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Rainwater Harvesting through Farm Ponds in Hills of Himachal Pradesh – Opportunities and Threats

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ABSTRACT: Himachal Pradesh is a hilly state and 70% of its population depends upon agriculture for their livelihood. 81% of the agriculture in Himachal is rain fed and farmers face severe soil moisture stress at germination stage and long spell without rain during subsequent growing in winter and pre monsoon crops due to erratic distribution of rainfall in space and time. Though the average annual rainfall in the region is 1200 mm, the agricultural productivity is severely affected due to non-availability of water at critical stages of crop growth. In addition to it, there is huge shortage of drinking water in Shiwalik hills of Himachal Pradesh during summer months. The only option available for most of the farmers is to collect and store water resources available in three forms namely, direct surface run off, run off from rooftops of houses and cowsheds and the discharge from small springs. These springs has low discharge which generally goes waste, but its collection in storage tanks can be developed into a large water resource to solve drinking water problem and for micro irrigation. The paper highlights the various alternatives available to solve water shortage problems of the region. The rainwater can be collected in dugout farm pond lined with Low density polyethylene sheet which can be subsequently used for irrigation and other purposes. The integrated approach can be applied in far off places in the Shiwalik hills which pose a challenge to developmental agencies in this undulating, rugged and difficult terrain.

Keywords: Shiwalik hills; Rainwater Harvesting and Farm pond.

INTRODUCTION: The water scarcity is a serious problem throughout the world both for rural and urban communities due to increasing population urbanization, industrialization and use of chemicals in agriculture.

In fact India is blessed with adequate rainfall as a whole and the average annual precipitation is about 1170 mm. This is much higher than the global average of 700 mm. However the rainfall distribution in time domain is skewed with 75% of it taking place only in monsoon season. There is also very large spatial variation. (Athavale 2003) Rain is ultimate source of water. The demand for water is increasing due to increase in population, urbanization, industrialization and agriculture development. According to Ministry of Water Resources, water shortage in India will be more acute by 2025 and may cause stress on human and economic development. India has an age old tradition of water harvesting. Mohenjodaro, the largest city belonging to Harappa culture had over 700 open wells. (Dhavalikar 1999) The citizens of Dholavira had constructed check dams across streams. (Bisht 1994) The rainwater harvesting has assumed overriding significance all the more in view of depleting groundwater levels during recent years in many parts of India. In Shiwalik hills of Himachal Pradesh people face acute shortage of water every year (Singh et al 2010[a]). The Shiwalik region is characterized by slope wash material comprising of loose soil deposits underlain by boulders and pebbles. The deposits have generally moderate to high percolation rates where the soil cover is thin. Often the ground water gradient is steep which is conducive to quick drainage of ground water into nearby stream. (Singh et al 2010[b], Singh et al 2011)

The term rainwater harvesting refers to direct collection of precipitation falling on the roof or on the ground without passing through the stage of surface runoff on land. (Verma et al 2012) Rainwater harvesting through roof and ground catchments is an ancient technique of providing water supply (BIS 1742-1983). This is an ideal solution for a water problem, especially related to hilly areas where the ground water table is low and the surface sources are few and that too are found at a very low elevation in the valleys. (Yie-Re Chiu et al 2009) The water has to be pumped and transported to a high elevation where the habitations are situated (IE, 2006). Rainwater harvesting has assumed significance in view of depleting ground water levels. (Ariyabandhu 2003) Rainwater harvesting is an innovative energy saving approach for hilly communities to growing water-energy shortage dilemma (Mishra, 1995, Sharma and Chandel, 2012). The rainwater

harvested from rooftops can be stored in a tank and can be used directly (Sharma and Chandel 2013).

Many rainwater harvesting studies have been reported and are being undertaken in the country and the world over (Frasier 1980, Michaelides 1990, Khan, 1995, Dwivedi and Bhadauria 2009, Panhalkar, 2011). Many studies from water deficient area of north and south India have also been reported (Vishwanath 2001, Pathak et al 2002, Sharma & Chandel 2012[b], Shiv kumar 2005, Yadupathi and Raje 2005).

Rain fed farming will remain the main stay for the livelihood support of millions of small and marginal farmers across the country even after realizing the complete irrigation potential. Rainwater management is the most critical component of rain fed farming. The successful production of rainfed crops largely depends on how efficiently soil moisture is conserved in situ or the surplus runoff is harvested, stored and recycled for supplemental irrigation. Since time immemorial, water conservation and harvesting have been practiced in India and other parts of world. The production process depends on the timely water conservation in *Talab, pokhar, johad, khet talab,* and *bandha.*

The Shivalik region spread over an area of about 3 m ha represents one of the eight most degraded ecosystems in India. The Shivaliks are characterized with low hills, undulating topography, steep slopes and easily erodible soils. The region is dissected by numerous seasonal streams. Like other sub-humid region, it has vast water, soil and biological resources. These vast resources of Shivaliks have its share of constraints also. About 80 per cent of the rain is received during monsoon, i.e. June-September, which produces runoff in the range of 30-50 per cent in untreated watersheds. Vast volume of runoff inundates low-lying fields and causes temporary water excess. Analysis of 42 years rainfall data (1958-94) at Panchkula (Haryana) reveals that during this period, the region experienced large and 5 severe droughts. Thus, one out of every three years had severe rainfall deficit even in the *kharif* crops. In the absence of good winter rains and irrigation facilities, the *rabi* crops fail completely twice in every five years. Only 18 per cent of the cultivated area in the Shivaliks is irrigated and rest all is rainfed. Water scarcity for irrigation is one of the critical issues of this region (Tiwari, 2009).

Though this region receives a good amount of rain every year, still problem of water scarcity becomes more acute due to the erratic behavior of monsoon/ winter rains *i.e.*, early and late onset and the closure of rains. This erratic behavior of rainfall badly affects the sowing of crops and other associated agronomical practices. There is always a scarcity of water for meeting domestic, agricultural and livestock requirements despite receiving rainfall more than the national average. This erratic behavior of rainfall in both the season results into various problems related to the agriculture of the region.

Study Area: The study is confined to Hamirpur, Bilaspur and Una district of Himachal Pradesh. The mean annual rainfall of this area is about 1170 mm, of which 75% is received during the monsoon months from June to September. The soil of this region is generally sandy loam type. The surface runoff tends to be high due to high slopes and low water holding capacity of the soils. Coarse soil texture and high seepage losses through soil do not permit sufficient moisture retention in the surface soil and upper layers of sub soil. Due to this the crops suffer badly at different stages of crop growth during pre and post monsoon periods and long dry spells during rainy season.

Hydrological cycle: The surface runoff can be estimated using various methods on the basis of past rainfall data and land use. The potential of rooftop rainwater harvesting has been calculated by using the following formula and it can be used for domestic uses after filtration. The flows from water springs can also be estimated using past records.

$$S=R \times A \times Cr \quad \text{[Gould \& Nissen Formula, (1999)]}\ldots(1)$$

Where;
S = Potential for rooftop rainwater harvesting (Cu.m)
R = Mean annual rainfall in meters
A = Roof Area in Sq. m
Cr = Co-efficient of runoff

The optimum size of a lined pond depends on; the amount of runoff expected, crops to be irrigated or the water required for domestic use and benefit-cost ratio of the harvesting system.

The probability analysis of rainfall data reveals that at 80% probability (assured level), the expected rainfall during pre- and post monsoon periods is almost negligible for the germination of rabi (winter) crops creating large moisture stress at the germination and reproductive stages of rabi corps and timely showing of summer crops. Under these circumstances, rainfall and/or runoff harvesting during rainy season along with spring-water harvesting at suitable locations seems to be the only way out.

Though water requirements of the farmers are greater, the size of storage structures has to be restricted accordingly to water availability and topography of the location. The capacity of the storage structures depends mainly on the availability of relatively flatter land on which these structures could be made, and the

runoff passing through that point. The small and scattered land holdings on different terrains permit the construction of small water storage tanks at the up-stream end of a cluster of fields to facilitate irrigation through gravity flow. Out of the existing options viz. cement-concrete, brick/stone masonry, and LDPE sheet, for lining the dugout pond, the LDPE lining has proved to be technically feasible and economically viable for the hill farmers. This technique is most appropriate for poor farmer, as it can be implemented and maintained by the farmers themselves using their own labour and locally available resources (Anil Kumar 2009).

Design of the Pond: The construction of dugout pond consists of digging of a truncated reverse-pyramid shaped pit with 1:1 side slopes. The depth has to be restricted to 1.0 to 1.5 m to avoid upward movement of bottom soil due to buoyant force of water. At the locations where stones are available near the site, the depth of pond may be increased to 2 m by doing the stone pitching all around the surface of the pond. A single piece LDPE sheet (0.25 mm thick) of required size is placed with properly folded corners and buried ends on all sides. Before placing the sheet, the inner surfaces of the pond were plastered with 5 cm thick mud plaster so that the sheet is properly stuck to the surfaces. Another 10 cm layer of mud mixture of soil and wheat straw or chopped dry pine needles (4:1) is placed on the sides, and a 15 cm thick layer is placed at the bottom. In case of harvesting the surface runoff, a small silt retention trench of 1x 0.5 x 0.5 m size is dug at the entry point to the main pond so that debris and suspended particles along with overland runoff could settle down and relatively clean runoff water may enter the main pond. The silt retention trench is not required while harvesting the runoff through roof-tops or water-springs. Evaporation losses from the pond can be minimized by spreading a small quantity of burnt engine oil or by broadcasting polyethylene granules of about 3 mm size on water surface. Being relatively free from dust or foreign materials, the run-off from roof-tops and the flows from water-springs can be stored in closed brick-cemented tanks for drinking, domestic uses and cattle feeding after proper treatment or filtration. Farm ponds can meet the objectives such as; to harvest rainwater, recharging of wells, increase moisture content in the field and ensuring the availability of drinking water for Livestock.

The primary objectives of farm pond constructions is to ensure life-saving irrigation, In the absence of monsoon rain, water from the farm pond could be used to save the crop. Farm ponds also maintain micro humid conditions during the dry spells, replenishes groundwater and most important is that these make water available for human consumption as well as for livestock. Farm ponds also provide opportunity for undertaking orchards & agro –forestry and the sprinkler system can be easily run with farm pond water.
Terminal drought is defined as the inadequacy of the rainfall when required i.e. during flowering, pollination and seed formation stages of the crop. Terminal drought reduces production of food grains by 80% and fodder by 20 to 25%. Farm ponds provide critical irrigation facility to the crops during the terminal drought phase.

There has been increased demand by farmers for the construction of farm ponds in the region due to the fact that; these farm pond make possible crop production even under terminal drought, they checks soil erosion and retains silt, they result in increased moisture content in the field, they prevents excess runoff from the field and they make availability of drinking water for the livestock.

CONCLUSION: There is a need to reintroduce traditional farm ponds in the regular government schemes. Farm ponds construction should be incorporated and converged with other development programmes such as planting of aromatic plants, orchards and forest nurseries, which are the major sources of income hill farmers. Efforts have also to be made to use this water through more advanced and efficient methods of irrigation such as drip and sprinkler in the orchards and other cash crops. The pumps required to pump water may be energized through solar panels.

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