN PLATEAU REGION

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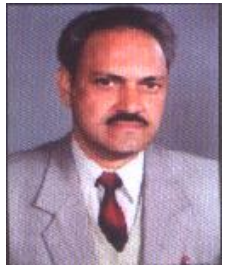
FOREWORD



The semi-arid black soil region in the dryland tract receives low rainfall of about 500 – 750 mm, spread over a relatively longer period of seven months from May to November with an uneven, unpredictable and erratic distribution both in terms of amount and intensity. Inspite of low rainfall, a few intense showers are common, which account for 20 to 30% of annual rainfall.

Studies on erosion control structures till date have suggested the suitability of drainage terraces with grassed waterways for disposing off the inevitable runoff. Possibilities of storing this excess water in dugout ponds and recycling it for protective irrigation was explored in detail at CSWCRTI, Research Centre, Bellary.

This brochure covers the design features of dugout type ponds for different sizes and depths along with economics in low rainfall black soils of India. I am confident that the technology would help the farmers and extension agencies to enhance the productivity of rainfed areas in the region.

(V.N.Sharda)
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Dugout Pond for Deep Black Soils in Deccan Plateau Region

Introduction

Water harvesting refers to collection and storage of rainwater and also other activities aimed at harvesting surface and groundwater and prevention of losses through evaporation and seepage and all other hydrological studies and engineering interventions aimed at conservation and efficient utilization of the limited water endowment of a physiographic unit such as a watershed. In general, water harvesting is the collection of rainwater. The rainwater collected can be stored for direct use or can be recharged into groundwater.

Vertisols and associated soils constitute 72 million hectares of total geographical area of India. There is enough potential to conserve runoff along with the sediment and periodically recycle the stored water to the fields to overcome the moisture stress to crop growth in semi-arid black soils region

Why Farm Pond in Black Soil?

- Black soils, which constitute 23.1% of rainfed lands in India have great production potential. These soils are generally put under cultivation in winter (post-rainy season), mostly on stored moisture.
- The annual precipitation in *rabi* tracts varies from 500 to 700 mm. Crop yields are very poor and unstable due to low and uncertain rainfall and inefficient crop management. Hence, the major task in the region is to improve production per unit area and reduce risks of uncertainty.
- Efficient utilization of the natural rainfall is required, as water deficiency is the major constraint in production. To mitigate this problem, water harvesting through dugout farm ponds in every 10 ha catchment is required to stabilize crop production.
- Water harvesting through dug out farm pond (with negligible seepage loss) has tremendous potential to boost agricultural production in semi arid black soil region.

Types of farm pond

As per the method of construction and their suitability to different topographic conditions, there are three types of farm ponds:

1. Excavated farm ponds for flat topography
2. Excavated cum-embankment ponds in mild sloping topography
3. Embankment type farm ponds for hilly and rugged terrain

In the black soil regions with flat to mild sloping topography, generally excavated type ponds (dugouts) are more suitable.

Implementation Process

Selection of site

The selection of site in for a dugout pond in a participatory mode depends on:

- Farmers' willingness to part with a portion of land for pond construction and to share harvested water with neighbours.
- Optimum catchment size for considerable storage and ensuring long period use.
- Well-protected (treated) catchment for arresting rapid siltation.
- While deciding the capacity, the conservation measures such as agronomical and mechanical measures are considered. The command area near the pond should be free from salinity /alkalinity and the site should require little or no land shaping around the pond.

Pond location: For drinking water it should be near the village.

Utmost care should be taken to avoid pollution near the pond.

i **Purpose**: For supplemental irrigation pond should be located in a way that it benefits maximum number of farmers.

ii. **Location:** Pond should be located on one side of the watercourse to avoid rapid siltation.

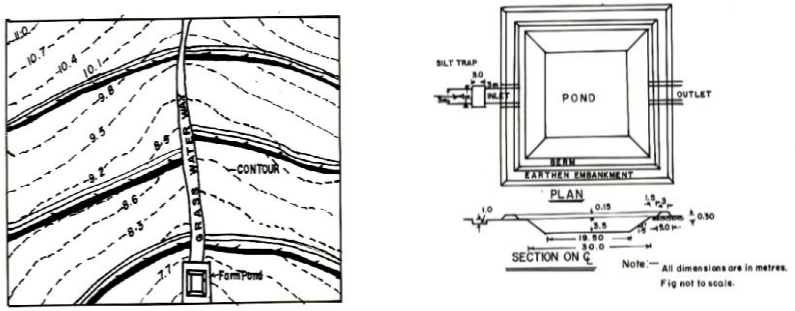
iii. **Sequence of soils:** when soils of different permeabilities occur in succession like red and black soils or shallow and deep black soils, the pond should be located in the deep black soils to avoid pond lining for arresting seepage.

iv. **Nature of sub-soil strata:** Ponds in shales, basalt or on shattered rocks are likely to lose more water. It is therefore, advantageous to learn the nature of the substrata.

Design criteria

While designing the dug out pond, following parameters are to be kept in view:

a. Storage capacity
b. Shape
c. Dimensions (depth, top and bottom widths, side slopes)
d. Inlet
e. Outlet



Line diagram of a typical farm pond showing the location in a field with contour lines and graded bunds

a. Storage capacity

The capacity of a pond is decided keeping in view the following:

- Purpose
- Annual water yield
- Storage losses
- Volume of silt anticipated

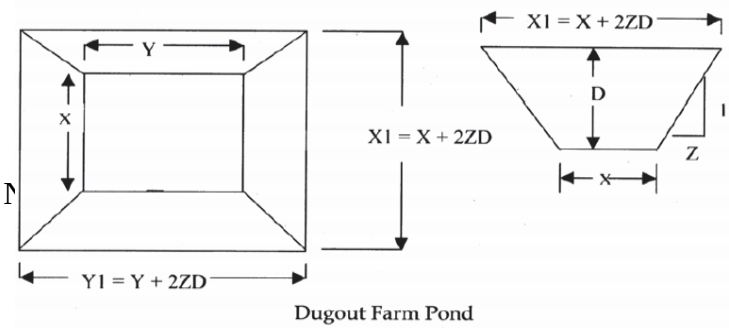
The capacity of the designed pond depends upon the catchment size and factors affecting its water yield. In general, for black soil region in Deccan plateau, the capacity may be made 250 m^3per hectare of catchment. Accordingly, the pond dimensions can be fixed as discussed below (Table 1).

b. Shape

Excavated farm ponds are of two types viz. Square and Rectangular However square pond is most commonly adopted having less evaporation and seepage area compared to a rectangular pond and is easy to excavate.

c. Dimensions

Side slopes: The side slopes are decided by the angle of repose for the sub-soil. Where the soils are very deep (more than 90 cm), the angle of repose for the deep black soils may also have to be considered. Generally side slopes of 1.5:1 would be sufficient for the *murrum* obtained under the deep black soils in this tract. The design is as follows:



Dugout Farm Pond

NB: For square section X = Y

The dimensions are shown in table 1 as per the design.

Table 1. Dimensions of dugout farm ponds of different capacities (V) and depths (D) in Vertisols with side slope 1.5:1

Design Capacity (V), (cum)	For 2.0 m depth		For 3.0 m depth	
	Bottom side of square section (X), (m)	Top side of square section (X1),(m)	Bottom side of square section (X),(m)	Top side of square section (X1),(m)
250	7.8	13.8	3.4	12.4
500	12.5	18.5	7.6	16.6
750	16.1	22.1	10.7	19.7
1000	19.2	25.2	13.2	22.2
1250	21.8	27.8	15.4	24.4
1500	24.2	30.2	17.4	26.4
1750	26.4	32.4	19.2	28.2
2000	28.5	34.5	20.9	29.9
2250	30.4	36.4	22.5	31.5
2500	32.2	38.2	24.0	33.0

The actual design is based on the data given in Table 2 wherein the effective storage is shown as twice of the design value by considering two fillings of the pond during the rainy period. This reduces the cost of the pond and minimizes the losses due to evaporation and seepage. Depending on the availability of water the supplemental irrigation is given to the crop at the rate of 5 cm water per irrigation to cover a part of the area adjoining the pond.

d. Inlet: The inlet is designed as a chute spillway for diverting the runoff into the pond in a controlled manner (Photo 1). The entry section can be designed as a rectangular broad crested weir. The peak discharge rate for deep black soils from a 10 years recurrence interval can be taken as 0.15 cum /sec /ha. Accordingly design the width and height of the crest and provide an allowance of 20 % extra height for free board.

Photo 1. Grassed waterway leading to farm pond (inlet, gauging scale shown)

e. Outlet: It is economical and advantageous to go in for an inlet-outlet structure where possible. When it becomes necessary to separate the two, the outlet is constructed as a rectangular or square channel, this outlet position will be a little lower than the elevation of the inlet to avoid backwater effect. The discharge capacity of the outlet can be assumed to be half as that of the inlet capacity at peak rate of runoff.

Construction steps

i) **Site clearing:** The area should be cleared from bushes, shrubs, stumps, thorns and other unwanted materials like roots etc. to an extent of about 20 m from all sides after demarcation.

ii) **Leveling:** As there will be depressions and undulation, it may be necessary to plough the area and harrow it to get a more or less even topography.

iii) **Demarcating pond area:** The farm pond site is demarcated by driving pegs to indicate the four corners and if necessary the sides can be extended beyond the actual site of the pond.

iv) **Establishing reference level:** Spot level at the corners and at the mid point are taken with reference to a nearby temporary Bench Mark. The average of these levels is transferred on to a permanent/semi permanent object at an approximate distance of about 15 to 20m from the pond site.

v) **Stepping method of construction:Since** it will not be possible to have the cutting exactly to the trapezoidal shape, a segment wise construction known as stepping method is adopted during the time of actual excavation. This step like formation can be subsequently eased out to get the required shape and designed side slopes.

Formation of spoil bank

Since considerable quantity of spoil would be obtained from such dug out ponds, the disposal of the same should be done systematically and in proper manner (Photo 2). Hence, the existing bunds and internal farm roads can be strengthened using the excavated *murrum.*

Photo 2. Farm pond at Joladarasi watershed showing inlet , outlet and spoil bank

Shoulder bund and toe drain

The rainwater falling on the spoil bank and the *berm* is likely to enter into the pond, which creates rills around. To prevent such riling, shoulder bund with a small toe drain (which should run along with spoil bank) may be provided to allow the water thus collected into the pond or take it out through earthenware pipes.

Silt trap

A silt trap of suitable dimension is created in the watercourse just near the entrance of the inlet to check the bed load entering the pond. The length of such silt trap can be slightly greater than the width of the watercourse and depth may be about 0.75 to 1m with side slopes of 1:1.

Maintenance

i) **Desiltation**: The farm ponds constructed in deep black soils get silted up @ 5 to 6 t/ha / year. Hence periodic desilting to restore the original storage capacity is required.

ii) **Maintenance of inlet and outlet**: Construction of any structure in black soil requires specific attention and care, owing to the excessive swelling and shrinkage properties of the black soil that ultimately leads to collapse the structure. A firm *murrum* base may be provided before actual construction of any such structures like inlet and outlet in black soils.

iii) **Maintenance of shoulder bunds**, **toe drains and spoil bank:** Breaches and rill formations in the spoil bank and shoulder bunds should be attended to and plugged promptly.

iv) **Clearing silt trap**: The silt accumulated in the silt trap should be removed periodically, and preferably as and when it gets filled up after a few runoff events.

v) **Fencing of the farm pond**: Fencing with 4 to 5 strands of barbed wire may be provided around the farm pond to prevent human beings and animals slipping or falling into the pond.

vi) **Maintenance of depth gauges**: In order to know the depth of water and thereby volume of water stored in the pond, depth gauges are installed. Repainting and rewriting the scales periodically would maintain them.

vii) **Control of water pollution**: Drinking water ponds should be chlorinated periodically to prevent waterborne communicable diseases. The water should be periodically tested for quality.

viii) **Control of aquatic weed growth**: Efforts should be made to remove weeds/plants, which not only transpire large quantities of water but also induce decaying, thereby affecting quality of water in the pond.

Cost

The average cost of construction of storage works out to Rs.70 per cum storage. This includes formation of spoil bank, inlet, outlet and silt trap as per the present rates.

Recycling of Stored Water

In deep black soil region, *rabi* crops are, in general, grown on residual moisture conditions, as there is practically little or no rainfall after sowings. The success or failure of early sown *rabi* crops depend on October rains. Experience shows that crops suffer from moisture stress right from 30^{th} day of crop growth. The potential of stored water as a source of supplemental irrigation to save crops was, therefore, studied since 1972 and its economics evaluated. The results showed that providing protective irrigation to *jowar* in small quantities of 5 cm over large areas at the start of mild stress is more paying than at higher levels of irrigation.

Economics

Due to recycling of pond water, 30% to 40% of the catchment area gets recharged with moisture and the yield increases between 55% and 90% and the gross return by 55% and 86% with 5 cm and 10 cm of additional water respectively. A study showed that in a normal year the supplemental irrigation provided from the stored water from a 10 ha catchment yields net benefits of Rs.76627, Rs. 61215 and Rs.59210 from 5 cm, 7.5 cm and 10 cm of irrigation water from farm pond by irrigating 5.2 ha, 3.5 ha and 2.6 ha, respectively.

The expected annual benefits from different sizes of farm ponds along with the design capacity, water availability and irrigated area are presented in Table 2.

Table 2. Expected net benefit per year from different sizes of dugout farm ponds with sorghum as the test crop

Catchment area (ha)	Expected runoff (cum)	Design capacity (considering two fillings during the rainy period) (cum)	Water availability after accounting evaporation and seepage (cum)	Area irrigated with two irrigations of 5 cm each (ha)	Net benefit (Rs)
1	500	250	400	0.4	9109
2	925	460	740	0.7	16852
3	1350	675	1080	1.1	24595
4	1710	855	1370	1.4	31199
5	2075	1038	1660	1.7	37803
6	2400	1200	1920	1.9	43724
7	2730	1365	2184	2.2	49645
8	3030	1365	2424	2.4	55110
9	3330	1665	2664	2.7	60576
10	3600	1800	2880	2.9	65586

Benefits of rainwater harvesting

- Meets water requirement for domestic and livestock use
- Provides life saving / supplemental irrigation to crops and plantation
- Augments groundwater recharge
- Improves moisture status of the soil profile
- Reduces soil erosion
- Helps in peak flood retardation

Scope of Application

The technology has become very popular in the semi arid region of Andhra Pradesh and Karnataka states. Watershed development department is following this technology in a big way and the technology is acceptable to the farmers. The technology can be implemented in any black soil area (having negligible seepage) in the semi-arid Deccan plateau region.