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# Micro-Rainwater Harvesting : Low-Cost Technology (Jalkund) for New Livelihood of Rural Farmers in Western Ghat of Maharashtra

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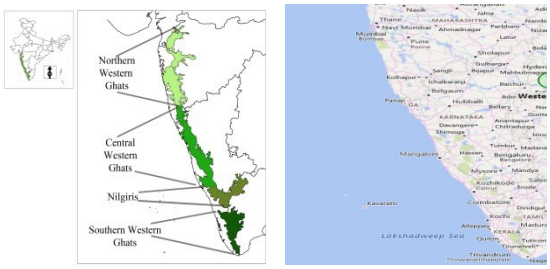
## ABSTRACT

Western Ghats, known for its high precipitation rate, suffers from water scarcity during post-rainy season. In the absence of major and medium irrigation potential/facilities, the alternative method is to explore minor irrigation potential through effective water-conservation measures. A low-cost rainwater harvesting structure called Jalkund of varying capacity (6000-30,000 l of water) developed for the hilltops, useful in water management. Farmers may have option for the capacity according to their water requirement for the crop intended to be cultivated and also for diversified use of stored water in various farm activities like crop, livestock and fish production during post-rainy season (stress period). The Jalkund was made up of clay and cow-dung plastering followed by 3-5 cm cushioning with dry pine leaf, laying down of 250 µm LDPE black agrifilm and covering with 5-8 cm bamboo thatch. The study revealed that the cost/l of stored water was Rs 0.14 during the first year considering Rs 4205 of total cost which came down to Rs 0.046/lit. of stored water during the third year owing to negligible maintenance cost. Using stored water economically in various farm activities is the most acceptable and profitable one particularly to those in the hilltops, who are the worst sufferers due to water scarcity. This economically viable and easily adoptable technology needs to be popularized among farmers.

**Keywords :** Micro-Rainwater Harvesting, Jalkund, Hilltops, Bamboo Thatch.

## I. INTRODUCTION

**Western Ghats–Physiographic view**
**Satellite image**




The western region of India comprising five states, viz. Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu has spread along west coast of India. The region is characterized by different terrain, wide variation in slope and altitude land tenure systems and cultivation practices. The agriculture is the region is mostly rainfed and monocroped. Economic development of this region is highly dependent on the judicious use of its natural resources mainly soil and water. Crop productivity through efficient water management and suitable agronomic practices enhances the rural economy, quality of life and creates more job opportunities through developing of agro industry. Maharashtra is located in the north centre of Peninsular India. It links the north to the south and the plains of India to the southern peninsula. The state is bound on west by Arabian Sea, on north-west by Gujarat, on north by Madhya Pradesh, on southeast by Andhra Pradesh and on south by Karnataka and Goa. It is the third largest state in terms of area in the country. Physiographical regions of this state are divided into three natural divisions - the coastal strip (the Konkan), the Sahyadri or the Western Ghat and the plateau. Konkan consists undulating low lands. North Konkan has the vast hinterlands. The average height of Sahyadri is 1,200 meters. The slopes of the Sahyadri gently descending towards the east and south-east directions. Tapi, Godavari, Bhima and Krishna are the main rivers of the state. Maharashtra receives its rainfall mainly from south-west monsoon. The rainfall in state varies considerably. There is heavy rainfall in the coastal region, scanty rains in rain shadow areas in the central part and moderate rains in eastern parts of the state.

## II. Water resources and potentiality

Water is considered to be the key input for augment agricultural production all over the world. The annual average range of rain fall of the region is 2000 mm, accounting from one of the country's total water of 420 Mha m. it can till date utilize only 0.85 Mha m of water [3]. The remaining more than 41.0 Mha m water is loss annually particularly due to its major portion being hilly. Though the region receives high rain fall, lack of appropriate rain management conditions coupled with lack of suitable rain and water conservation measures lead to severe water scarcity, particularly during post monsoon season and effect crop productivity. June to October duration is water surplus period while November to May is mainly categorized under water deficient period.

## III. Necessity of micro rain water harvesting

Rain water harvesting has tremendous potential of being an irrigation water resource for domestic as well as agricultural purposes for the resource poor farmers in this vulnerable environment. One of the major constraints for water harvesting structure in the hilly region is high seepage loss from storage tanks. As soil is coarse textured and lower strata are seepage losses are high seepage loss is reported to be 300- 400 l/$m^2$ wetted area per day[7]. Gradual siltation clogging of soil pores has resulted in the development of layers of low hydraulic conductivity. Konkan region is having low altitude (valley), mid altitude and high altitude (upland terrace)[1]. In the valley, collection of runoff water in micro water harvesting structures (ponds) having reasonably large catchment area has been proved successful, provided due attention is given to check seepage loss. In case of upland terrace at the hilltop ,where land available for constructing a pond is less with limited catchment area and there is scarcity of water during off season as most of the rain water goes waste by runoff through terrace land, In this area construction of low cost micro rain water harvesting structure is the right option. If subsistent farmers of this region invest in micro rain water harvesting structure with suitable lining material which completely check seepage loss, this can increase productivity .They can diversify their farming by growing cash crops and rearing of live stock (poultry, dairy, piggery and fisheries). Micro rain water harvesting structure called Jalkund for hilltops has been developed. Cost of preparation, water loss lounge, lining material used water productivity; size and capacity are delt with. An account of this technology is discussed in this paper.

## IV. About Jalkund

Site is selected on hilltop and excavation of kund is completed before the onset of monsoon. The bed and sites of kund are leveled to avoid damage to the lining material. Spraying of endosulfan on the surface of inner walls and bottom. Apply aluminiun phosphide 1 tablet per live hole around 5 meter of kund done before lining process. The inner walls were properly plastered with mixture of cow dung and clay in the ratio 5:1. After plastering 3to5 cm thick cushion of dry leaves to avoid any kind of damage to the lining material is done. This is followed by lying down of 250µmLDPE black agri-film. Seepage loss was completely checked. Jalkund was covered by thatch (5to8 cm thick) made of locally available bamboo and grass .Use of neem also help to reduce evaporation during off season.

## V. Water loss Seepage

There was no seepage loss of water from poly- lined Jalkund of all sizes (6000-30000l) except from a 40000 l capacity where the joint of LDPE agri- film Jalkund, had opened probably due to more water load during heavy rains. During the rainy season water load in the big sized Jalkund also damaged the bottom of the embankment.

**Evaporation:**

The evaporation rate of water was maximum in February (9.2mm/day) and minimum (1.8mm/day) in October in the control Jalkund[7]. Use of neem oil as anti evaporates on the water surface and Jalkund covered with thatch were found effective to minimize evaporation. It was recorded that application of neem oil (10 ml/sq.m ) on the water surface after each watering reduced 43.25% evaporation rate whereas use of thatch reduced up to 80% in comparison to the control water (without neem oil or thatch )[7,8] the size was restricted from 6000 to 30000 lit. with respective dimensions of 3m X 2m X 1m, 3m X 2m X 1.5m, 4m X 3m X 1m, 4m X 3m X 1.5m and 5m X 4m X 1.5m. the size of lining material of the

corresponding dimension was 6m X 4m, 7m X 6m, 8m X 7m and 9m X 8m respectively.

## VI. Low preparation and maintenance cost

The cost per lit. harvested water, which was calculated on the basis of aging ,duration of lined LDPE agri-film, to expenditure under different materials and capacity of Jalkund is given in Table 1.It was observed that during the first year ,cost/l of stored water was Rs.0.14,conside the total expenditure of Rs.4205 for preparing a 30,000 capacity Jalkund .At end of the third year ,the cost came down to Rs.0.046/l of stored water, owing to negligible maintenance cost during the second and third year (Table 1).

**Table 1.** Cost of making Jalkund (capacity 30,000 *lit*)

| Particulars | Unit price | Cost in Rs. |
|---|---|---|
| Digging expenses | 30/$m^3$ | 900 |
| Plastering with clay | 2.50/$m^2$ | 120 |
| Cushing with dry leaves | 2.50/$m^2$ | 120 |
| Lining with LDPE agri film (250µm) | 40/$m^2$ | 2880 |
| Thatching | 2/$m^2$ | 60 |
| Fencing | 2/m | 75 |
| Insecticide | - | 50 |
| Total | - | 4205 |
| Cost/lit stored water for First year | - | 0.14 |
| Cost /lit stored water for Second year | - | nil |
| Cost /lit stored water for Third year | - | nil |
| Average cost/ lit stored water | - | 0.046 |

## VII. Capacity

Farmers have the option to go in for size and capacity of the Jalkund according to the water requirement for clay intended to be cultivated. Preparation cost is reflected accordingly. However considering the seepage loss due to unavailability of water during November to April, most of the hill areas remain barren. Stored water from the Jalkund was used for irrigation. Siphon technique was used for supplying water to the plant through a polypipe. Medical plants (Alpina galanga, local name: kulanjan) are grown all along the periphery of the Jalkund increase farm income as a whole. This does not require direct water in for growth as they require soil moisture is maintained throughout the periphery of the Jalkund. The rhizome of the plant yield essential oil contains methyl cinnamate, cineole and oleoresin used to for rheumatism, bronchitis and carminative, and having high medicinal value for pharmaceutical/ clinical industries[1].

**Livestock and fish production**

The stored water in the Jalkund could partly be used for crop production and partly for livestock and fish production or integration of both livestock and fish. Use of stored for the dual purpose of crop production and live stock are fish production was a complementary system, where none of the enter pries was practiced at the cost of the other as far as water use was concerned. Various options of farmer choice were tested for diversification and economic use of stored water in the Jalkund. Farmers can opt for this farming system according to resources available with them.

**Pig based activity:**

based on three years on study at the research farm, per unit water requirement of rabbi crop and piglet has been standardize, which envisaged that 30000lit of stored water could support 2000 plant plant in 250sq. m area and five piglets for 200 days during dry the spell period (November to April) of the year.

**Poultry based activity:**

based on per unit water requirement, 30000lit of stored water can support 200 plant plants in 250 sq.m area along with 50 poultry birds for 200 days during water stress period (November to April) of the year.

**Fish and duck based activity:**

The stored water in Jalkund could be partly used for crop production and partly for integration of fish cum-duck culture where Azolla is used as a feed for fish production (figure 5). In duck fish integration the duck

variety selected was the Indian runner which was found to survive well in the mid hill conditions. Excreta of duck reared in the Jalkund were also used as a fish feed. The water was used for vegetable production during December to February, an fish and duck live together in the Jalkund during the whole post rainy season without affecting water supply to the vegetable crops. The fish culture was with grass carp, Ctenopharyngodonidella and golden hybrid tilapia. These two species were selected considering their compatibility in the culture system, utilization of unwanted weeds and Azolla for raising grass carp and the effective utilization of decomposed feed materials and fecal matter of grass carp by golden hybrid tilapia. Grass carp was stocked@1 no./sq.m and golden hybrid tilapia @3 no. /m. Golden hybrid tilapia being a natural breeder, bred in the pond during the culture period and the young ones were allowed to grow even after the harvest of main stock (table size fish)in November. The study revealed that apart from meeting water requirement of rabi crops , 30000lit of water could support 1000 fish seedling of one month age ,25 fishes five months age and two ducks. By doing so, the water quality of stored water not only improved, but also income had increased.

**Impact analysis based on economics:**

It was observed that with 30000lit of stored water in Jalkund ,farmers can opt for three complementary diversified farm activities, viz (i)crop production and duck cum fish culture ,(ii)crop production and pig rearing (iii)crop production and poultry rearing .However ,selection and adoption of a particular farm activity depends on resources available with them to bear initial expenditure and preferential food habit ,and the income should also improve their standard of living .Economical analysis of each activity was made with the aim to select ,recommend a profitable activity for farmers, which they should adopt for properly utilizing stored water in Jalkund as well as for maintaining their livelihood. Details of economic analysis are presented in Table 3. Expenditure on seedling, feed cage and maintenance was also included in the analysis. Water requirement 90 days(December to February) for plant and 200 days (November to April) for fish was considered the analysis. Since the Jalkund is usually field directly with rain water during may-October, water during this period was not included in the calculations.Call market price of each input was also taken into consideration. If a farmer utilizes 30000 liter of water each system will be as follows:

**1. Plant-pig based activity:**

Water Application to for @11/days and for pig 101 days has been standardized based on this ,it was estimated that to grow 200 plant 18000 liter of water was needed for 90 days, while 10000 was needed for pig rearing for 200 days. The rest 200 could be used for miscelleous purposes.

**Table 3:** Economic analysis

| **Farming Activity** | **Total Water Requirement** | | | **Expenditure(Rs)** | | | | **Income** | | | **Profit** | **Cost** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Plant - pig** | **Plant** | **Pig** | **Misc. use** | **Plant** | **Pig** | **Jalkund** | **Total** | **Plant** | **Pig** | **Total** | | |
| | 18000 | 10000 | 2000 | Hybrid seed-500 | Piglets-5000 | Making-4205 | 14,205 | 3700 | 20000 | 23700 | 9495 | 1.67 |
| | | | | Other inputs-250 | Feed-4000 | Polypipe-250 | | | | | | |
| Plant poultry | 18000 | 5000 | 7000 | Hybrid seed-500 | Chicks-750 | Making-4205 | 10955 | 3700 | 15000 (egg) | 18700 (egg) | 7745 (egg) | 1.71 (egg) |
| | | | | Other inputs-250 | Feed-5000 | Polypipe-250 | | | | | | |
| | | 12000 (meat) | 15700 (meat) | 4745 (meat) | 1.43 (meat) | | | | | | | |
| Plant-Duck Fish | 18000 | - | - | Hybrid seed-500 | Ducklings-30 | Making-4205 | 5835 | 3700 | 1600 (egg) | 8800 | 2965 | 1.51 |
| | | | | Other inputs-250 | Fish seed-100 | Polypipe-250 | | | 2000 (mature fish) | | | |
| | | | | | Feed-500 | | | | | | | |

**Plant-poultry based activity:**

Water requirement poultry @500 ml/day for 200 days has been standard and total 5000 L of water was needed for 200 days

**Plant fish duck based activity:**

a Jalkund of 30000 L capacity can support 200 Plant plants,two ducks and about 1000 finger-lings,where 18000L of water was needed for Plant. The rest 12000 L was utilized by duck and fish for survival during the stress period. In this case, 12000 L of water was not considered as actual consumption perse, unlike other live stock. Therefore calculation of water requirement per unit was not done for fish and duck. Since the kund was small, maintenance cost, including water treatment was negligible and was not considered in the calculations. Though the total Expenditure incurred in this system was much less, net profit and B:C ratio was also less(Rs 2965 and 1.51 respectively) compared to pig and poultry based activities

**If net profit and B:**

C ratio of all 3 systems are compared, it is clear that Plant –Pig based Activity provided 22.6 and 220% higher profit than poultry and Fish-Duck based activity respectively[1].

**Future plan**

1. A sanitization programme in each state is necessary to disseminate and popularize the proven technology among farmers of western Ghat regions. In the context, linkage is needed among the research instituted, financial institutes, state departments and farm to channelize the technology from the technology producing center to farmers. Having successfully implemented the technology the farmers at 25 locations in each state where 2 Jalkund of 30000 L capacity, about 1.2 hectares rainwater may be stored in the region, which otherwise goes waste. It is also estimated that with 1.2 hectares water, 100 hectare area may be covered along with region of 2000 piglets or 20000 poultry birds and 800 ducks.
2. The technology may open options for farmers who can afford a green house, polyhouse for cultivation of vegetables/flowers/medicines/medicinal plants/orchids. Not only for fetching higher market value during off seasons, also for providing employment opportunities to run youth.
3. Usually at the hilltop, area available with farmers is cultivated and their homes are situated with cultivated field. Therefore to store water in Jalkund for longer periods during off season, collection may be linked up wherever possible.

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