Plant Archives **Vol. 25, Special Issue (ICTPAIRS-JAU, Junagadh) Jan. 2025 pp. 577-582**
e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.SP.ICTPAIRS-081

REJUVENATION OF LOW YIELDING BORE WELLS VIS-À-VIS GROUND WATER AUGMENTATION THROUGH RECHARGE FILTER IN SEMI-ARID REGION OF KARNATAKA INDIA

B.S. Naik[1*], Ravi Dupdal[1], S.L. Patil[2] and B.K. Rao[1]

[1]ICAR-Indian Institute of Soil and Water Conservation, Research Centre, Ballari (Karnataka), India.
[2]ICAR-Indian Institute of Pulses Research, Regional Research Station, Dharwad (Karnataka), India.
***Corresponding author E-mail:** naikbsn@gmail.com

ABSTRACT

Meager and unsure rainfall, excessive withdrawal of ground water and frequent droughts are major factors resulting in continuous depletion of ground water, and drying/low yielding of bore wells in semi-arid region of Karnataka. To address this critical issue, a field study was conducted using recharge filter technique to rejuvenate the drying/ low yielding bore wells in Chitradurga district in semi-arid tract of Karnataka. A total of 11 recharge filters were constructed in the farmers fields under Tribal sub plan (TSP) programme. Using this technique, temporal changes and increased water levels in bore wells were found varied from 23 m to 5 m and 23.5 m to 3 m bgl (below ground level) compared to control bore wells 24 to 8.5 m and 25.8 to 9 m bgl at two different locations (Netranahalli and Meramanahalli village). There was net increase of ground water levels varied from 1.6 to 3.2 m and 1.7 to 6.9 m in bore wells with recharge filters compared to bore wells without recharge filters. Higher bore well discharge was found ranged from 104 to 113 lpm in bore wells with recharge filters compared to control bore wells (96 to 100 lpm). The daily pumping hours also increased and it ranged from 6 to 8 hours compared to earlier 2 to 4 hours. Due to good rainfall and increased water levels in bore wells, a total of 12.75 acres was brought under irrigation resulted in higher cropping intensity of 146%. Crops yields increased in maize, sorghum, tomato, chilli, ragi and onion crops ranged from 20 to 52% compared to controls. The BC ratio in crops found ranged from 1.15 to 2.44 as compared to control (1.09 to 1.75).

***Key words*: Bore well, Crop yield, Recharge filter, Runoff, Ground water**

Introduction

Agriculture is the backbone of the Indian economy and the farmers are working hard facing various adversities to fulfill the food demand of the country's burgeoning population. However, enhancing the food production in rainfed regions under changing climatic scenario is a gigantic task, and in such situation, irrigation plays a critical role for increasing the productivity. Irrigated lands produce three-fourth of food grain production and is contributed by groundwater only. To meet the high demand for irrigation and drinking purpose, water is recklessly extracted from groundwater through bore wells and it causes more burdens on groundwater. Meager and unsure rainfall, lack of surface water, frequent droughts and excessive withdrawal of ground water are major factors resulting in continuous depletion of ground water. Technological developments in bore well construction and pumping methods also have resulted in the large-scale exploitation of groundwater. Digging more and more bore wells in close proximity, over-extraction from existing bore wells, and neglecting groundwater recharge has resulted in severe depletion of groundwater levels and drying/low yielding of many bore wells in the semi-arid region of Karnataka (Naik *et al.*, 2023). Failure of bore wells also a major concern and it causes farmers to face lot of financial stress and hardships. The depletion of groundwater on one side and its quality deterioration on the other side are equally important. Pollution of ground water due to external contaminants produced by industrial, urban and agricultural activities is quite well documented (Bhatnagar and Sharma, 2001). The challenges faced to mitigate the impact of over exploitation of groundwater need a sound groundwater management policy on scientific considerations. In addition, for augmentation of the depleting ground water resources, equal importance to be given for ground water recharge through conserving the excess runoff during monsoon for recharging the aquifer. As estimated by the Central Ground Water Board (CGWB, 2002), the total quantity of surplus monsoon runoff that can be recharged, works out to be 36.4 BCM. It reveals that there is huge scope for artificial recharge by harvesting the runoff. It is well known that artificial recharging of aquifers in many cases has resulted in a remarkable recovery of ground water levels locally in the vicinity of artificial recharging structures.

Artificial recharging is becoming increasingly necessary to ensure sustainable groundwater supplies to satisfy the needs of growing population (Ramachandrappa, *et al.*, 2015). The important advantages of artificial recharge are subsurface storage at no cost, negligible evaporation losses and higher biological purity with minimum temperature variations (Bhalerao and Kelkar, 2013). A study conducted in Maharashtra revealed that, artificial recharging using groundwater recharge models not only increased the groundwater level in the tune of 0.3-0.4 m but also increased the groundwater recharge in treated bore well 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 (Pendke *et al.*, 2022).

Keeping in view the problem of continuous depletion of ground water level and low yielding of bore wells, rainwater harvesting and utilizing it for recharging the bore wells has greater significance in the semi arid region of Karnataka. In this context, recharge filter technique may be a suitable alternative for rejuvenation of dry/low yielding bore wells. Under this technique, the runoff from the farmers' field is captured and fed to the bore well point directly with runoff filtration beds for augmenting the ground water level and increase the water yield. The suitable bore well site selection for treatment is most important for the effectiveness and success of this innovative technique. In this study, based on comprehensive field survey and hydrological investigations, the defunct/low yielding bore wells were selected in farmers' fields for recharging using recharge filters, and the performance of this recharge filter technique was evaluated.

Materials and Methods

An experiment was conducted on evaluation of bore well recharge using recharge filter technique in farmers' fields in two neighboring villages *i.e.* Netranahalli (14° 38' 46" N to 76° 43' 39" E) and Maramannahalli (14° 37' 13" N to 76° 42' 9" E) in Molkalmuru taluk of Chitradurga district in semi-arid region of Karnataka. The elevations of study area ranging from 566 to 573 metres above MSL with average annual rainfall of 417.3 mm in an average of 31 rainy days, out of which about 80% is received during north-east monsoon season (September to November). The minimum and maximum temperature in the region varies from 20 to 33°C during the year. The groundwater table is available at 100- 300 feet with very meager recharge due to less rainfall and most of the runoff goes as waste during high intensity rainfall in absence of soil and water conservation measures. The texture of soil varies from sandy clay loam to loamy sand with infiltration rate varies from 15 to 18 mm hr^{-1}.

Under the present study, a total of 11 low yielding/ dry bore wells were selected in two villages to evaluate the recharge using recharge filter technique. One recharge filter was constructed for one bore well and altogether 11 recharge filters were constructed for 11 bore wells in phased manner under the Tribal Sub plan programme funded by Government of India. The location and technical specifications details of selected bore wells in farmers' fields for recharge using runoff water is given in Table 1.

Methodology and design of recharge filter

- Selection of dry/ low yielding bore wells in farmers' fields.
- Construction of pit of size 3 m × 3 m × 3 m by excavating soil.
- Filling of the excavated pit with sized stones/jelly stones as below (Total 5 layers)
    - Bottom: 30-40 cm rough stones (up to 1.5 m)
    - Middle 1 : 15-20 cm rough stones (0.6m)
    - Middle 2 : 5-7 cm rough stones (0.15 m)
    - Middle 3 : 2-4 cm gravel/jelly stone (0.15 m)
    - Top: Coarse sand (0.6 m)

A nylon net with a mesh size below 1mm is placed over the gravel/jelly stone layer below the sand layer.

Filtration process through recharge filter system

The recharge filter pit consists of five different layers of stones/jelly, including a coarse sand layer on the top separated by a nylon net from the stone layer (Fig.1). When the rainwater flows through the channel towards

Table 1: Location and technical specifications details of selected bore wells for recharge with runoff water using recharge filter technique.

Bore well No.	Locationwith GPS Coordinates	Casing diameter, depth of bore well, and water level at the time of construction	Pump details	Catchment (Acre)	Runoff diverted	Remarks
1	Netranahalli 14° 38' 31" N76° 43'21" E	6 inch, 91.44 m, 54.86 m	5 hpMulti stage submersible	2.5	417	Low yielding
2	Netranahalli 14° 38' °18" N76° 43'25' E	6 inch, 91.44 m, 50.29 m	5 hpMulti stage submersible	1.5	250	Defunct
3	Netranahalli 14° 38' 27" N76° 43'23" E	6 inch, 97.53 m,51.81 m	5 hpMulti stage submersible	2.25	376	Defunct
4	Netranahalli 14° 38' 19" N76° 43'17" E	6 inch, 73.15 m, 62.48 m	5 hpMulti stage submersible	2	334	Low yielding
5	Netranahalli 14° 38' 19" N76° 43'14" E	6 inch, 79.24 m,67.05 m	5 hpMulti stage submersible	2.5	417	Defunct
C-1	Netranahalli 14° 38' 39" N76° 43'20' E	6 inch, 91.44 m, 51.81 m	5 hpMulti stage submersible	2	334	Low yielding
6	Maramanahalli 14° 37' 18" N76° 42'13" E	6 inch, 45.72m, 18.28 m	5 hpMulti stage submersible	2	334	Low yielding
7	Maramanahalli 14° 37' 42" N76° 42'9" E	6 inch, 54.86 m,21.33 m	5 hpMulti stage submersible	2.5	417	Low yielding
8	Maramanahalli 14° 37' 16" N76° 42' 14" E	6 inch, 48.76 m, 18.28 m	5 hpMulti stage submersible	2.5	417	Low yielding
9	Maramanahalli 14° 37' 45" N76° 41' 46"	6 inch, 51.81m, 19.81m	5 hpMulti stage submersible	2	334	Low yielding
10	Maramanahalli 14° 37' 43" N76° 41' 46" E	6 inch, 54.86 m,24.38 m	5 hpMulti stage submersible	2.5	417	Low yielding
11	Maramanahalli 14° 37' 46" N76° 41' 46" E	6 inch,57.91m, 27.43m	5 hpMulti stage submersible	2	334	Low yielding
C-2	Maramanahalli 14° 37' 42" N76° 42'8" E	6 inch, 54.86 m, 20.72m	5 hpMulti stage submersible	1.5	250	Low yielding

recharge filter point, it contains eroded soils (silt), crop residues, leaf litters, grasses, etc. along with runoff which is trapped by the uppermost sand layer. Again, the nylon net below the sand layer will filter the rainwater, allowing silt free water to percolate down. For direct entry of filtered rainwater to the bore well, small holes of 4 mm size are made on the casing pipes up to 1.5 m from the bottom of the pit. Based on the silt and dirt deposited over the nylon mesh and sand layer, the sand layer and nylon mesh to be replaced once in 3-5 years for better functioning of the system. A study was conducted using different types of filters using sand, pebbles, charcoal aggregates, cotton cloth, nylon mesh, etc. as porous media to evaluate the performance of developed filtering units for rainwater harvesting for groundwater recharge (Agarawal and Soni, 2005). The runoff water from the farmer's field was channelized during the rainfall and diverted to the bore well recharge filter point for artificial recharging. The rainfall and runoff causing events were recorded following the standard procedures. After the filling of rainwater in recharge pits, observations on frequency of fillings, water level changes in bore wells and borewell yield/discharge was recorded at monthly interval. Water level indicator was used for recording water level changes in bore wells. Bore well yield / discharge was measured by collecting bore water in a bucket of known volume and diving it by time taken to fill the bucket. By dividing the bucket volume (litres) by the time required to fill the volume (seconds), the discharge rate in litres/second (L/s) is determined. The rainfall during different months of study and resulting bore well discharge is correlated to assess the actual impact as per the procedure indicated by Gomez and Gomez (1984). Apart from this, observations were recorded on pumping hours, change in cropping pattern and crop yield and water level change in nearby selected control bore wells (without recharge filter). All the relevant data collected were analyzed using suitable statistical tools.

Results and Discussion

This study was carried out in farmers' fields during the period 2017-2023 selecting total 11 bore wells for

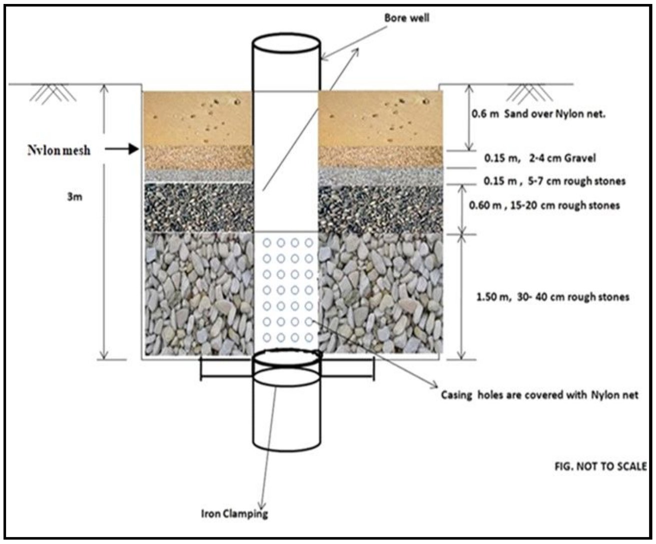

Fig. 1: Schematic diagram of bore well recharge filter.

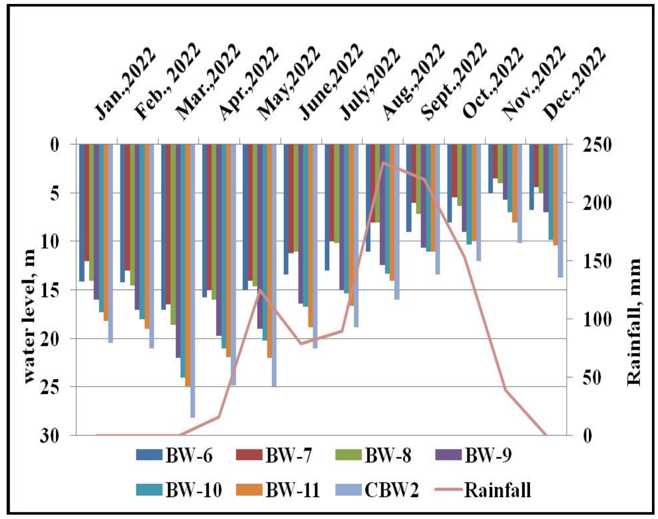

Fig. 2b: Temporal change in water level due good rainfall at Maramanahalli village

recharge using recharge filters in two adjacent villages Netranahalli and Maramannahalli in Chitradurga district in semi-arid region of Karnataka. Out of which 8 bore wells were working and 3 bore wells were dry/defunct. In addition, 2 control bore wells (without recharge filter) were also selected separately. For construction of each bore well recharge filter, an amount of Rs.25720/- (including material and labour charges) was spent. This cost may vary place to place as per the local rates but is quite affordable by the farmers. Out of 11 bore wells, three defunct bore wells did not respond at all to recharge filter and as such abandoned by farmers without use. It indicates that only low yielding bore wells should be selected and given priority for artificial recharge through construction of recharge filter. Rainfall plays crucial role for the groundwater recharge. Effect of rainfall on ground water recharge in terms of change in water level in bore wells and bore well yields have been analyzed. During 2022, there was a good rainfall of 954.7 mm followed by 818.7 mm in 2021, 884.5 mm in 2020 and 671.1 mm in 2019 compared to earlier years of draught and below normal rainfall (273.5 mm, 425.4 mm and 254.4 mm during 2016, 2017 and 2018), and it resulted into appreciable improvement in ground water recharge. Higher rainfall resulted in elevated water levels in bore wells with recharge filters during 2020 to 2022 compared to below normal rainfall years 2016 to 2019. Maximum effect was observed in the year 2022 due to higher rainfall in 2022 and its preceding years. The temporal increased ground water level in bore well 1, 3 and control-1 at Netranahalli, found varied from 23 to 7 m, 18 to 5m and 24 to 8.5 m, and at Maramanahalli in bore well 6, 7, 8, 9, 10, 11 and control-2, it varied from 14.5 to 4 m, 15 to 3 m, 16 to 3.5 m, 19 to 4.5 m, 23 to 5.6 m, 23.5 m to 7 m and 25.8 to 9 m, respectively (Fig. 2a & 2b). There was net increase

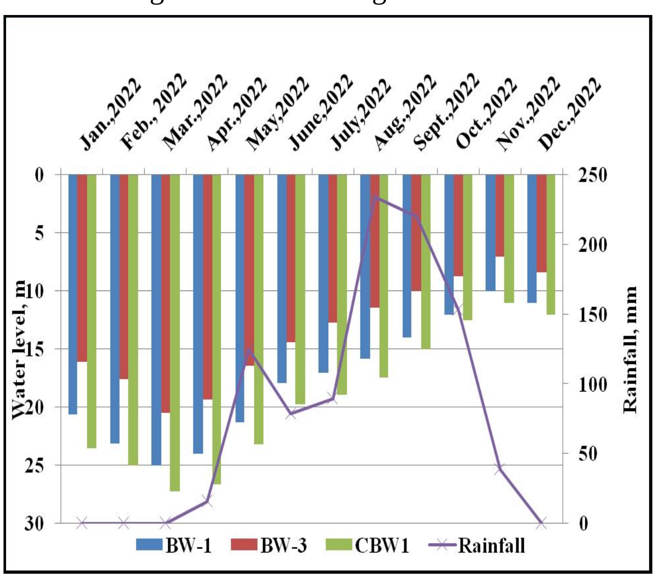

Fig. 2a: Temporal change in groundwater level due to good rainfall at Netranahalli village

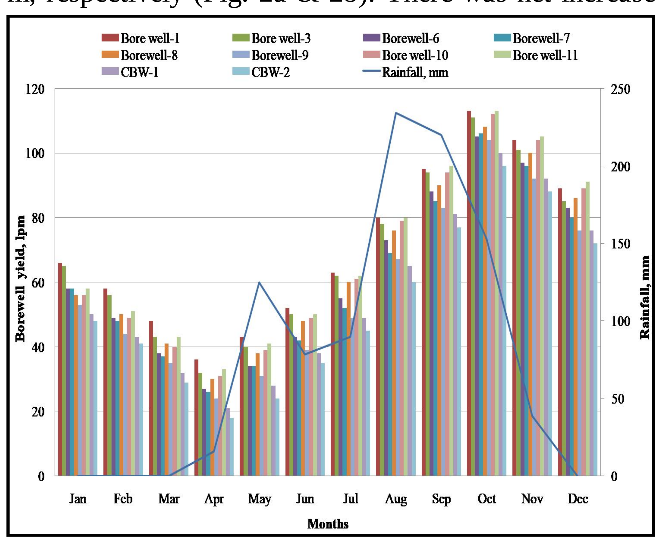

Fig. 3: Improved bore well yield with respect to increase in rainfall.

Table 2: Change in cropping pattern and cropping intensity of adopted and non-adopted farmers.

Crops	Adopted farmers		Non-adopted farmers	
	Area (acres)	Percent	Area (acres)	Percent
Maize	5	14	3	11.76
Onion	4	11	2	7.84
tomato	3.5	10	1.5	5.88
Ragi	2.5	7	3	11.76
Chilli	3	8	1	3.92
sorghum	5	14	1.5	5.88
Fallow land	1	3	4.5	17.65
Total kharif	24	66	16.5	64.71
maize	5.5	15	2	7.84
tomato	4	11	1	3.92
sorghum	1.5	4	3	11.76
Fallow land	0	0	3	11.76
Vegetables	1.5	4	0	0.00
Total rabi	12.5	34	9	35.29
GCA	36.5	100	25.5	100.00
Net cultivated area		25	21	
Cropping intensity	**146**		**121**	

of water levels varied from 1.6 to 3.2 m and 1.7 to 6.9 m in bore wells with recharge filters compared to control bore wells. In all bore wells, the water levels started improved from the month of May and it continued up to October and then started depleting due to cessation of rainfall (Fig. 3).

As a result of consecutive higher rainfall, appreciable increase in bore well yield/discharge was observed. Highest bore well yields/discharge of 113, 111, 105, 106, 108, 104, 112 and 113 lpm were observed in bore well 1, 3, 6, 7, 8, 9, 10 and 11 with recharge filter compared to control-1(100 lpm) and control-2 (96 lpm) bore wells in the month of October (Fig. 3).

Rainfall and discharge showed significant and positive correlation in all bore wells including control (Bore well 1= 0.592, Bore well 3= 0.572, Bore well 6= 0.605, Bore well 7= 0.58, Bore well 8= 0.661, Bore well 9= 0.592, Bore well 10= 0.683, Bore well 11= 0.679, Control 1= 0.615, Control 2= 0.592). The higher discharge rates of bore wells using artificial recharge filters were attributed to augmentation in groundwater recharge by the diverted runoff directly to the recharge pit point. Using artificial recharge pits, similar results of improved bore well yields were reported by Shivakumar (2006). Similar type of study conducted by Reddy and Khybri (2008) and they observed that the groundwater level in the open wells and bore wells started rising from June till the end of September and later declined during first week of October. The water stored with infiltration of rain water and percolation into ground water helped in pumping the reserved water, and it resulted in increase in the daily pumping hours during 2022 in respect of bore well 1, 3, 6, 7, 8, 9, 10 and 11 which varied between 6 to 8 hours compared to earlier 2 to 4 hours during 2016-18 (low rainfall years).

Due to good rainfall and improved water levels in bore wells, the total area irrigated under bore wells 1, 3, 6, 7, 8, 9, 10 and 11 with recharge filters was increased to 12.75 acres, and higher yields for different crops (maize, sorghum, tomato, chilli, ragi and onion) found ranged from 20 to 52% compared to controls. Economic analysis of recharge filter technique was carried out and the result reveals that higher cropping intensity of 146% was observed among adopted farmers compared to control farmers (121%), and the BC ratio in crops found ranged from 1.15 to 2.44 as compared to control (1.09 to 1.75) (Table 2 & 3). The increased yield was due to higher rainfall and increased ground water level that resulted in availability of adequate water for applying irrigation. Dupdal *et al.*, (2024) has also reported that due to on-farm rainwater conservation and harvesting surplus runoff in farm ponds, the area under irrigation and cropping intensity was increased compared to control. Many such studies also reported that watershed development activities have significant impact on groundwater recharge and therefore policy focus must be for the development of water harvesting structures

Table 3: Economics of bore well among adopted and non-adopted farmers.

Crops	Adopted farmers				Non-adopted farmers			
	Yield/ Acre (Qntl.)	Cost of Cultivation (Rs./Acre)	Net Returns (Rs/Acre)	BCR	Yield/ Acre (Qntl.)	Cost of Cultivation (Rs./Acres)	Net Returns (Rs/Acres)	BCR
Sorghum (Hyd)	12.5	18120	19255	2.06	09	16720	10190	1.60
Maize (Hyd)	24	23860	23228	1.97	20	23300	15940	1.68
Tomato	25.67	30314	31294	2.03	18.4	28366	23734	1.84
Chilli	11.83	43620	62850	2.44	7.8	40100	30100	1.75
Ragi	06	11350	3050	1.27	4.2	9144	936	1.10
Onion	5.4	14133	2067	1.15	04	10155	1845	1.09

(Palinisami and Suresh Kumar, 2005; Chandrakanth and Nagaraj, 2006).

Conclusion

Recharge filter is a promising technology to rejuvenate low yielding bore wells with naturally filtered rainwater. As a result of this technology, there was net increase of ground water levels varied from 1.6 to 3.2 m and 1.7 to 6.9 m in bore wells with recharge filters compared to control bore wells. Increased bore well discharge is found ranged from 104 to 113 lpm in bore wells with recharge filters compared to 96 to 100 lpm in control bore wells. Improved pumping hours varied between 6 to 8 hours compared to earlier 2 to 4 hours. A total of 12.75 acres area was brought under irrigation due to improved water levels in bore wells resulting in increased crops yields in various crops ranged from 20 to 52% including increased BC ratio in crops ranged from 1.15 to 2.44 as compared to control (1.09 to 1.75). Thus, the use of recharge filter technique may be viable options for farmers for recharging low yielding bore wells to ensure higher production and farm income using their existing bore wells, in semi-arid region of Karnataka, Andhra Pradesh and Telangana.

References

Agarawal, A. and Soni V. (2005). Study of various types of filter used in roof tops rainwater harvesting, Proceeding of the 38th Annual Convention of Indian Society of Agricultural Engineers, 75-82.

Bhalerao, S.A. and Kelkar T.S. (2013). Artificial recharge of groundwater: A novel technique for replenishment of an aquifer with water from the land surface. *International journal of Geology, Earth and Environmental Science,* **3(1)**, 165-183.

Bhatnagar, P.N. and Sharma B.R. (2001). Groundwater pollution through agricultural practices and agro-industries in India. Workshop on ICAR-IWMI Groundwater Policy Initiative2001 Central Soil Salinity Research Institute, Karnal, India.

Central Ground Water Board (2002). Master Plan for Artificial Recharge to Ground Water in India, Central Ground Water Board, Faridabad, India.

Chandrakanth, M.G. and Nagaraj N. (2006). Theoretical and empirical issues in impact assessment of watershed development projects including environmental impacts, In K Palanisamy and D Sureshkumar (Eds.), Impact Assessment of watershed development: Issues, Methods and Experiences, Associated Publishing Company, New Delhi. 76-87.

Dupdal, R., Naik B.S., Ramesha M.N., Ravi K.N. and Rao B.K. (2024). Water harvesting structure-farm pond for increasing crop yields and farm income in rainfed semiarid ecosystem of Karnataka. *Indian J. Soil Cons*., **52 (Global Soils Conference - 2024 Special Issue)**, S68-S73.

Gomez, K.A. and Gomez A.A. (1984). Statistical procedure for Agriculture Research, Wiley-Inter Sci. Pub., New York, USA, 680.

Naik, B.S., Dupdal R., Patil S.L. and Muralidhar W. (2023). Recharge Filter Technology for Rejuvenation of Dry/Low Yielding Bore Wells in Semi-Arid Tropics (English Language), ICAR-IISWC, RC, Ballari. 1-8. (Brochure No. 1461/PMEC (9)/HQ/DDN/2023).

Palinisami, K. and Suresh Kumar D. (2005). Impact of watershed development activities in augmenting water resources and agricultural production in K Palanisamy and D Suresh Kumar (Ed): Impact Assessment of watershed development: Issues, Methods and Experiences, Associated Publishing Company, New Delhi, 239-250.

Pendke, M.S., Devaraja K., Pradhan A.K., Momin U.M., Thakur A.K., Chandrakar Tejpal, Kerketta A., Manikandan M., and Deora B.S. (2022). Groundwater recharge models for rainfed regions. *Indian Farming*, **72(08)**, 16-20.

Ramachandrappa, B.K., Thimmegowda M.N., Anitha M., Sathish A., Devaraja K., Jagadeesh B.N., Savitha M.S., and Srikanth Babu P.N. (2015). Studies on Borewell Recharge through Filter Bed using Runoff Water in Eastern Dry Zone of Karnataka. *Indian J. Dryland Agric. Res. & Dev*., **30(2)**, 44-49.

Reddy and Khybri M.L. (2008). Estimation of groundwater recharge in semi arid watershed. *Indian Journal of Dryland Agricultural Research and Development,* **6(1, 2)**, 37-45.

Shivakumar, B.L. (2006). Conservation of ground water through artificial recharge using roof top rainwater in RV College of engineering Campus Bangalore (a case study). National Seminar on Rainwater Harvesting and Water Management, 11-12 Nov. 2006, Nagpur.