Water Management in Hill Area: An Overview

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Abstract— Water is very essential for humans, plants, and animals. Water is needed to ensure food security, feed livestock, maintain organic life, and take up industrial production and to conserve the biodiversity and environment. In India primary source of water is south – west and north east monsoon. There are only 9 weeks of rainy season in India, and other months are dry period of India .It is an agricultural base country and its economic development is also associated with agriculture. For agriculture the major limiting factor is water. A growing population and consequent need for increase in food production requiring increasing area of agricultural fields and irrigation are resulting in over use of water. Total 97 % percent of water comes through the hilly region but the hilly region faces a big problem for the water conservation to use it for drinking and irrigation purposes. Hills have terrence and slopes so all the water goes down to the bottom of the hill, by which the people of upper most and middle region of hills cannot utilize this water properly. So in this paper we present some technic and method for conservation of water for drinking and irrigation which is already being used but did not known by everybody**.**

Key words: Ruza System, Panikheti system, Rice cum fish culture

I. INTRODUCTION

70% of the earth surface is covered with water, which amounts to 1400 million cubic kilometers (m km^3). However, 97.5% of this water being sea water, it is salty. Fresh water availability is only 35 m km^3 and only 40% of this can be used by human beings. Out of the total fresh water, 68.7% is frozen in ice caps, 30% is stored underground and only 0.3% water is available on the surface of the earth. Out of the surface water, 87% is stored in lakes, 11% in swamp and 2% in rivers. India is blessed with good rainfall well distributed over 5-6 months in the year. India has about 16 percent of the world's population as compared to only 4 per cent of its water resources. The average annual rainfall in the country is 1170 mm with a wide range between 100 mm in desert areas of Rajasthan to 10000 mm in Cherapunji. The total available sweet water in the country is 4000 billion m^3 per annum. Out of this, over 1047 billion m^3 water is lost due to evaporation, transpiration and runoff, reducing the available water to 1953 billion m^3 and the usable water to 1123 billion m^3. It is disturbing to note that only 18% of the rainwater is used effectively while 48% enters the river and most of which reaches the ocean. Out of the total usable water, 728 billion m^3 is contributed from surface water and 395 billion m^3 is contributed by replenish able ground water. Against the above supply, the water consumed during the year 2006 in India was 829 billion m^3 which is likely to increase to 1093 billion m^3 in 2025 and 1047 billion m^3 in 2050, as estimated by the Government of India (2014). As the potential for increasing the volume of utilization of water is hardly 5-10%, India is bound to face severe scarcity of water in the near future.

A. Water uses by India

Year	**Agriculture**	**Industry**	**Domestic**	**Total**	**Per Capita**
India	**Billion Lit/Day**				**Lit/Day**
2014	1658	115	93	1866	88.9
2050	1745	441	227	2413	167.0

India has eight major mountains ranges having peak over 1000 m(3300 ft).

- Himalayan Range
- The Karakoram Range(in Jammu and Kashmir)
- The Patkai (Purvanchal)
- The Vindhya Range
- Satpura Range
- Aravali Range
- Eastern Ghats
- Western Ghats

This hilly region of India have 80% of water of country but can utilize only 35 % of this due to lack of facilities and costly projects so there some cheap and economically technic for conservation of water for drinking and irrigation.

II. LITERATURE REVIEW

Sustainable development and efficient management of water is an increasingly complex challenge in India. Increasing population, growing urbanization and rapid industrialization combined with the need for raising agricultural production generates competing claims for water. There is a growing perception of a since of an impending water crisis in country. The work done for conservation, development and management of water resources in hilly region by various authors in India and abroad are given below:

G.K.Khadse et.al. (2011) They carried out an analysis for "Conservation, development and management of water resources, for Himalayan region in India". They made to study the sustainable water resources management with particular reference to rainwater harvesting, water quality improvement for safe drinking water supply and sanitation with active public participation, training and awareness programs in Chamba block in TehriGarhwal district (Uttrakhand). After their analysis they found that-

- For household and domestic use Rooftop water harvesting is very suitable during scarcity period.
- For ground water recharge in the area the chhals/ponds were found suitable.

- For drinking water the filtration units such as pot chlorinator system in rooftop harvesting are successful.
- Slow sand filters are also used in water purification for treating raw water to produce portablewater.

R. Saha et.al. (2007) They researched on "Low cost micro rain water harvesting technology (jalkund) for new livelihood of ruler hill farmers .They found that due to some backdrop ,a low cost rainwater harvesting structure called jalkund for the hilltops has been developed . They gives an integrated homestead farming program which is subjected to crop production, livestock production (pig, duck, poultry),and fish production. They applied this program in the village of Ri-Bhoi district, Meghalaya. The capacity of jalkund was 18000-30000 l of water. This stored water was used for maintaining a kitchen garden and also for pig, duck and poultry-rearing. After success of this program they found that this is very helpful program for the poor farmers of NEH states.

Manoj P. Samuel et.al. (2008) They give an article on "Concentrated rain water harvesting technologies suitable for hilly agro- ecosystems of Northeast India" .They gives a brief review on rain water harvesting, harvesting and storing of rainwater for the lean days. Storing of rain water can be done in to two ways –

- In an artificial storage
- In the soil media as ground water

A demand supply analysis is required such as frequency of rainfall, runoff coefficient of the collecting surface, number of users , daily requirements while designing water – collection tanks. Their analysis indicate that establishment of such an integrated system is not only financially variable, but also a highly attractive proposition for low cost harvesting and effective use of rainwater /runoff. The studies suggested that these technologies are sustainable, locally adoptable cost effective, applicable and affordable to the formers.

R.A Singh et.al. (2001) They studied on the traditional and water management system of North –East hill region .They found that a number of tribes inhabiting the NEH region. These tribal societies with long history and traditions have developed ingenious indigenous farming system, which have built-in ecofriendly system for conservation, preservation, and utilization of natural resources. They briefly described these tradition farming practices-

- Zabu or Ruza System
- Agriculture with Alder trees
- Panikheti system
- Hubur and Bund system
- Rice cum fish culture
- Bamboo drip irrigation

After their study the found that these traditional system can again be made economically viable. The added advantages will include reduction in shifting cultivation and misuse of natural resources.

Paul Polak et.al. (1997) They present a brief review on low cost drip irrigation system for small farmers in developing countries. In their paper they applied this system in hill area in Nepal. The first of these systems was installed on the half an acre of vegetables at an agricultural research station outside khathmandu. Tests were run on uniformity of flow from the drip holes, head losses in the drip lines, and uniformity of flow from one terrace to next.After their research they found that in areas with high concentration of small farmer operations and a scarcity of water, the low cot drip irrigation system will provide access to water, saving irrigation technology which is affordable on small scale and divisible.

III. METHODOLOGY

The hilly region of India are facing problem in storage of sufficient water, especially during summer, for drinking and irrigation purposes.so some technologies and methods for water conservation are-

For Drinking Purposes…

There are some types of water conservation through which we can utilize the water for drinking and living hood purposes.

(1) Rain water harvesting
  (1) Rooftop rain water harvesting
  (2) Percolation pits
  (3) Development of chaals
(2) Slow Sand filtration
(3) The pot chlorinator

A. Rain water harvesting

1) Rooftop Rain Water Harvesting

In this region rooftops are made up of slates. During rainfall water drips from the rooftop and is collected puttingcontainers beneath on the courtyard. Usually this water is used for cattle (drinking and washing), cleaning clothes,utensils and house premises, toilet cleaning, and rarely for drinking (only when the water is sufficiently clean).Traditionally, there is no special structure on the roof to guide the overflowing rainwater at a fixed location. Therefore, most of the water just flows down through the courtyard and finds its way through holes kept for the outlet of this water, which open in adjoining kitchen garden and serve the purpose of minor irrigation. However, of late, people have also started to fix tin / rubber plastic gutters along the sloppy edge of the roof top to guide this water to fall at one corner of the courtyard and also use big polytanks / drums / permanently built small cement-lined tanks to store this water for further use. Sometimes a canal-like carving in the wooden log is permanently kept beneath the roof at the backyard to store rooftop water and for use by cattle.

Fig. 1: Rooftop rainwater harvesting

2) Percolation Pits

Percolation pit is any pit that is designed to allow fluid place in the pit to "Percolate" into the ground, i.e., drain. A recharge well is typically a well with a water supply that is used to recharge a water supply as is a recharge trench (used to direct the water supply to arecharge point).

a) Underground Percolation System

(1) Subsoil storage/percolation systems can be
 (1) Infiltration Wells
 (2) Soak Pits/Percolation Pits
 (3) Open Wells, Ponds etc.
(2) Ground water storage system through a borewell

Fig. 2: Percolation Pits

3) Ponds

The pond size ranged from 170 m^2 to as large as 1000 m^2 with average size of about 500 m^2 and depth of 1.25-1.5 m. The existing underutilized and defunct ponds of the farmers were renovated during the dry season (December to March) by removing the silts, repairing the dykes and spillways. The unwanted weeds, bushes, weed fish, etc. was removed from the pond before stocking the fish.

Fig. 3: Pond

B. Slow Sand Filtration

Slow sand filers are used in water purification for treating raw water to produce potable water .Slow sand filters are used in water purification for treating raw water to produce a potable product. They are typically 1 to 2 meters deep, can be rectangular or cylindrical in cross section and are used primarily to treat surface water. The length and breadth of the tanks are determined by the flow rate desired by the filters, which typically have a loading rate of 0.1 to 0.2 meters per hour (or cubic meters per square meter per hour). During this passage the water quality improves considerably by reduction, removal and changes in biological, physical and chemical composition of raw water. Raw spring water is collected in a small sump and transported by gravity through G.I. pipes to the SSF plant. Filtered water is stored in ground level tank and distributed in the village again by gravity through PSPs. The plant is adequate for a population of 450 @ 40 lpcd. This plant will be effective in propagating the technology specifically for small community water supply in hilly region. It is worth mentioning that this is a water treatment technology without any power requirement. O and M is limited to removing upper sand layer once in 3-4 months.

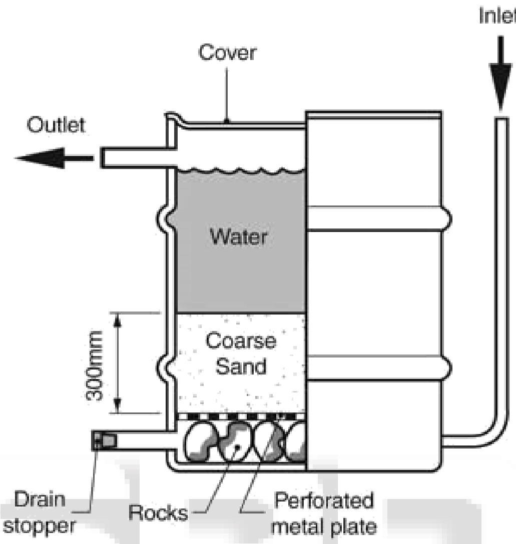

Fig. 4: Slow Sand Filtration System

C. The Pot Chlorinator

If water is contaminated but clear,disinfection can be used to kill microorganisms it contains. Using chlorine for this purpose provide a residual that helps in preventing re-contamination. A method or device developed by NEERI has effective chlorination of storage tanks and wells in rural areas for about 12 to 15 days. Pot chlorinators also installed in rain water harvesting tanks wherefrom water is used for drinking purpose.

A plastic pot of 7 to 8 liter capacity is used in this system. Holes (2 to 3) of 0.5 cm diameter are made at the bottom, which. The holes are covered with stones or pebbles of 2 to 4 cm size which is further covered with gravel of smaller size. A dry mixture of 1.5 kg of bleaching powder and 3 kg of coarse sand is placed over the gravel. The pot is then filled with pebbles or stones up to the neck to facilitate its immersion in the water. It is lowered in a tank about 1 m below water level with the help of a rope.

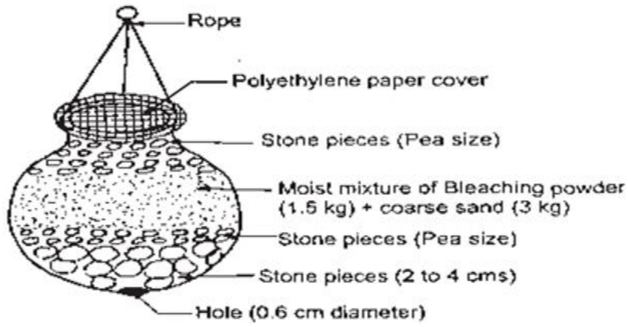

Fig. 5: The Pot Chlorinator

For Irrigation purposes…

1) Water management in Apatani Plateau

The Apatani Plateau is located in Subansiri district of Arunanchal Pradesh and has an area of 26 sq.km.It is inhabited by Apatani tribal. The Apatanis have developed an efficient system of water management for rice and fish culture. All streams averaging out from the surrounding hills are tapped, channelized at the beginning of the valley and diverted by network of primary, secondary and tertiary channels. Some water is allowed to flow in the first feeder channel, which the stream continues its course.Apatani version of wet rice is one of the most advanced with an exceptionally high energy and economic efficiency.

Fig. 6: The 'Zabo' system of water management

"Zabo" means impounding of water. The place or origin of this system is the Kikruma village in Phek district of Nagaland. This system includes harvesting water from hill slopes, storing them in tanks and using it for crops. The rainwater from top hill slopes is diverted to dugout tanks. Usually there are one or two desiltation tanks where the runoff water is stored for desiltation before taking it to the main tank below Water from the desiltation tanks is taken to the main tank for storage. The water from the main tank is passed through animal yard before taking it to the fields for irrigation. The water carries with it the dung and urine of the animals, thus helping in maintaining soil fertility.

2) Bamboo drip irrigation

Bamboo drip irrigation system is mainly followed in Jaintia and Khasi hills of Meghalaya. This is a very good system for areas where water is scarce, soils have poor water holding capacity, the topography is undulating and the water requirement of crops is low.

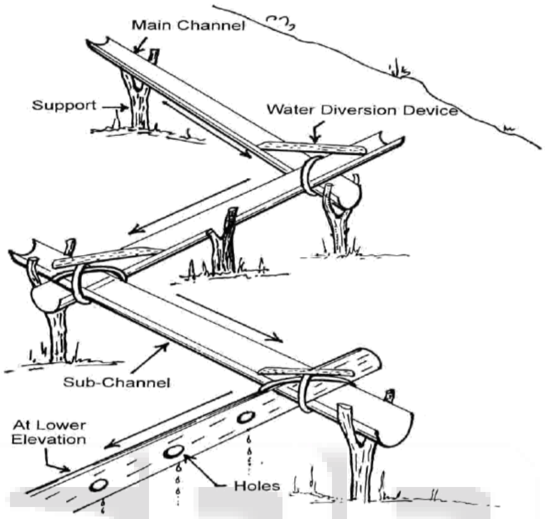

Fig. 7: bamboo drip irrigation

Angami and Chakhesang tribes of Nagaland have developed a system of irrigating rice fields grown on terraces. Due to high rainfall in the region, the growth of weeds in upland rice is a serious constraint for higher productivity. The terraces are irrigated by channels which carry water from some stream or torrent. About 10 to 15 cm of water is maintained in the field. The extra water runs down from one terrace to another through wedge type openings in the bunds. To maintain the desired level of water in the field, a stone is kept at the opening of the bund, also preventing soil erosion. The traditional practice ensures that there is no wastage of water while protecting the rights of farmers over water use.

IV. Conclusion

The design, development and commissioning of rainwater harvesting structures with the introduction of pot chlorinator has resulted in improved groundwater recharge and safe water supply respectively in study area. The design, development, commissioning of appropriate technological intervention through SSF plant with the introduction of pot chlorinator has resulted in improved and safe water supply in hilly area. The environmental awareness programs and training had interactive participation to change current non-scientific thinking and practices. The pre and post assessment of socio-economic survey, water quality, health survey and beneficiary's opinion reflect positively in achievements of anticipated benefits and impacts.All the tribal systems of water management is partly community managed and partly self-managed. Once the systems are erected by the tribal people they run for years, provided, maintained properly. The methods adopted traditionally by the tribal farmers of the region due to their skill and experience are simple, make use of locally available resources, require no investment and are most suitable for hilly terrains. These methods combining soil and water conservation techniques, do not involve deforestation, and, therefore, are eco-friendly.

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