Int.J.Curr.Microbiol.App.Sci (2020) Special Issue-11: 3218-3223

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Special Issue-11 pp. 3218-3223**
Journal homepage: http://www.ijcmas.com

Original Research Article

Rainwater Harvesting for Sustainable Development of Hill Region

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A B S T R A C T

The crop production in Rajouri District of Jammu and Kashmir, Union Territory is characterized by low input –low yield concept and rather region rain-fed agriculture. The unique bio-diversity is the peculiarity of this region. This region receives very good precipitation even during the non monsoon months. In spite of sufficient rainfall in the region, availability of irrigation water during post monsoon period is always very meager. This region comprises of sloppy terrain and with highly percolative and impounding less water. Thus an attempt is made to harvest the rainwater in the HDPE lined farm ponds. The cost of water harvested in the farm pond comes as 0.90 paise per litre, while the life of HDPE lining material has considered as five years. The harvested water was used for irrigating short duration vegetable crops like strawberry, broccoli, capsicum, knolkhol, cabbage and chilli. The economics was also worked out and average B: C ratio was 5.76. The rain water harvesting through lined pond is viable technique for sustainable development of this region for livelihood security of farmers.

Keywords

Infiltration, Rainfall, Water holding capacity, Agricultural production

Introduction

Water is most crucial resource for sustainable agricultural production in the dry land/rain fed areas. However the major part of the rain water coming over the farmers field in these areas goes away unused as runoff. The runoff does not only cause loss of water but it also washes away precious top soil. The problem of water scarcity in this region is the biggest challenge to cope up with the growing food demand. Water flows in the soil system depend upon two principal factors, infiltration of rainfall, and water holding capacity of the soil. Rainwater harvesting for crops is therefore closely related to soil system management; namely, the actions taken to improve infiltration into the soil and to increase water holding capacity and fertility functions in the soil. In the water management community, much attention has been devoted to irrigated agriculture, since it appears to be the major consumer of water, when compared to water requirements for domestic and industrial purposes. However, much less attention has been paid by water managers and investment institutions to the issues of rain fed agriculture. To address these problems, the water harvesting and its efficient utilization through micro irrigation

is one of the steps which shall be demonstrated through low cost technology. The harvested water full fill the water requirement of different crops during lean period/water scarcity period which commonly occurs after the receding of monsoon (Oct-Dec) and after winter rains (April - June). Therefore, local harvesting of a small portion of the water in wet periods, utilizing the same for supplemental/protective irrigation during devastating dry spells, offers a promising solution in the fragile, rain fed regions of the district is an attempt for optimum utilization of harvested water through efficient methods of irrigation i.e. micro-irrigation. In order to meet the future food requirement, the current rainfed farming systems in hills need to upgrade yield output both quantitative and qualitative. Moreover, the agricultural enterprises in the hilly region need to diversify in order to be competitive. The distinctive features of rain fed agriculture in developing countries are that both productivity improvement and expansion have been slower in relation to irrigated agriculture. Rainfall is the crucial input factor in the rain fed production system. Its variation and uncertainty is high in areas of low rainfall and a major cause of low productivity and heightened distress among farmers. The erratic behavior of monsoon/winter rains i.e. early and late onset and closure of rains badly effects sowing of crops and other associated agronomical practices.

The water resources in the Rajouri district of Jammu and Kashmir state is distributed unevenly both spatially and temporary. This region is blessed to have some precipitation even during the non monsoon months; however the timing of the rains does not always coincide with the time of actual/critical requirement. Out of a total geographical area of 253,000 hectares, Rajouri has a net sown area of 52,000 ha and an additional area of 20,000 ha is under pastures and only 8 per cent area is under irrigation. About thirty per cent of the population is directly involved in agriculture (Anonymous, 2018). Moreover, the traditionally irrigated lands in this region, which get *Kul* waters, already have the technology for distribution of irrigation waters to various fields through irrigation channels. However, the rainwater harvested in ponds is limited in quantity; so cannot be used indiscriminately like *kul* waters that are used for irrigating rice fields (Kohli and Sharma, 2007). In spite of sufficient rainfall in the region, availability of irrigation water during post monsoon period is always very meager major portion of rain water to be lost as run-off (Kumar *et al.,* 2007). Crop failure is common event for want of pre-sowing irrigation, if rain is not received at sowing time of the crops. The alternate mean of irrigation in uplands are exploitation of small spring and rainwater collected to the impermeable tanks or ponds. The LDPE film lined tanks has been found as one of the best option for water storage in order to maximize water availability for irrigation.

Farmers in this region have the capability of distributing the irrigation water in their fields if the water is flowing under gravity (Mehta *et al.,* 2008). This capability can be enhanced with the availability of harvested rainwater if they can also get access to the application technology for the harvested rainwater in ponds (e.g. low cost technologies like solar powered pumps for lifting the harvested rainwater).

Water harvesting structures are environmentally sound and apart from increasing bio-mass production they are helping in giving the additional benefits of flood and drought moderation, ground water augmentation, employment generation and improvement in socio-economic conditions

of the people. This has resulted in collection of inevitable runoff, efficient storage of harvested water, its application and optimum utilisation for maximising production besides, supplementing the soil moisture deficiency. This region comprises of sloppy terrain and with highly percolative and impounding less water. Therefore the farmers who harvest rainwater in ponds are recommended to use it for high value crops like vegetables, flowers or fruits. Demonstrations were conducted at the farm of Regional Agricultural Research Station, Rajouri with objective to demonstrate the most economical and viable source of supplemental irrigation at critical stage of crop growth to high value crops. Dug out pond was constructed on the selected farmer's fields in these villages and the respective farmers were encouraged to use the harvested rainwater to irrigate their crops. Training activities in these villages have provided the access of the rainwater harvesting technology to many other farmers of the selected villages, who are also showing inclination to get a rainwater harvesting pond constructed in their fields.

Materials and Methods

Field demonstrations were conducted at Regional Agricultural Research Station of SKUAST, Jammu having elevation of 920 m above mean sea level, latitude 33º37' N and 74º31'E longitude for use of harvested rainwater in ponds for providing supplemental irrigation for high value crops. The soil of the experimental area was clay loam with bulk density of 1.38g/cc. The surface soil was slightly acidic having pH 6.7 and EC of 0.084 dSm^{-1}. The farm pond having 10.5 m x 7.50 m dimensions at the bottom and 15 m x 11 m at the top with 4 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. The HDPE lining material was used as lining material. 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 HDPE 250 micron 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 turbulent runoff water in to the pond. The drip was used for growing short duration vegetable crops like strawberry, broccoli, capsicum, knol khol, cabbage, marigold and chilli. The life saving irrigation to the crop was provided through PVC pipes preferably of about 5 cm dia using the pre monsoon period (15 April to 15 June) and post monsoon 15th October to 15th January as and when required. If the water in the pond is not utilized for any activity, then 27 per cent of evaporation loss from the pond was estimated. 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 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

Nectarine

The crop can be taken at a spacing of 5 m x 5 m. Six live saving irrigation with 5 -10 litres of water applied from March - June to the first year grafted plants. Total 400 nos. of plants comprising an area of 1 ha can be irrigated on the water saved in the pond. The B:C ratio for this crop comes as Rs.6.85 as a response of irrigation (Fig. 1 and Table 1).

Plum

The crop can be taken at a spacing of 5 m x 5 m. Six live saving irrigation with 5 -10 litres of water applied from March - June to the first year grafted plants. Total 400 nos. of plants comprising an area of 1ha can be irrigated on the water saved in the pond. The B:Cratio for this crop comes as Rs. 6.85 as a response of irrigation.

Cabbage

The crop can be grown by the standard package of practice recommended by the University. The crop period is October to January and the integrated factor of 0.8 PE was taken for irrigation. An area of1ha can be irrigated on the water saved in the pond. The B:C ratio for this crop comes as 6.51 as a response of irrigation.

Chilli

The crop can be grown by the standard package of practice recommended by the University. The crop period is 15th April to 15th June and the integrated factor of 1.0 PE was taken for irrigation.

An area of0.75 ha can be irrigated on the water saved in the pond. The B:C ratio for this crop comes as 4.60 as a response of irrigation.

Knol Khol

The crop can be grown by the standard package of practice recommended by the University. The crop period is October to January and the integrated factor of 1.0 PE was taken for irrigation. An area of 1.54ha can be irrigated on the water saved in the pond. The B:C ratio for this crop comes as 4.65as a response of irrigation.

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 1.6ha can be irrigated on the water saved in the pond. The B:C ratio for this crop comes as 5.12 as a response of irrigation.

Demonstrations were conducted at the farm of Regional Agricultural Research Station, Rajouri and farmers field. The study reveals that the rainwater harvested in the HDPE lined farm ponds, costs 0.90 paise per litre, while the life of HDPE lining material has considered as five years.

The harvested water was used for supplemental irrigation of short duration vegetable crops like strawberry, marigold, broccoli, knolkhol, cabbage and chilli and fruit crops *viz.*, nectarine and plum. The economics was also worked out and average B: C ratio was 5.76 in response to irrigation.

The rain water harvesting through lined pond is viable technique for sustainable development of hilly region for livelihood security of farmers.

Benefits/Impact

After interventions and adoption of rainwater harvesting techniques helps the farmer to raise his socio-economic status and source of inspiration for other farmers of the area.

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

Sr. No.	Particulars	Pond
1.	Top (length and width), m x m	13 X 11
2.	Bottom (length and width), m x m	10.5 X 7.5
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	252
5	Size of 250 GSM UV stabilized lining material required	17 m X 15 m = 255 m^2
6	Cost of 250 GSM UV stabilized lining material, @ of Rs 95 per sq m.	24225.00
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	54725.00
9	Operational cost of pond, Rs per year (by considering the life of 250 GSM UV stabilized lining material as Five years)	10945.00
10	Water harvested per year, m^3	252
11	Water harvested during five years, m^3	1260
12	Cost of water, Rs per litre	0.90
13	Total evaporation, 1st Nov.-15th June	583.38 mm
14	Evaporation from pond	158.4 mm
15	Net quantity of water evaporated (excluding irrigation & other uses)	68.04 (27 %)
16	Total water available for crop use	183.96m^3 (73 %)

Fig.1

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