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REACHING THE UNREACHED: CHALLENGES FOR THE 21ST CENTURY

Artificial recharge to sustain drying tubewells

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THE SUCCESS OF Rural Water Supply Programmes in a developing country like India where surface water utilisation is not economically viable; depends solely on the capacity to harness ground water to the maximum. But since about the last two decades, the importance of ground water has been realised for irrigation and industrial purposes also. This has resulted in indiscriminate drilling of tubewells for these purposes without any consideration to the limited extent of the ground water available. This over exploitation of the ground water has resulted in lowering of the water table so much that the tubewells giving sufficient yield earlier are dwindling in yield and ultimately drying up. The situation becomes more precarious in summer when most of the shallow tubewells dry up and yield of the deep tubewells reduces considerably. The drinking water crisis in most of the villages in Madhya Pradesh in India is prevalent in summer imposing serious health hazards to the rural masses and responsible for the loss of the huge livestock for the want of drinking water.

Artificial recharge of ground water seems to be the only corrective measure to compensate for this overexploitation and sustain the drying tube wells. But at the same time, the need for proper planning, conservation, optimum utilisation and management of this precious resource is of paramount importance. Hence the ground water resource must be harnessed properly and husbanded judiciously.

Artificial recharge may be defined as the process of replenishing ground water by augmenting the natural infiltration of rain water or surface water into underground formations through various methods designed specially for the purpose. Artificial recharge may be induced by some of the following methods depending on the local topographic, geologic and soil conditions:-

- Direct surface recharge by surface spreading or flooding .
- Direct sub surface recharge by injection wells, pits or shafts.
- To causewater from nearby surface water bodies to flow to add to the ground water table.

Ground water recharge techniques have been developed worldover through large number of experimental projects. In India, Central Ground Water Board and the state ground water organisations also conducted number of studies to find the applicability of the technologies to tropical conditions. The general findings suggest that:

- The structures in preading methods have been found to be most economical.
- Underground dyke which acts as a ground water dam is the most preferred conservation measure as it is maintenance free. The evaporation loss is also minimum.
- Basin development schemes, minor irrigation tanks, afforestation, soil conservation schemes do also serve the purpose of recharge to ground water in addition to the purpose for which they are built.
- Rock formation should be of moderate permeability. Low permeabilities reduce intake rate whereas high permeabilities do not allow retention of recharged water for a longer time to make use of it during dry season .
- Injection wells or connector wells are costly scheme requiring high order of quality control and hence are not economically viable for a developing country.

The general considerations for adopting a ground water recharge project can be summarised as below:-

- Water availability.
- Favourable Topographic, Physiographic and hydrogeologic set up.
- Infiltration and percolation characteristics of vedose zone.
- Hydrologic characteristics of the aquifers such as capacity to store, transmit and yield water.
- Economic viability.

Looking to the financial constraints in a developing country, the water injection or induced recharge methods can't be accepted in general for artificial recharge, but could only be adopted in specific cases where the benefits are linked with some other multipurpose projects at the same time .

But to solve the problem of drinking water in a village arising out of drying tubewells in summer season, a general concept regarding recharge of ground water is to be evolved and developed targeting all the possible water channels, how small they may be, existing in and around the village to contribute more to the ground water storage as compared to that in their natural course. This way the resulting additional infiltration could be useful in sustaining these drying tubewells.

So it has become imperative to construct such structures which could help to arrest the rain water precipitation in the targeted watershed and make it infiltrate under ground before it goes away as surface or sub surface runoff. The topographic, physiographic and hydrogeologic set up of the area need not to be investigated at length, but only to be utilised to suit best in the existing frame, as these proposed structures are relatively of small scale operations in terms of catchment area, volume of water storage and capital investments. These constructions are within the easy reach and resources of small villagers / farmers of that scarcity tract.

In the first part to achieve the objective , water barriers are constructed in shape of 'Soil checks' and 'Boulder checks' across all small water channels of the village and agricultural fields around the village to detain rain water for a longer period of time throughout the monsoon season (i.e. 4 months in India , from 15th June to 15th Oct.) and hence enhancing the period of contact of surface runoff in the targeted watershed and allow it to percolate down the surface and converting more quantity of precipitation in to sub surface or ground water flow rather than going waste as straight surface runoff. These 'Soil checks' and 'Boulder checks' could be constructed in series at the narrow sections of the channels as per the common knowledge of water storage practices being adopted by the villagers and farmers for agricultural purposes. These water channels possess only a very limited catchment area and hence this part of arresting the water are got done by the villagers with a little guidance about the location and method of construction of the " Soil check" or " Boulder check".

Now the second part of arresting the water in the main Nalla (A big water channel draining the targeted water shed) is to be taken up by the technical experts. This Nalla may pass through many water sheds so targeted and managed and may be a tributary to a river or to another bigger Nalla. The sub surface flow through all the targeted watersheds which certainly gets enhanced due to flooding and detention caused by the 'Soil checks' and 'Boulder checks' , percolates down to meet the water table and recharges the top unconfined aquifers and at the same time moves towards the main nalla draining the watershed. So this main Nalla is to be surveyed by conducting fly levelling at the Nalla bed and on both the banks simultaneously, right from its origin to confluence point in the river or another bigger Nalla. Based on the survey data, a series of "Boulder check dam cum dyke" is chalked out at suitable cross-sections along the entire length of the main Nalla to arrest all the sub surface flow passing through the Nalla bed through underground dykes. The "Boulder check dam" constructed over the dyke heads up the 'Nalla flow' and acts as a barrier causing flooding and retention of water throughout the rainy season and even afterwards in winter with storage and flow available in the Nalla.

The basic principles involved in arriving at the locations of the 'Boulder check dam cum dyke" in the series are given under :

- The location of the 'Boulder check dam cum dyke" should be just down stream of the village end targeted for watershed management. This way the waterpool is available in the village during and after rainy season for various domestic uses.
- The depth of the underground dyke which should be a complete barrier for sub surface flow is so decided that either it goes up to 0.5m deep inside the impervious rocky layer, if existing, or exceeds the water head exerted by the flowing water gained from its origin to the point of arrest. But to avoid deep excavations which are expansive and unsafe, the total head is divided into small fragments by forming a series at suitable locations as shown in the fig 1 . The depth of the underground dyke at locations I ,II, III, IV, & V are shown as h_1, h_2, h_3, h_4 and h_5 respectively which are suitably chosen to keep the depth of excavation limited to 1.5m wherever impervious rocky layer exists at lower depths.
- The height of the 'Boulder check dam' over the dykes is so selected that the water stretch of the d / s structure just touches the toe of the U / S structure.

Because of the series of "Boulder check dam cum dyke' so constructed, the whole Nalla is flooded during the monsoon season continuously recharging the underground acquifers through the Nalla banks and bed. Another advantage of arresting water in such a series fashion is that the water arrested at various targeted watersheds doesn't tend to flow towards the main draining Nalla in the flooding period and it is bound to recharge its own unconfined acquifers as well as deeper acquifers too as per the existence of discontinuities, lineaments, shear / fault zones etc. in the recharge region. Later on in the coming summer season when flow in the Nalla ceases and it is almost dried, the sub surface flow from the various water sheds gets arrested underground by the dykes and it percolates through the bed and banks of the Nalla and appears at the watershed situated on D / S side of the structure as a renewable source to the drying tubewells .Thus the series of "Boulder check dam cum dyke " helps in recuperating the depleting unconfined acquifers even in summer to sustain drying tubewells in all the watersheds connected to the main Nalla through a structure constructed U / S of it.

These structures not only recharged the ground water but also helped in curbing top soil erosion and providing soil moisture in agricultural fields to enable the farmers to take a second crop which was not possible earlier with out irrigation facilities in the tropical climate of India.

Constructional details of the structures

Underground dyke

This is an underground structure having rectangular section and is dug across the width of the Nalla up to required depth. The width of the excavation trench is generally kept @ 1.5 to 2.0m. The parameter of the excavated section is lined with low density polythene film and is back filled with black cotton puddle or with locally available clay soil to act as a underground barrier.

Boulder check dam

This is a small barrier constructed with the locally available stone boulders minimum 22cm in size having trapozoidal section with a height about 1 to 1.5m . The boulders are placed in layers to form the structure . The top width of the structure is kept as 1.25m and the U / S slope is kept as 1:8 whereas the D / S slop is kept as 1:6 . These flatter slopes are provided to avoid any silt deposition. The silt passes away the structure quite easily with these slopes.

Boulder check and soil check

These are the small bunds constructed across the small water channels and may be of trapozoidal section with top width varying between 0.3 to 0.6m . The U / S and D / S slopes are kept as 1:1 to 1:2 depending on the discharge expected in the channel. A by pass channel may also be excavated from U / S side of the structure to the D / S side to pass over the excess runoff to avoid overtopping of the soil check.

A series of such "Boulder check dam cum dyke" constructed across a Nalla namely Parmalkasa Nalla in Rajnandgaon district of M.P. in India has proved to be quite useful in providing soil-moisture in agricultural fields in summer to enable the farmers to take a second crop and maintain the water level quite high in the tubewells as compared to that in the previous years though the year (i.e. 1995) received a poor rainfall . The water table remained much higher (@ 25m on Av.below G.L.) as compared to that observed before the construction of these structures (@ 35 to 45m below G.L.) in summer enabling a sustained drinking water supply through the tubewells installed with hand pumps in the surrounding villages .

Recognising the role of such recharging structures in meeting the requirement of drinking water by replenishing the drying tubewells, there is a great need to lay emphasis on research and investigation in this area to make available the sustainable under ground water sources.

Refrences

'Jal Samvardhan-Ek Samadhan' (water conservation - a solution), A booklet published by P.H.E. Deptt., M.P. (India).