

Groundwater recharge

models for rainfed regions

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India's groundwater position is in precarious situation. Depletion of groundwater has been a major concern in rainfed regions depend upon groundwater for irrigation. The centres of All India Coordinated Research Projects for Dryland Agriculture developed groundwater recharge models according to soil strata and rainfall situation. In Maharashtra, artificial groundwater recharge models for open well as well as bore well were developed, tested and evaluated. Due to artificial recharging, the groundwater level is increased in the tune of 0.3–0.4 m. Groundwater recharge in treated bore well was in the tune of 19.78–29.10% with an average of 23.28% as against average recharge of 5.56% in untreated bore wells. In northern dry zone of Karnataka, using normal size wells (5 m × 5 m × 10 m), it is possible to recharge around 4–5 lakh litres of water during a normal rainfall year. In Bengaluru artificial recharging has improved the water level and groundwater recharge.

Keywords: Bore well, Groundwater recharge models, Open ring wells, Rainfed areas

WATER is a prime natural resource and over three-fourth of food grain production is from the irrigated lands and is contributed by fields irrigated by groundwater. This is one of the reason why India is experiencing explosive growth in groundwater demand during recent decades. Groundwater is a renewable resource and its appropriate management has great significance. The groundwater recharge depends on quantum and pattern of rainfall. Large-scale pumping out of groundwater and negligible recharging has created 'water havoc' in borewell-fed areas of India and groundwater levels in various regions have reached to alarming levels. Hence attention is needed to enhance the groundwater potential through artificial recharging techniques. Assured crop production in rainfed areas can only be achieved if supplemental/protective irrigation is provided.

Artificial recharging model for open wells in Marathwada region of Maharashtra

All India Coordinated Research Projects for Dryland Agriculture (AICRPDA) centre, Parbhani, Vasantao Naik Marathwada Krishi Vidyapeeth developed and demonstrated artificial well recharging model in the assured rainfall zone of Marathwada region in

Maharashtra. The filter unit was designed in 3 blocks/parts and constructed near the open well at a distance of 5–10 m. First one is called primary filter (0.6 m × 0.6 m) which is combined with layers of stones, sand and gravels. Runoff water from the cultivated area/catchment area is diverted towards well recharge unit through field trenches. This primary filter arrests major sediments from runoff water received from the catchment area. Primary filter is joined by pipe to silt trapping unit/energy dissipation unit (1.5 m × 1 m × 1 m) having a rectangular notch opening in main filter unit. In the secondary unit called as energy dissipation unit, the velocity of water will be reduced and heavy silt will be deposited at the bottom. The muddy water containing suspended and dissolved silt will enter into main filtration unit through a notch.

Third block acts as a main filtration tank with dimensions of 2 m × 2 m × 2 m having three layers of different filter materials such as 30 cm stones overlaid by 30 cm gravels and 30 cm sand one above other. The main filter unit is connected to open well by PVC pipe. The filter unit is constructed with brick walls and cement concrete (2 m × 2 m × 2 m). A well recharging model constructed with cement and brick, external and main filter unit with silt trap unit of size 1 m × 1 m × 1.5

m is recommended for the region (Table 1). The filtration efficiency of main filter was found to be 92–95%. The availability of 25–35% surface runoff for well recharging was found to be useful to enhance the groundwater level in the tune of 0.3–3.4 m.

Table 1. Dimensions of filter units

Filter material	External filter 0.60 m × 0.60 m × 0.60 m	Main filter 2 m × 2 m × 2 m
Boulders/big stones	20 cm	30 cm
Gravels/small stones	20 cm	30 cm
Sand	20 cm	30 cm

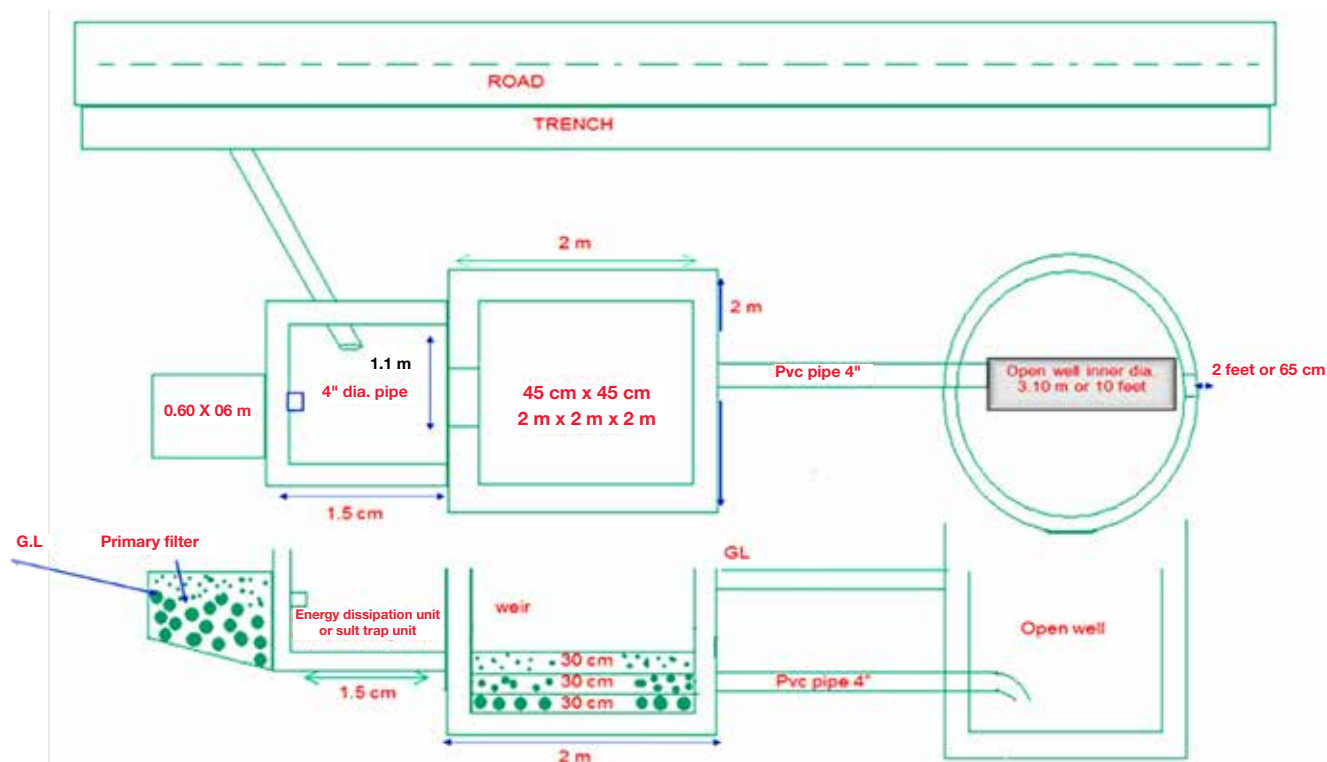
Working principle of bore well recharging system

Runoff water enters into primary filter unit wherein the major sediments were arrested and water flows to the secondary filter unit. Secondary filter unit consists of excavation of soil around the bore well casing pipe by 2.5 m depth and 1.5 diameters. From the bottom, up to 50 cm height, small holes are made with a pointer at a spacing of 5 cm and this casing pipe is wrapped with nylon mesh. Then the pit is filled with 4 layers of big stone, metal, gravel sand and fine sand one above each. On the top, the unit is covered with cement ring for not allowing the sediment from the flowing water. It was found that the water table starts rising from September–November and later a gradual reduction was observed. The specific yield was used for estimation of groundwater recharge from the bore well based on water table fluctuations. It was observed that in recharged bore wells, the water table fluctuation was in the range of 5.90–8.84 m. It was also revealed that the groundwater recharge in

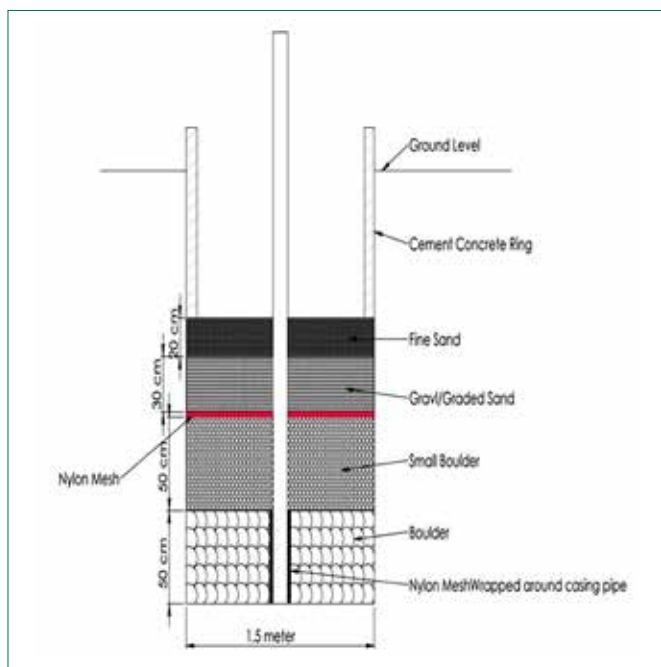


Bore well recharging model for assured rainfall zone of Marathwada region

treated bore well was in the tune of 19.78–29.10% with an average of 23.28% as against the average recharge of 5.56% in untreated bore wells. Artificial recharging of 10 open wells and 10 bore wells using designed filtration system was undertaken in farmers' fields of Babulgaon village of Parbhani district. The groundwater levels were monitored during pre-and-post monsoon in recharged and un-recharged open wells and bore wells. A long duration pumping test was conducted on representative bore well. The well characteristics like specific yield and transmissivity were determined as 0.0134 and 572.37 m²/day, respectively. The water level fluctuation in pre-and post-monsoon season in recharged open well and bore wells were found to be in the range of 4.36–8.79 m and 6.01–8.84 m, respectively. The average groundwater recharge in recharged open well and bore well was found to be 36.39% and 23.33%



Schematic view of artificial open well recharge model (Source: AICRPDA centre, Parbhani)



Schematic view of bore well recharge model
(Source: AICRPDA Centre, Parbhani)

of annual rainfall respectively. Both, open well and bore well recharging system were found to be effective in enhancing the groundwater potential. The specific yield was used for estimation of groundwater recharge from the bore well based on water table fluctuations. It was found that the groundwater recharge in treated bore well was in the tune of 19.78–29.10% with an average of

23.33% as against average recharge of 5.56% in untreated bore wells.

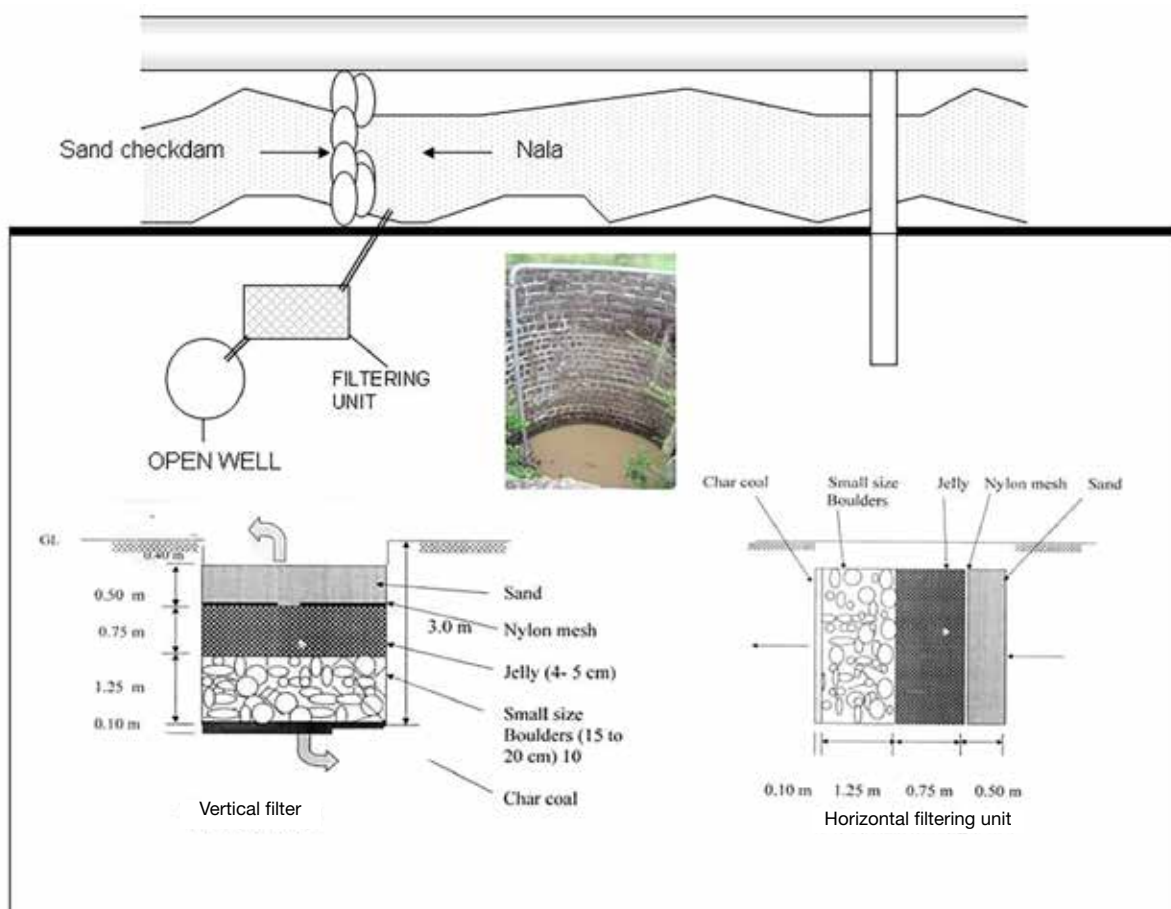
Artificial recharging model for open and bore wells in northern dry zone of Karnataka

AICRPDA centre, Vijayapura developed and demonstrated dug well recharging models. The *nala* water from water ways, streams, minor *nalas* or runoff from the fields was diverted into the defunct dug wells or functioning wells by the feeder channels/pipes through a suitable filter having different layers of sand, boulders, charcoal etc. The construction of a small check across the *nala* causes the heading up of water on upstream side and it leads to the collection of more runoff water in the well. The minimum catchment required for this practice is 40 ha. The cost of the technology was ₹45,000/unit.

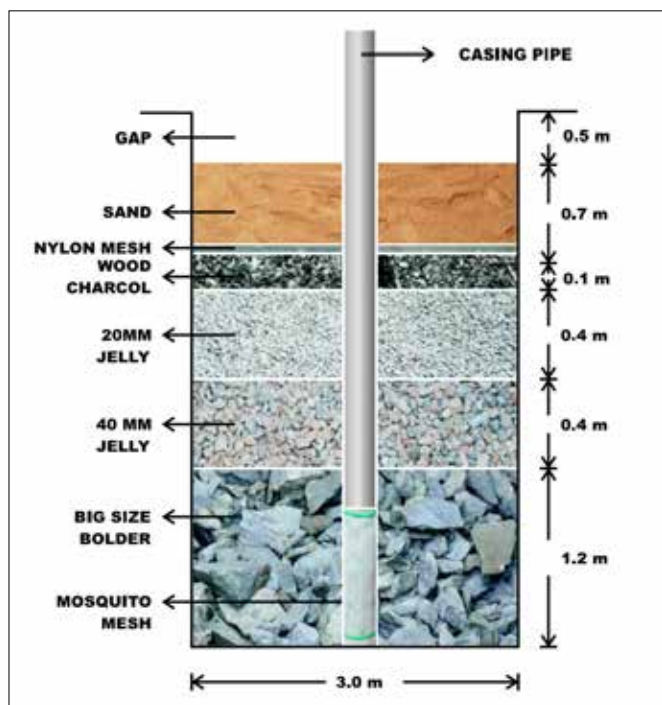
During normal rainfall years, with this diversion, the existing defunct dug well was filled two or three times. From the normal size wells (5 m × 5 m × 10 m), it is possible to recharge about 4–5 lakh litres of water per year during normal rainfall year. This technology is more effective when adopted on community basis.

Artificial recharging model for bore wells in eastern dry zone of Karnataka

AICRPDA centre, Bengaluru developed and demonstrated groundwater recharge model for bore well. Bore wells in use or the wells with falling water levels or dried up/drying up wells should be used for recharging. To construct recharge pit around a bore



Recharging open well by diverting *nala* water (Source: AICRPDA Centre, Vijayapura)



Schematic representation of artificial recharge of borewell
(Source: AICRPDA Centre, Bengaluru)

well, it should have a good catchment area at upstream side and bore wells in downstream side to receive the recharging water. The surroundings of the selected bore well should be cleared off from debris and waste material. Recharging of bore wells model consists of a pit of size 3 m × 3 m × 2.9 m in the region surrounding the bore well. At the bottom of the pit, filter holes should be made to a casing pipe and mosquito mesh should be fixed tightly to the casing pipe. This casing pipe will function as a filter.

- In the first layer, pit should be filled with big size boulders from the base up to a height of 1.2 m depth.
- In the second layer (0.4 m height) pit should be filled with gravel stones of 40 mm size.
- The third layer is to be filled up to 0.4 m height with gravel stones of 20 mm size.
- The fourth layer should be filled with charcoal of 0.1 m depth.
- The fifth layer needs sand of 0.7 m depth.



Open ring well recharge technology (Source: AICRPDA Centre, Jagdalpur)



Artificial well recharging model for bore wells

- The remaining space of 0.1 m should be gap.

Six bore wells were recharged with improved recharging techniques in eastern dry zone of Karnataka. The runoff of 5000–30000 m³ was diverted to bore well locations. The filters of dimensions 3 m × 3 m with a depth of 2.85–3 m were constructed. The discharge of the same bore wells was found increased during rainy and summer season.

Artificial recharging model for bore wells in Malwa zone of Madhya Pradesh

AICRPDA centre, Indore developed and demonstrated artificial well recharging model for bore wells in Malwa zone, Madhya Pradesh. A pit of 3 m wide and 3 m deep was excavated around the tube well casing. Number of perforations were provided throughout the exposed casing length by using a welding kit. A screen of plastic perforated sheet was then wrapped around the casing. A cylindrical plastic water tank of 5000 litres was utilized by removing its base and was inserted upright down into the pit. The annular space between the tank and the pit was refilled with the excavated soil by keeping only cylindrical portion unfilled. Different layers of broken bricks/boulder (1.3 m deep) and a layer of pebbles/stone crush of 0.25 m was provided. A notch of 0.3 m × 0.3 m facing to drainage line of the tank was cut which acts as entry point, so that runoff water



enters into the cylindrical portion. The enhancement in groundwater level was observed. This resulted in groundwater availability for supplemental irrigation and thereby yielded advantage.

Groundwater recharge with open ring well technology in Bastar Plateau of Chhattisgarh

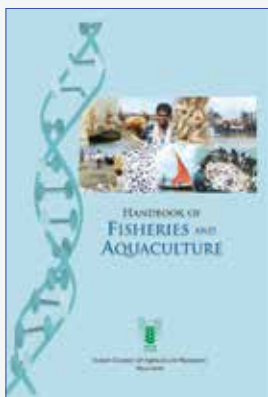
AICRPDA centre, Jagdalpur developed and demonstrated open ring well technology (40 feet depth and 5 feet diameter) for harvesting sub-surface flow in Bastar region of Chhattisgarh. One metre diameter and 10 m deep well can add/recharge about 1 million litres of water from nearly 1000 m² area. Recharge wells are excellent for recharging bore wells. The cost is about ₹3500/m depth and ₹35000-40000/ring well. The recharged groundwater through open ring wells is being used for supplemental irrigation in rainfed crops and resulted in 20% yield advantage/ha and 15% income benefit/ha to the farmers. Large number of open ring wells have been dug out in farmer's field in the district.

SUMMARY

Large-scale pumping out of groundwater and negligible recharging has created water havoc. The groundwater levels in various rainfed regions have reached at alarming levels. It is necessary to recharge groundwater through innovative, cost effective and technically feasible methods/techniques. Assured crop production in rainfed area can only be achieved if supplemental/protective irrigation facility is available. The groundwater recharging models/techniques are available that enhance the groundwater potential in rainfed areas. In Maharashtra, the bore well recharge model was upscaled through World bank funded PoCRA Project of Govt. of Maharashtra as well as through KVKs. Similarly, the other models in various states can be upscaled through various central and state government schemes.

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