RAINWATER HARVESTING FOR SUSTAINABLE DEVELOPMENT OF HILLY KONKAN REGION

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ABSTRACT

The Konkan region of Maharashtra is situated along the western coast having length of 720 km and width varying from 40 to 60 km. The unique bio-diversity is the peculiarity of this region. This region receives heavy average annual rainfall of 3000 to 3500 mm. In spite of this heavy rainfall scarcity of water during the summer months is the common phenomena of this region. This region comprises of sloppy terrain and with highly percolative lateritic soil impounding less water. Hence an attempt is made here to harvest the rainwater in the silpaulin lined farm ponds. The cost of water harvested in the farm pond comes as 0.87 paise per litre, while the life of silpaulin lining material has considered as five years. The harvested water was used for irrigating short duration vegetable crops like water melon, cabbage, chilli, kohlrabi, broccoli and color/green capsicum. The economics was also worked out and average B:C ratio was 6.09. The projection of area irrigated under various crops is made on the basis of data generated in the present study. The rain water harvesting through lined pond is viable technique for sustainable development of this region.

The Konkan region of western Maharashtra state is bestowed with unique bio-diversity. The hilly slopes, lateritic soil, heavy annual rainfall etc. are some of the pecularities of this region. This region is spread in the four districts viz. Thane and Raigad situated in the North, while Ratnagiri and Sindhudurg are situated in the South. The soils of Ratnagiri and Sindhudurg districts are coarse, shallow and derived mostly from lateritic rock and their water retention capacity is very poor. The basic infiltration rate of these soils is also high and having the values of 7 to 10 cm/hr. Though the average annual rainfall of this region is high and of the order 3000 to 3500 mm distributed in the four months i.e. from June to September, the occurrence of dry spell is common. From the analysis of 39 year daily rainfall data revealed that the dry spell occurred 11 times in 26th (25th June to 1st July) and 34th (20 to 26 August) meteorological week, while 10, 14 and 20 dry spells occurred in the 37 (10 to 16 August), 38 (17 to 23 September) and 39

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(24 to 30 September) meteorological weeks, respectively. As the paddy is the major crop during the *kharif* season, during the period of dry spells the crop suffers due to water/moisture stress, which can be made available through rain water harvesting in properly lined farm ponds. The research efforts at the All India Co-ordinated Research Project on Water Management, Dapoli centre has developed one such technique of rain water harvesting in small ponds known as 'Konkan Jalkund' (Mehta *et. al.*, 2008). The stored water of 4000 lit in one Konkan Jalkund can be used to irrigate 10 mango/cashew plants @ 10 lit/week/tree from 15 November to 15 June, comprising of 30 weeks through sub-surface irrigation.

The seepage losses from these pits were reduced to zero by lining these with multi layered polyethylene. However, the evaporation losses pose a problem as this accounts for 35 to 40 per cent of the total quantity harvested. Some effective anti-evaporants are available in the market. Acelol is a chemical, which can be used as an anti-evaporant to reduce the evaporation from water bodies (Anonymous, 2000). It should be applied @ 7 gm per sq.m. on the water bodies for preventing evaporation. Orosorb can also be used as an anti-evaporant, as it lowers the surface tension of water and reducing evaporation (Anonymous, 2006). The newly planted mango and cashew plants requires irrigation in post-monsoon season at least for three consecutive years, while the mature mango and cashew plants can be given only two irrigations, first in January and second in the February. In spite of heavy rainfall region, availability of irrigation water during post monsoon period is always very meager. This is well identified that even area under irrigation is less i.e. 1.5 %. In order to resolve this issue lined pond technique for harvesting rainwater is technically feasible and essentially viable. The techniques of controlling different losses through these structures and effective utilization of this stored water and the option of taking different crops on this water is reported here in this paper.

MATERIALS AND METHODS

A field experiment was conducted at the Research Farm of College of Agricultural Engineering and Technology, Dapoli, Dist.: Ratnagiri (M.S.) having elevation of 210 to 230 m above mean sea level, latitude $17^0$45' N and $73^0$20'E longitude. The soil of the experimental field was sandy clay loam with field capacity and wilting point of 28 % and 16 %, respectively. The surface soil was slightly acidic having pH 6.2 and EC of 0.084 dSm^{-1}.

The farm pond having 15 m x 38 m dimensions at the bottom and 26 m x 48 m at the top with 3 m gross height was excavated. The side slopes of the pond were 1.67 H: 1 V along the length, while 1.5 H: 1 V along the width. All other specifications of the farm pond are given in Table 1. the multi layered polyfilm (silpaulin) was used as lining material. The sharp edges of the exposed stones all along the sides and bottom of the pond were removed and surfaces were smoothened and sufficient quantity of anti-termite powder viz. folidol, lindane etc. dusted on the sides and bottom of the pond. About 5 to 10 cm thick pre-lining cushioning bed of paddy straw bundles was put along all the sides and bottom so as to become it as paddy straw cushioning bed. The extended portion of the lined silpaulin film on the land surface all along the length and width of the pond buried in a trench and covered with soil on all the four sides so as to avoid entry of trubulent runoff water in to the pond. Assuming the lift of film as 5 years, the cost of harvested rain water comes as 0.87 paise per litre.

For scheduling of irrigation the recommendation given by the Dr.Balasaheb Sawant Konkan Agriculture University, Dapoli were used. The drip and micro-sprinklers were used for growing short duration vegetable crops, while the sub-surface irrigation was used to irrigate the orchards.

Sub-surface irrigation for orchards:

Three hollow bamboo pieces or PVC pipes etc. preferably of about 15 cm dia. and each with 35 cm length were buried in upright position over the excavated trench around the graft. Thus, 5 cm portion of the piece remains above ground level. The lowermost portion of the piece was provided with three 5 mm size holes for dripping of water over excavated trench. During the post monsoon period (15 November to 15 June) every week, 10 lit of water from the pond poured in equal proportion in all the three pieces around each planted graft or tree.

The recommendations regarding the different crops and the integrated factor for calculating the water requirement has been given in Table 2. For calculating the actual water needed by the crop the data of last 25 years pan evaporation was used. If the water in the pond is not utilized for any activity, then also quantity of water lost by evaporation from the pond would be 971 m^3 (37 %). For calculating the water lost from pond, the daily average of 25 years pan evaporation was taken and it was multiplied by 0.7 as to calculate the evaporation from large water bodies. The crops like kohlrabi, broccoli, color and green capsicum can be grown in the shade net house, while the watermelon, cabbage and chilli crops can be grown in the field. The projections regarding the crops area, irrigated on the

stored water in the farm pond has given in the Table 3. The dead storage of 10 % of water in the farm pond was considered during the calculations.

RESULTS AND DISCUSSION

The projection of area irrigated under various crops is made on the basis of data generated in the present study and these are as follows,

Crops proposed to be grown on the available water in the pond

1. **Cashewnut-** The crop can be taken at a spacing of 7 m x 7 m. Two protective irrigations of 250 lit. of water each needs to be applied one at 31st January and other at 15th February to the fully grown crop. Total 3650 nos. of plants comprising an area of 18.25 ha can be irrigated on the water saved in the pond. The B:C ratio for this crop comes as 2.47 as a response of irrigation.
2. **Mango-** The crop can be taken at a spacing of 10 m x 10 m. Two protective irrigations of 250 lit. of water each needs to be applied one at 31st January and other at 15th February to the fully grown crop. Total 3720 nos. of plants comprising an area of 37 ha can be irrigated on the water saved in the pond. The B:C ratio for this crop comes as 1.50 as a response of irrigation.
3. **Coconut-** The crop can be taken at a spacing of 10 m x 10 m. The irrigation has to be started from 1st November to 15th June. Total 200 nos. of plants comprising an area of 2 ha can be irrigated on the water saved in the pond. The production of nuts is not possible without irrigation. Hence the B:C ratio for this crop comes as 14.0 as a response of irrigation.
4. **Watermelon-** The crop can be grown by the standard package of practice recommended by the University. The crop period is November to January and the integrated factor of 0.4 PE was taken for irrigation. An area of 2 ha can be irrigated on the water saved in the pond. The B:C ratio for this crop comes as 3.44 as a response of irrigation.
5. **Cabbage-** The crop can be grown by the standard package of practice recommended by the University. The crop period is November to January and the integrated factor of 0.8 PE was taken for irrigation. An area of 1 ha can be irrigated on the water saved in the pond. The B:C ratio for this crop comes as 7.51 as a response of irrigation.

6. **Chilli-** The crop can be grown by the standard package of practice recommended by the University. The crop period is 15th November to 15th March and the integrated factor of 1.0 PE was taken for irrigation. An area of 0.6 ha can be irrigated on the water saved in the pond. The B:C ratio for this crop comes as 3.06 as a response of irrigation.
7. **Kholrabi:** The crop can be grown by the standard package of practice recommended by the University. The crop period is 1st November to 31st January and the integrated factor of 1.0 PE was taken for irrigation. An area of 1.74 ha can be irrigated on the water saved in the pond. The B:C ratio for this crop comes as 3.33 as a response of irrigation.
8. **Broccoli:** The crop can be grown by the standard package of practice recommended by the University. The crop period is 1st November to 31st January and the integrated factor of 1.0 PE was taken for irrigation. An area of 1.74 ha can be irrigated on the water saved in the pond. The B:C ratio for this crop comes as 12.46 as a response of irrigation.
9. **Color/Green capsicum:** The crop can be grown by the standard package of practice recommended by the University. The crop period is 1st November to 28th February and the integrated factor of 1.0 PE was taken for irrigation. An area of 1.00 ha can be irrigated on the water saved in the pond. The rates of color capsicum are more than green capsicum, hence the B:C ratio for this crop comes as 8.58 as a response of irrigation, while it was 4.51 in case of green capsicum.

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Table 1. Design details and cost of harvested rainwater in Pond

Sr. No.	Particulars	Pond
1.	Bottom (width and length), m x m	15 X 38
2.	Top (width and length), m x m	26 X 48
3.	Depth of pond, m (gross)	3.0
4.	Net depth of water in pond, m	2.94
4	Volume of water stored, m^3	2672
5	Size of 250 GSM UV stabilized lining material required	30 m X 52 m = 1560 m^2
6	Cost of 250 GSM UV stabilized lining material, @ of Rs 55 per sq m, Rs	85,800.00
7	Total cost of construction (for excavation with JCB, Man days and other miscellaneous) Rs,	30,500.00
8	Total cost for construction and lining of pond	1,16,300.00
9	Operational cost of pond, Rs per year (by considering the life of 250 GSM UV stabilized lining material as Five years)	23,260.00
10	Water harvested per year, m^3	2672
11	Water harvested during five years, m^3	13,360
12	Cost of water, np per lit	0.87
13	Total evaporation, 1st Nov.-15th June	1204.87 mm
14	Evaporation from pond	843.4 mm
15	Net quantity of water evaporated (excluding irrigation & other uses)	971 m^3 (37 %)
16	Total water available for crop use	1661.24 m^3 (63 %)

Table 2. University recommendation regarding the integrated factor

Sr. No.	**Name of the crop**	**Integrated factor**
1.	Water melon	0.4 PE
2.	Cabbage	0.8 PE
3.	Chilli	1.0 PE
4.	Kohlrabi	1.0 PE
5.	Broccoli	1.0 PE
6.	Color/green capsicum	1.0 PE

Table 3. Proposed area under different crops to be grown on pond water

Sr. No.	Name of the crop	Crop period	Irrigation interval or dates	Spacing, m x m	No. of plants/ha.	Total water require., m^3/ha	Area covered, ha
1	Cashewnut (matured)	-	31 Jan. & 15 Feb.	7 x 7	204	102	18.25
2	Cashewnut (newly planted)	-	Weekly	7 x 7	204	61.2	24.51
3	Mango (matured)	-	31 Jan. & 15 Feb.	10 x 10	100	50	37.2
4	Mango (newly planted)	-	Weekly	10 x 10	100	30	50
5	Coconut	1st November to 15th June	Alternate day	10 x 10	100	817.5	2.00
6	Water melon	1st November to 31th January	Alternate day	1 x 1	10,000	995.48	2.00
7	Cabbage	1st November to 31th January	Alternate day	0.45 x 0.30	75,000	1990.96	1.00
8	Chilli	15st November to 15th March	Alternate day	0.60 x 0.60	27,777	3185.25	0.60
9	Kohlrabi	1st November to 31th January	Alternate day	0.45 x 0.30	75,000	1142.29	1.74
10	Broccoli	1st November to 31th January	Alternate day	0.45 x 0.30	75,000	1142.29	1.74
11	Color/green capsicum	1st November to 28th February	Alternate day	0.45 x 0.30	75,000	1910.69	1.00

Note: The above projections are made for single crop at a time on the pond water.