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EVALUATION OF CEMENT NALA PLUG

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ABSTRACT

A field study to evaluate the cement nala plug in Wagarwadi watershed of Hingoli district was carried out during 1998-99. Water storage characteristics in the cement nala plug was studied by monitoring the depth of water storage in cement plug and length of water spread. The losses from surface water storage in the form of evaporation and seepage/percolation were estimated. The effect of seepage on ground water recharge was studied by monitoring water levels in the observation wells. Utilization of stored water in the cement nala plug was observed. The full water storage of cement nala plug was found to be 1725.91m, with the maximum length and width of spread, 11.3m and 14.0m, respectively with maximum impounding of water as 3.0m. The maximum evaporation loss and seepage loss from the cement nala plug was found to be 257.2 m^3 and 1634 m^3, respectively. The impounded water in cement nala plug resulted in the increase in water levels in the observation wells of the influencing area. Due to silting, the storage capacity of the cement nala plug was reduced by 2.16 percent in 5 years its construction with silt retention rate of 24.124 tonnes/year.

INTRODUCTION

The water conservation structures are integral part of soil and water conservation programmes and are important component of the watershed development and management programme. Conservation structures not only control the erosion and conserve water but also help in meeting the soil economical demands in various ways. Recharging of ground water storage can be effectively done by the construction of percolation ponds, nala bunding and cement nala plug to ensure sustained agricultural production under well command. In the state of Maharashtra, nala bunding works are being carried out since 1969. The soil and water management activities in the state are being carried out in integrated manner on watershed basis since 1983. Nala bunding is one of the important activities of the comprehensive watershed development programme in the state. Nala bunds are embankments constructed across the nala for storing water increasing water percolation and improving soil moisture regimes. Embankments which are made of stone masonary are called cement nala plug. These embankments are constructed with or without gates. The embankments of stone masonary are more preferred as they require less area for construction than that of earthen embankments.

Wagarwadi watershed is located near Golegaon Tq. Aundha, about 5km from Aundha on Aundha-Jintur road. Total area of the watershed is 324 hectare. The average rainfall of area is 879mm with an average number of rainy days as 48 South-west monsoon is the major source of rainfall. Most of the soil in this region is medium to deep black soil. Topography is flat to rolling type. Soil and water conservation measures adopted are nala bunding, gully control structures, cement plug, loose boulder dams, contour vegetative bunding, afforestation and pasture development.

MATERIALS AND METHODS

For studying the existing cement nala plug, the detailed dimensions of structures viz. length, width, depth, dimensions of outlets, its discharging capacity etc. were measured and noted down. The structures were evaluated from design and structural stability point of view. Also details of nala such as depth, width etc. and other site conditions were studied for the suitability of structure with respect to specific site condition.

Water storage and losses

For studying the water storage in cement nala plug and losses from it water level standing behind the head wall of cement nala plug and length of water spread in the nala were recorded at fortnightly intervals to determine the changes in stored volume of water.

For the determination of volume of water storage in nala at fortnightly intervals, the cross-sections of nala bed at different locations were measured by following standard method of cross-sectioning after nala was dry. The bed gradient of the nala was also determined by profile leveling and details of reduced levels of nala beds under the study are recorded. Storage volume in nala was computed by summation of volumes determined by taking the product of average of two cross-sections and the distance between them. The cross-sections of water storage were varying at fortnightly interval which was determined from plotted cross-sections of nala bed and depth of water storage in nala bed.

The evaporation losses from nala were determined by considering the total water surface area in the nala at fortnightly intervals by taking widths of nala at different locations from plotted cross-section of the nala and the distance between them. The total evaporation losses were determined by considering daily evaporation rate with pan coefficient.

The volume of water lost through seepage/percolation was computed by subtracting the evaporation losses and leakage losses plus taking two to five per cent loss was that part of water which might be used by animals for drinking, pesticide application and other uses from total stored volume of water in each nala at regular intervals.

Water table observations in wells

To study the influence of cement nala plug on water level in wells, some open wells were selected in the zone of influence and out of influence of cement nala plug i.e. at longer distance from the structure in the watershed. Water levels of each well were recorded at fortnightly interval from the month of August to January during the year 1998-99 from the fixed reference point marked on the top of each well with the help of tape. The water surface elevation in each well with respect to full supply level of cement nala were determined by estimating the reduced levels of the fixed reference point marked on the top of each well by leveling elevations of water levels in the observation wells. Water surface in cement nala plug for different periods were plotted on a graph paper to study the effect of impounded water in cement nala plug on ground water recharge.

RESULTS AND DISCUSSIONS

The cement nala plug constructed in Wagarwadi watershed was evaluated in terms of water storage, inflow-outflow losses and effective utilization.

Water harvesting and storage

The average length, width and depth of impounding were recorded at fortnight intervals. The data is presented in Table-1. The maximum volume of impounding i.e. 1725.91 m^3 was observed in the month of September, 1998. The quantity of stored water i.e. impounded water in cement nala plug was drastically reduced after the month November, 1998. A very little quantity of water i.e. 3.262 m^3 was available in December, 1998. After January, 1999 storage area of the cement nala plug was completely dry. This is because of the stored/impounded water lifted by the farmers for giving supplemental irrigation to rabi crops.

Evaporation losses from water surface area

The daily pan evaporation data was recorded since June 1998 (Table-2). It was observed that the maximum evaporation was recorded in the month of June and the minimum evaporation was recorded in the month of September. As the evaporation rate is increasing since October, the depth of impounding ultimately the volume of impounding reduced since October, 1998 and thus it would result in drying of water storage area after January 1999. Another reason for dryness of storage area of cement nala plug is the excessive lifting of water for supplemental irrigation to crops.

Utility and seepage losses

The volume of water loss in seepage percolation and utilized by farmers was computed by subtracting evaporation losses from the stored volume during corresponding monthly interval. The maximum stored water was available in August and September. The maximum seepage loss was observed in the month of November-December. It was observed that in the first month maximum water was lost through seepage/percolation as the influence area was completely dry. The maximum seepage losses particularly in the month of August-September were due to maximum water storage during that particular month. The gradual reduction in seepage losses in subsequent months is due to reduction in storage volume of water in cement nala plug because of high evaporation and seepage losses.

Effect of impounded water on water table fluctuations

The water table fluctuations in different wells were determined. The 4 wells were located in the vicinity of cement nala plug. However, 2 wells were located in the untreated area and considered for comparison of water table fluctuations. Well hydrograph (Figure-1) reveals that the water table starts rising since mid June and attained its peak in September. This rise in water table is due to the rains received in the monsoon months. There has been a steady decline in the water table up to December and then the water table has maintained a constant level up to the some extent. The comparison of water table in the wells of treated and untreated areas indicated that the water table is available in wells of the treated area in the month of April. However, the wells in the untreated area get dried after January only. Hence, it was concluded that the stored volume of impounded water resulted in increase in water table in the wells.

Reduction in storage capacity due to silting

The reduction in storage capacity of cement nala plug due to sedimentation was determined by finding the depth of silting at different sites selected previously. The existing storage capacity of the cement nala plug in 3364m^3 as against the designed storage capacity of 3420 m^3. This indicates that 2.16 percent of the storage capacity is reduced due to silting in five years after construction of this cement plug. The storage capacity is reduced by 74 m^3. Considering the bulk density of the stored material as 1.63 gm/cm^3, the deposited sediment load is estimated as 24.124 tonnes/year.

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Table-1. Average length, width and depth of impounding water at fortnight intervals.

Date	Average length (m)	Average width (m)	Average depth (m)	Volume of impounding water (m)	Average
16/6/98	80.4	8.2	1.05	692.244	473.97
30/6/98	68.3	7.8	0.48	255.7	
14/7/98	59.4	7.3	0.35	151.76	128.01
28/7/98	53.2	7.0	0.28	104.27	
11/8/98	58.6	6.5	0.27	102.84	1724.39
25/8/98	113.0	14.1	2.1	3345.93	
08/9/98	101.2	12.2	1.7	2098.88	1725.91
22/9/98	92.1	11.3	1.3	1352.94	
06/10/98	78.3	10.2	0.83	662.88	518.47
20/10/98	69.4	9.8	0.55	374.06	
3/11/98	52.2	7.2	0.26	97.96	78.72
17/11/98	48.6	6.8	0.18	59.48	
01/12/98	31.5	4.9	0.05	7.717	3.26
15/12/98	22.5	3.2	0.025	1.8	
29/12/98	18.3	2.1	0.007	0.269	

Table-2. Volume of water loss in seepage or percolation.

S. No.	Month	Volume of impounding (m^3)	Evaporation loss (m^3)	Utility + Seepage (m^3)
1.	June	473.97	257.2	216.77
2.	July	128.01	146.3	-179.90
3.	August	1724.39	114.1	1611.210
4.	September	1725.91	91.2	1634.71
5.	October	518.47	116.2	402.27
6.	November	78.72	111.7	-32.98
7.	December	3.26	99.9	-96.63

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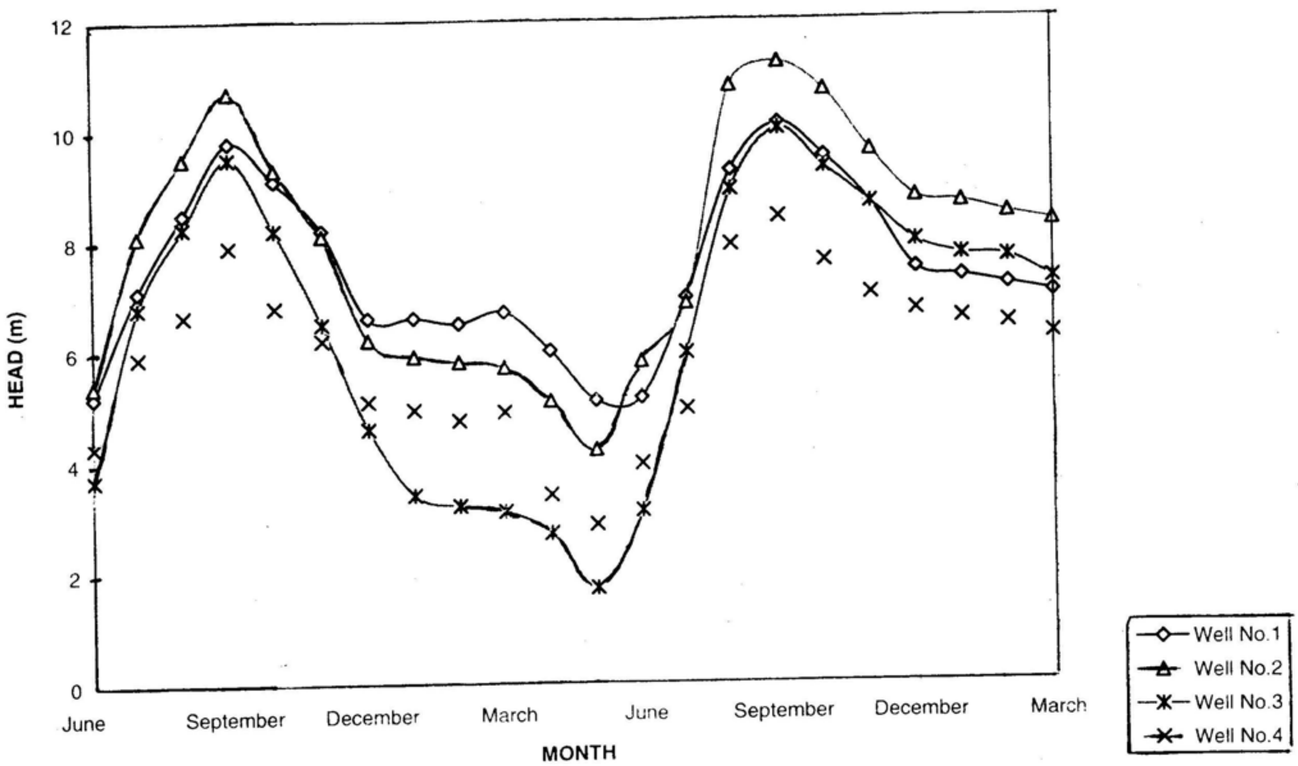

Figure-1. Water Table fluctuations in wells located in the vicinity of CNB.