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ECONOMIC EVALUATTION OF WATER HARVESTING POND UNDER ARID CONITIONS

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ABSTRACT : Water is most precious in the arid region due to prevalence of unfavourable hydro-meterological conditions. Studies carried out in Jhanwar model watershed during 1988-1994 reveal that water harvesting by means of farm pond of 271 m^3 capacity coupled with ber *(Zizyphus mauritiana)* in the adjoining area could sustain the system even in very low rainfall situations. The benefit-cost ratio of the system worked out to be 1.672 which indicates that, in order to impart stability to agricultural production on rainfed lands in arid and semi-arid areas farm ponds seems to hold the key.

Water is critical determinant to accomplish the challenging task of enchancing the productivity in arid eco-system. Recent population growth coupled with economic developments has made it imperative to use all available water resources efficiently throughout the world. Water harvesting by means of farm ponds are used to even out variation in rainfall supply by storing water when supply is limited during the dry season. Safe economic design and construction of farm pond to harvest the surplus runoff from watershed has, thus assumed much greater urgency especially in arid areas where short spell intense rainfall causes wastage of water coupled with heavy soil erosion.

In the semi-arid or sub-humid climatic regions the surface land morphology is conductive to runoff generation from large areas. The quantum of runoff is therefore, much higher than that can be expected from the arid regions. The cost of construction of the farm pond/m^3 of water harvested is less in semi-arid and sub-humid areas. The harvested water in such regions can economically support fairly large areas of agricultural production, whereas under the arid conditions more runoff can be harvested at a number of micro-catchments than a single large unit (Boers and Ben-Asher, 1982). Therefore, the quantum of runoff that can be harvested in a single pond is less and is constrained by the size of micro-catchment. The cost of construction/m^3 of water is also high due to sandy soil conditions.

Further, the rainfall occurrence has a high variability. Hence considering these problems, the pond should be designed at low risk level of failure and at the same time associated benefits should be assured. In the Jhanwar watershed, therefore. a system of pond and ber plantation was implemented on the farmer's field. In this paper, the post-construction performance of the system and its economic viability is presented.

MATERIALS AND METHODS

A pond of 271 m^3 capacity was constructed in 1988 and eighty six ber (Zizyphus mauritiana) plants were planted in 0.25 ha. These were irrigated manually with harvested water in the pond. The plants started fruiting from third year onwards. All the costs of the system are based on the year 1988 and maintenance of the structure assumed is negligible. The interest rate on agricultural loans is taken as 16 percent. The expected economic life of the system is taken 20 years which is equal to the biological life of ber plants. Only direct benefits are considered in the analysis. Economics of the system was judged by present worth. The present worth factor (PWF) was calculated as:

$$PWF = \frac{(1+i)^n - 1}{i(1+i)^n}$$

where, i is the annual interest rate, and n is the number of years.

Data on rainfall, runoff and fruit yield were collected for five years. The runoff data were used to demonstrate the resilience of the system to severe drought conditions.

RESULTS AND DISCUSSION

The details of rainfall, runoff and fruit yield is given in Table 1. It shows that under the varied rainfall situations the observed runoff was up to the designed capacity in all the years. In some years excess runoff was generated which did not cause any damage and was safely drained away. The resilience of the pond is obvious because a very low runoff coefficient was used in the design. Hence, the objective of low risk level design was significantly achieved and chances of failure of the production system were reduced to a minimum even in the drought years. The total irrigation requirement for eighty six plants was 40 cubic metre per year.

Table 1. *Runoff and fruit yield from the system in different years*

Year	Monsoon Rainfall (mm)	Runoff producing rainfall (mm)	harvested water (m^3)	Fruit yield
1989	221.5 *	191.4	271	--
1990	776.6	701.0	271	9.5
1991	192.3 *	127.7	271	10.5
1992	387.3	338.5	271	11.0
1993	219.6 *	172.9	271	11.0

* Drought year

The fruit yield reported in Table 1 is for 5 years old ber plants. As the age of trees increases, it is expected that the yield will increase and hence average total yield of 11 q/year is taken for calculations. Various fixed costs, operational costs and direct bebefits are given as follows.

Fixed costs

i) Initial investment for construction of pond	= Rs.	12200.00
ii) Cost of 86 ber plantation (includes pits preparation and seedlings)	=	151.00

Operational costs

i) Depreciation	= Rs.	549.00
ii) Interest on capital @ 16%	=	1073.60
iii) Irrigation @ Rs.0.50/plant/irrigation		
8 irrigations in the first year	=	344.00
4 irrigations in the subsequent years	=	172.00
iv) Fertilizer in the first year (@ 200 g N/plant/year)	=	300.00
v) Furit harvesting from third year (3 man-days/year @ Rs. 50/day)	=	150.00
vi) Pruning of plants (1 man-days/year @ Rs. 50/day)	=	50.00
Direct benefits		
Total average fruit yield from third year onwards is 11q/year @ Rs. 8/kg	=	8800.00

The present worth of various costs and benefits taking 1988 as the base period is presented in Table 2. The B : C ratio of the system is estimated as 1.672 which is acceptable as per Irrigation Commission. Althouth, the farmer was given 75 percent subsidy for the adoption of this technology under the Jhanwar Model Watershed Project but even without subsidy this technology is profitable. It should be noted that with the existing capacity of pond more number of ber plants can be planted and irrigated thereby increasing the direct benefits. However, the farmer showed interest to a small

Table 2. *Present worth of costs and benefits of the system*

Year	Cost (Rs.)	Benefit (Rs.)
1	13045.00	-
2	2144.60	-
3	02294.60	8800.00
4 to 20	2294.60	8800.00
Total present worth	26402.39	44136.55

BC ratio = 1.672, Net Present Worth = Rs. 17734.16

scale plantations only. Further, several indirect benefits like availability of safe drinking water, positive environmental effects due to the creation of water body and permanent tree cover, reduction in wind erosion are not considered in the economic analysis, but they are more remunerative than the direct benefits under the arid eco-system. If both the direct and the indirect benefits were taken into account the B/C ratio of the system would have been more attractive.

It is concluded that under the highly varied rainfall condition of arid climate, an adequate design of pond can reduce the chances of failure of the agricultural production to a minimum and therefore, can provide a surer means of income to the farmers.

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REFERENCE

Boers, T.M. and Ben-Asher, J.(1982). A review of rain water harvesting, *Agric. Water Mgt.*, 5 : 145-158.