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Rain Water Harvesting and Ground Water Recharging in North Western Himalayan Region for Sustainable Agricultural Productivity

[1]Rohitashw Kumar, [2]Thaman S., [3]Agrawal G. and [4]Sharma Poonam

[1]Associate Professor and Head, Division of Agricultural Engineering, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar Campus, Srinagar ,
[2]Asstt. Prof., Division of Agricultural Engineering, SKUAST- Kashmir, Srinagar
[3]Asstt. Prof. , Deptt. of of Soil Science,UHF, Nauni, Solan (HP)
[4]Junior Extension Specilist, Directrate of Extension Education, SKUAST- K, Srinagarr

Corresponding author: rohituhf@rediffmail.com

Abstract:

This paper reveals the study of low cost traditional water harvesting structures that helps in improving the socio-economic status of the poor farmers of the hill region. In the foothill region of North Western Himalayan region of India, the soil erosion has converted most of the fertile soils into barren, fallow and degraded lands. It is estimated that about 40 per cent of the total geographical area of Himachal Pradesh, Uttrakhand and Jammu and Kashmir is highly degraded. Soil loss through erosion is about 3.6 to 80 t ha^{-1}. The farmers are not aware of rainwater management for storage and ground water recharge. The major constraints identified for conservation and management of water and soil in the area includes lack of technical knowledge and poor economic status of the farmers. Assessment of the area showed that if rainwater is conserved vis-à-vis managed properly and existing technologies are refined for specific land and pedospheric characteristics, it would rehabilitate the degraded lands and in turn increase the productivity in the area. Low cost farm ponds are a better option for collecting rainwater excess during monsoon periods for utilization for irrigation. The most efficient and cheapest way of conserving rainwater at the agricultural farm was found to be in- situ runoff management, which also reduces soil losses and increases the opportunity time for ground water recharging. The earthen embankment for rainwater harvesting has cost benefit ratio of 1.38:1. In addition, good results of harvesting and storage are being achieved in ferro-cement water storage structures of different dimensions of 3 to 5 m deep and 1 to 3 m in diameter.

Keywords: In-Situ runoff management, Surface ponds Water harvesting structures.

1.0 Introduction:

The region of North-western Himalayas locally known as kandi belt lies in the foothills of Siwaliks. Most of these villages face water scarcity during summers. The agriculture in the region is totally dependent on rain, where the type and amount of rainfall is such that if the vegetation is disturbed, large-scale erosion could ensue. Land dissected by innumerable seasonal streams or choes provide a spectacular picture of accelerated erosion in the area (Arora and Hadda, 2006). The seriousness of the problems can be imagined from the fact that in highly denuded Siwaliks, 3-7 cm top soil layer often disappears during a single monsoon. Although with fairly high rainfall (1000-1400mm) and presence of number of seasonal streams or choes, water availability is a problem (Arora, 2006). The different methods, objectives for rain water harvesting in different areas vis-à-vis ground water recharges excellently described by Suraj Bhan (2009). Rainwater can be captured by using the rainwater harvesting system. Generally, rainwater harvesting system is the direct collection of rainwater from roofs and other purpose built catchments, the collection of sheet runoff from man-made ground or natural surface catchments and rock catchments for domestic, industry, agriculture and environment use. The systems can be categorized as small, medium and large scale (Gould 1999). Normally, the size of rainwater harvesting was based on the size of catchment area (Thamer *et al*., 2007). In scientific term, rainwater harvesting refers to collection and storage of rainwater and also other activities aimed at harvesting surface and groundwater, prevention of looses through evaporation and seepage and all other hydrological studies and engineering

interventions, aimed at conservation and efficient utilization of the limited water endowment of physiographic unit as a watershed (Agrawal and Narain, 1999).

Urban centers in India are facing an ironical situation with regard to water today. On one hand there is acute water scarcity and on the other, the streets are often flooded during the monsoons, requiring managerial efficiency of the Urban Local Bodies to use the surplus water of the rainy season to overcome the deficiency in other seasons. The shortage of ground water is more pronounced due to urbanization and limited open areas available for recharge of ground water. In some cities ground water extraction has reached very high levels and has brought problems like declining water table day by day, failures of wells/ tube wells and deterioration in ground water quality and quantity. Water is more than often been seen as a cause for social conflicts, protests, demonstrations and road-blockades. In the given situation rainwater harvesting could prove to be a solution for overcoming this scenario. Depending on local environmental conditions, water harvesting may provide a supplementary supply, an alternative supply or the only feasible improved supply, especially in urban areas. To meet these challenges, the Government has made roof top rain water harvesting (RWH) mandatory for all buildings. Rainwater harvesting (RWH) primarily consists of the collection, storage and subsequent use of captured rainwater as either the principal or as a supplementary source of water. Both potable and non-potable applications are possible (Fewkes, 2006).

2.0 Rainfall pattern:

Although total rainfall seems to be sufficient for two crops in the area but the unreliable nature of rainfall leads to periodic drought and soil erosion. 60-70% per cent of the annual rainfall occurs during summer monsoon months (July-September). The rains are especially erratic in time and space. However, most of the rainstorms received in monsoon season are of short duration and high intensity whereas those received in winter season are of low intensity and erratic in distribution in the area. All these results in serious problem of soil erosion through rainfall excess in summer monsoon months and soil moisture deficit in the winter months in the region. The detail of rainfall pattern and rainfall and evaporation are given in figure 1and 2

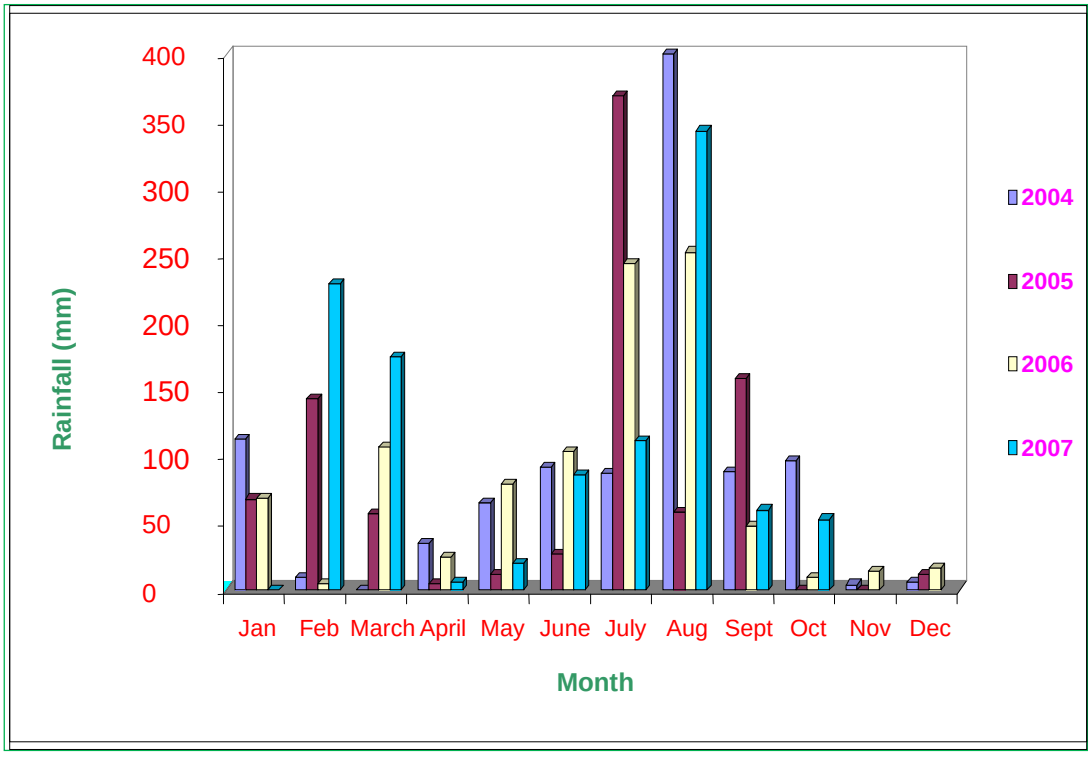

Figure 1: Rainfall pattern at Solan (Himachal Pradesh) during 2004-2007

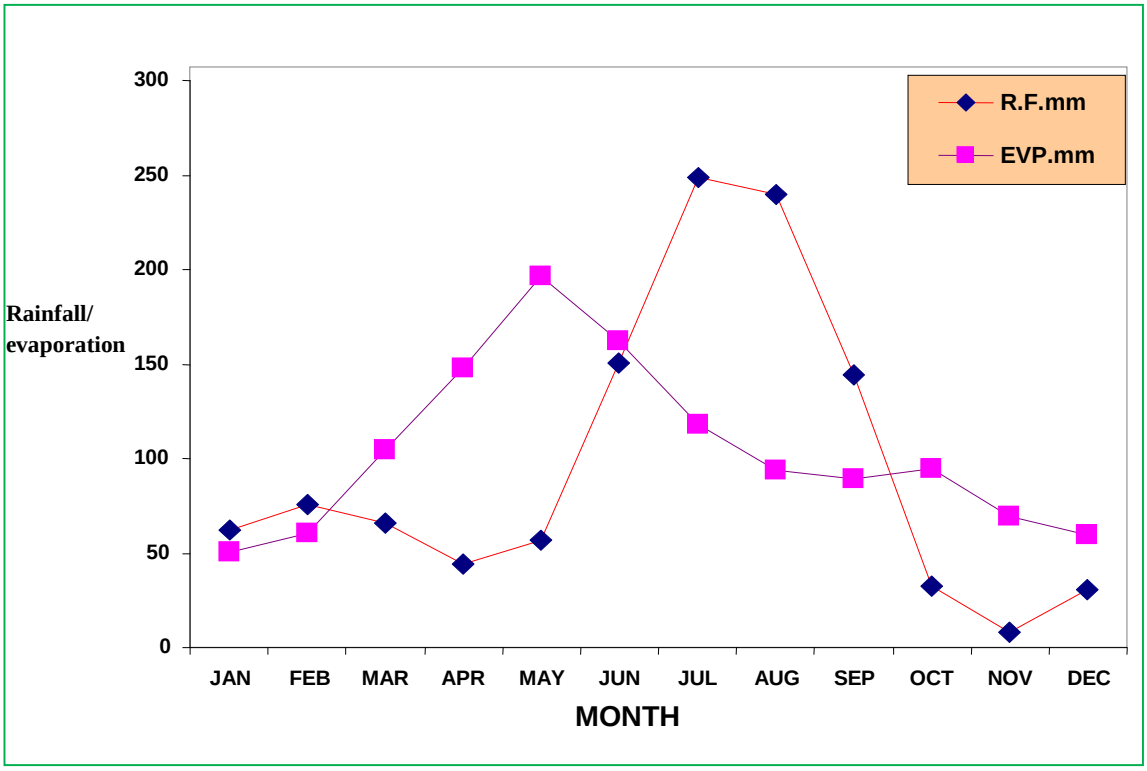

Figure 2: Normal climatic water balance (1990-2010)

Table 1: Irrigated area (hectares) through different sources and wasteland in J&K state

District	Canal	Tanks	Wells	Other Sources	Total	Net Sown area	Waste Land
Jammu	52.47	0.04	0.26	2.13	54.90	111	26
Udhampur	4.34	-	-	1.01	5.35	71	15
Doda	6.58	0.04	0.01	0.78	7.41	64	23
Kathua	15.89	-	0.30	5.79	21.98	64	11
Rajouri	2.39	-	0.04	4.89	7.32	52	12
Poonch	3.15	0.01	-	0.68	3.84	28	7
Total of state	284.15	2.71	1.53	22.48	310.87	748	140

Source: Anonymous (2003)

3.0 Water Resources:

Water resources are limited and highly variable. The judicious use of these resources is essential (Choudhary and Aneja, 1991). Agriculture is the main occupation of the people of almost all the states of India. Therefore, with the introduction large-scale adoption of high yielding fertilizer responsive varieties of various agricultural commodities, the rate of irrigation water has gained importance in the overall development of hilly states economy. Shortage of water for irrigation purposes is the main problem of the cultivation hilly states. As a result, especially during the current decade over-exploitation of water resource has adversely affected the soil productivity. There is a growing concern about the sustainability of today's agricultural breakthrough. The state of jammu and Kashmir , out of the total irrigated area, i.e. 310.87 ha; nearly 91 per cent of total irrigated area depends on surface canal water source in the year 2000-01 and rest of other sources (Table1).

4.0 Framers Attitude for Rainwater Management:

According to the survey conducted in some of the villages in *kandi* region of hill states about faced the constraint of lack of awareness and knowledge for rainwater harvesting, the detail of rain water management adaption practices are given in Table 2.

5.0 Rainwater Harvesting in Farm Ponds:

For harvesting of rainwater, farm ponds played a crucial role in the *kandi* belt, and were the main source of water for irrigation as well as drinking(e.g. in horticulture, agro-forestry).Solution to water scarcity problem in the *kandi* belt lies to a great extent in the rejuvenation of farm ponds. There is need for scientific assessment of storage capacity and related hydro-geomorphic characteristics of farm ponds. The percolating type farm pond of 10-15 thousand litres capacity may be constructed for ground water recharge. In addition earthen farm ponds as well as poly lined farm pond of different capacity are most suitable and viable for hilly areas. Due to lost cost of these farm ponds small and marginal farmers can afford .The construction cost of poly lined farm pond nearly @0.50 paise/litre and the storage water may be used in lean season for life saving irrigation in vegetable and fruit crops.

Table 2: Rainwater management practices and their adoption

Rain water conservation practices ***Practices and their adoption***	**% adoption**
Bunding, terracing and haloding (earthing- up)	20
Cultivating across the slope	60.00
Application of farm manure/ agricultural waste	71.60
Deep ploughing and Mulching	40.10
Problem in adoption	
Non-availability of design and implements used for improved conservation practices	80.11
Lack of technical know-how	65.20
Topographical problems	85.00
Ignorance for rainwater management practices	71.50
Small & fragmented land holdings	86.00
Poor socio-economic condition	67.27

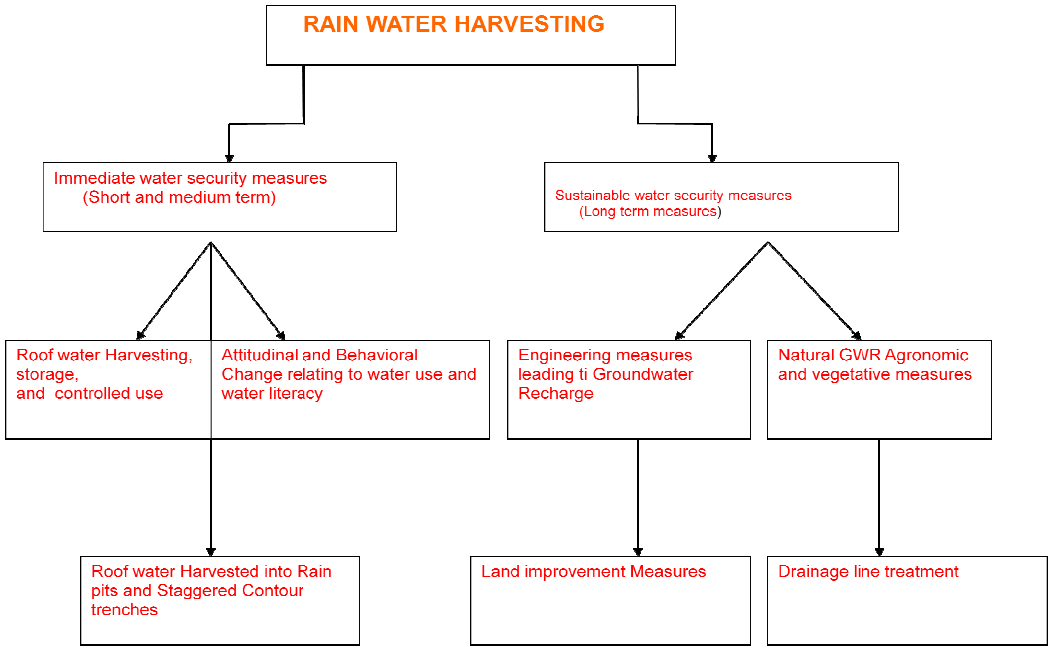

Fig.3: Percolating type farm pond

Fig. 4: Poly lined farm pond

Fig. 5: poly lined farm pond with brick pitching

The harvested rainwater in reservoirs can serve as a source of life saving irrigation to he crops and also have many indirect advantages like flood control, recharging of ground water, reclaiming land below the embankment and improvement of ecology etc. Jindal *et al*. (1990) in the submontane region. Demand on water resources has increase day by day due to the population growth and expansion in urbanization, industrialization and irrigated agricultural. Adopting the concept of sustainability and conservation of water resources can help to cope with the global water shortage. Rainwater harvesting system is one of the concepts that can be implemented to meet the water shortage problem. The quantity and quality of rainwater collected is different from place to place depending on the weather, geographic location, activity in the area and storage tank. Furthermore, rainwater has a lot of potential as an alternative water resource for the future because of its high quality. Rainwater quality always exceeds the surface water and comparable to ground water. Successful implementation of rainwater harvesting system is a great contribution for future rainwater harvesting development and living quality. Government agencies are playing an important role to promote this practice.

6.0 Conclusions:

The erratic and uneven distribution of rainfall both spatially and temporally, necessitates rainwater harvesting to increase and sustain the agricultural productivity. Excavated dug-out farm ponds tanks are found most suitable for storing runoff in cultivated lands with inverted truncated pyramid shape having 1:1 side slopes with lining of polyethylene sheet of 200 micron buried under 20 cm thick soil at bottom and pitched with bricks. The rainwater harvesting during monsoon and its use for irrigation during follow scarcity period was found to increase the crop yield by 25-35% during rabi season and additional water for population use by 55 % in the area. For successful implementation of traditional and new on farm rainwater harvesting techniques, strengthening of project implementing agency's capacity should be done for undertaking investigations and research of surface hydrology, groundwater and micro-watershed studies.

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