COMMUNITY-BASED SUSTAINABLE WATER RESOURCE DEVELOPMENT AND MANAGEMENT (SWRDM) PROGRAM NEAR PAITHAN, DISTRICT AURANGABAD, MAHARASHTRA, INDIA

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Background

The bottling plant ("Plant") of PepsiCo Holdings India Pvt. Ltd. (PIHPL) is located in Paithan Industrial Area, Maharashtra Industrial Development Corporation (MIDC), near the township of Paithan in District Aurangabad of Maharashtra State. This industrial estate is about 60 km from Aurangabad on Aurangabad-Paithan road. PIHPL, one of the largest multinational food and beverage businesses in India, has been implementing a water conservation program near its Plant since 2009. Alternative Development Initiatives (ADI), a professionally managed Civil Society Organization working in Environmental Resource Management and Climate Change, is PIHPL's implementation partner for this program.

ADI carried out Water Resources mapping with community participation in the neighbouring areas of the Plant to assess their vulnerability in terms of water scarcity and water quality issues. After critical study of the area, topography, and potential, key potential water resources initiatives were identified in the neighbouring villages and it was decided to undertake Community based Sustainable Water Resource Development and Management (SWRDM) program in the nearing villages to conserve and replenish ground water.

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The present paper deliberates the groundwater recharge and its impact that has taken place through various interventions for water resources development from the year 2009 till 2015.

1. About the area

1.1 Location

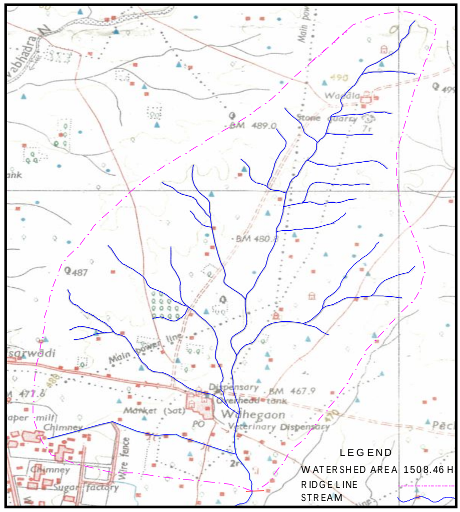
The area under the project encompasses five revenue villages namely Wahegaon, Mudhalwadi, Shahapur, Owa and Isarwadi falling in Paithan Block of Aurangabad District. Paithan is known for the very big earthen dam constructed on river Godavari known as Jayakwadi dam, which also supplies water to MIDC Paithan. Out of these villages, the detailed impact study presented here is of a micro-watershed that falls between Latitude 19° 33' to 19° 35' N and Longitude 75° 23' to 77°25' E comprising of villages Wahegaon and Mudhalwadi at an altitude of 475 m above mean sea level (MSL). The entire area is surrounded by industrial units in the northwestern as well as southeastern side. These villages are connected with motorable roads.

1.2 Rainfall and climate

Wahegaon and its neighbouring villages, the area selected for community-based SWRDM program, falls in semi-arid tropical climatic zone and receives around 730mm of rainfall annually. The annual average rainfall of Marathwada Division, based on the data of the past 92 years, is 786.7 mm. Most of it (650 mm or 82.6%) is received between June to September during the southwest monsoon and subsequently during December to April less than 50mm. July is the wettest month and the peak rainfall recorded in the month of July ranges between 50 to 100mm.

1.3 Topography and Drainage

Figure 1



The area represents gently sloping topography having a general slope towards the south. If we consider the mini-watershed covering these two villages, then Wahegaon watershed shows fern leaf shaped narrow strip of land having an average width of about 3000 meters and a length of 7500 meters. The average gradient is 5.14% and is steeper as we go towards north west and it steadily reduces towards the south. There are three nallahs passing from this village and ultimately meet river Godavari in the downstream side of the dam.

1.4 Land Resources

Total geographical area of Wahegaon village is 931.67 Hectares (ha) out of which 137.2 ha was barren, rainfed 643.35 ha, seasonal irrigated area 161.40, perrinial irrigated area 42.84 ha and wasteland, but culturable was 3.80 ha. The population of the villages falling in the watershed is around 12000 out of which Wahegaon is about 3600 people. The majority of the farmers were belonging to the small and marginal category. The rainfed cultivation had a cropping pattern of Bajra, Cotton, Maize during Kharif and wheat/gram during Rabbi.

1.5 Irrigation and geohydrology

The area is governed by the Deccan basaltic terrain where the shallow black soil is underlain by basaltic rock in which sheet jointing is developed due to weathering. Sheet jointing in vesicular amygdaloidal basalt creates favourable conditions for holding water. Hence, groundwater resource in this area is constituted by shallow weathered hard-rock aquifers with modest yield and thickness limited to a few tens of meters depending on thickness of weathered zone. The shallow ground water that occurs between a depth ranging 10 to 20m below ground level (bgl) tapped through open wells fitted with diesel or electric pump sets for providing critical irrigation to seasonal crop during periods of dry spell. The shallow aquifer is mainly replenished by the seasonal streams flowing in this area.

2. Interventions for recharging and conservation of water

As discussed, during the initial study of these villages in 2008, the community consistently put forth the need for the harvesting of the rainwater. In this context, the key objectives of the Wahegaon watershed project were two fold, namely, to enable groundwater recharge, by working at the watershed level, and to give a boost to the local economy in terms of intensification in agriculture and allied activities. For this purpose, two types of water harvesting structures were strategically built, by employing geo-hydrological considerations.

1. Groundwater recharge through soil water conservation structures. (Check Dam)
2. Artificial recharge structures for 100 open wells.

The first type of intervention came up in the form of check dams in series (total thirteen) which were constructed on three different drains to harvest the surface run-off. To augment the impact of check dams, the second type of structure, namely, open well recharge, was also constructed for hundred open wells scattered across the watershed in which the program was being implemented.

2.1 Groundwater recharge through soil water conservation structures (Check dams)

The unequal distribution of water resources over time and geographic area has necessitated the development of water harvesting systems.

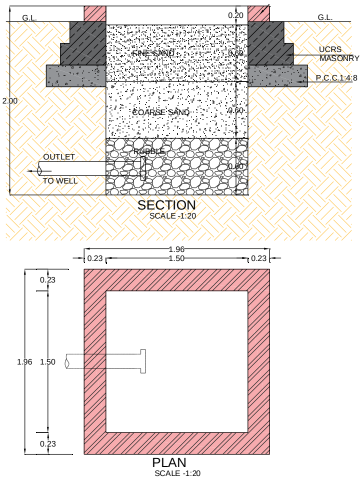
The constructed "Check-dams" are permanent structures of masonry (low cost technique) built across the direction of the water flow on three drains (i.e. drain no. 1, 2 & 3) for the purpose of water harvesting. These check dams at different locations, height and length, retain excess water flow in the decentralised manner during monsoon and replenish groundwater reserves. The water harvested by the dams is intended for use through the open wells. As described earlier, there are 3 drains in this watershed. Out of these 3 drains, drain no. 2 is the longest and carries a good amount of water on which 10 dams are constructed. Location and details of the Check dam are discussed in the table 1

Table 1

Structure no	Drain no	Latitude	Longitude	Length	Height
1.1	1	19°34'7.98"N	75°24'21.20"E	20	2
2.1	2	19°35'23.98"N	75°24'30.98"E	15	1.5
2.2	2	19°34'52.59"N	75°24'17.48"E	20	1.5
2.3	2	19°34'38.92"N	75°24'14.04"E	17	1.5
2.4	2	19°34'22.66"N	75°24'7.46"E	15	2
2.5	2	19°34'10.68"N	75°24'4.27"E	15	2
2.6	2	19°33'54.87"N	75°24'1.58"E	20	1.5
2.7	2	19°33'38.58"N	75°23'58.88"E	20	1.5
2.8	2	19°33'22.19"N	75°24'0.24"E	20	1.5
2.9	2	19°33'10.75"N	75°24'0.41"E	20	2
2.10	2	19°33'2.66"N	75°24'5.13"E	15	1.5
3.1	3	19°33'29.10"N	75°24'38.19"E	20	1.5
3.2	3	19°33'24.31"N	75°24'32.94"E	20	1.75

2.2 Artificial recharge of open wells

Figure 2



This intervention was designed for water artificial recharge of the open wells and has a catchment of 2 ha. Two small pits with a dimension 1.5x1.50x2m was excavated near the open well in the upstream portion. The pits were provided with brick masonry lining from the top till 0.30m depth so as to avoid any soil entering into the recharge structure. The first pit is acting as a silt trap which is kept empty to gather the runoff and settle the silt load. The overflow of this pit is connected to the adjoining pit which has a filter media in the form of pebbles, coarse sand and the top covered by sand layer. The water thus filtered through this filter media enters into the well in the form of artificial recharge.

3. Monitoring and Estimation of Recharge

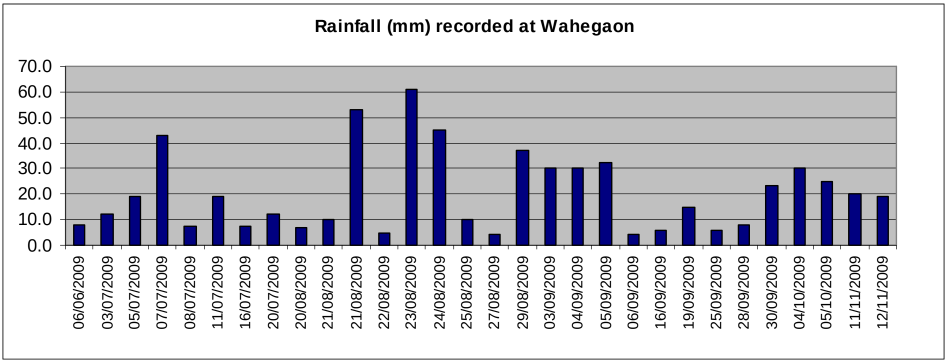
3.1 Methodology for calculating the recharge

Rain water harvesting measures are monitored for the following:

1. Rainfall – Actual rainfall where the measures are adopted
2. Water level monitoring of 100 open wells– Water levels of selected 100 wells are recorded on every fortnight basis
3. Groundwater recharge– Cropping pattern and use of groundwater

Rainfall: Rainfall is the primary source of water in natural form and actual rainfall received in the year is being measured at two locations

Figure 3



The methodology for calculating the recharge is based on area catchment and total rainfall in a year. For example, in the year 2009 the area received annual rainfall of 609mm. The calculation of the recharge through the check dams is illustrated below

Table 2

Particulars	Amount	Unit
Total catchment area	1725	Ha.
1 ha =	10000	Sq m
Total area	17250000	Sq m
Rainfall measured by installed rain gauge	609	mm
Total Rainfall in meters	0.609	m
Total volume of water through rainfall (Rainfall x Total Catchment)	10505250	Cum
Total volume of water in Thousand Cubic Meters (TCM)	10505.25	TCM
Total Runoff available for harvesting (15% of the total volume of water)	1575.788	TCM

It is also observed that sometimes water from the check dam no 2/10 which is constructed at the outlet of the watershed and 3/2 on drain no 3 have overflown during the heavy showers. The quantity of water discharged through a weir which is deducted from the recharge volume.

3.1.1 Aquifer Performance Test

The water stored or accumulated in the open well is pumped for agricultural use with the help of 3 HP or 5 HP electric mono block or submersible pumps. The pumping results in a steady decline in water level and generally lead to the emptying of the well after continuous 5 to 6 hours pumping. The recharging of the wells takes place slowly, which generally takes place in 12 to 24 hours to achieve original state. Aquifer drawdown tests were carried out on 16 wells spread in this with drawdown. The results obtained are mentioned below. Recharge due to rainfall is computed by specific yield water table fluctuation method as below:

Rr = A x S.F. x Sy

Where,

Rr = Recharge due to Rainfall

A = Area available for recharge (watershed area) = 17250000 m^2

S.F. = Seasonal Fluctuation in Dynamic water level Zone = 5 m at average rainfall.

Sy = Specific Yield = 0.02 (As per APT)

Therefore,

Rr = 17250000 x 5x 0.02

Rr = 1725000 m^3/ Year

Recharge through rainfall is = 1725 TCM / Year

3.1.2 Estimation of Artificial recharge of open wells

As discussed the groundwater recharge structure gathers runoff from the catchment area of almost 2 to 2.5 ha.

Table 3

Total Number of Wells	Actual Rainfall (mm)	Runoff Available per Well (STRANGER's Table) (TCM/ha)	Avg.catchment Area for each structure (Ha)	Runoff Harvested per well (TCM)	Total Potential created (TCM)
100	609	0.59	2	1.18	118

Therefore, the water harvesting achieved by the artificial recharge intervention in a normal rainfall year is over 118 TCM per year.

3.2 Institutional Mechanism

Community members, Gram Panchayat, various forms of user groups and Water User Associations (WUAs) capacities have been built around various issues and towards larger development perspective. An institutional mechanism was evolved for maintenance of the created assets and towards group based marketing. This helped to build an improved understanding of the groundwater regime and ownership amongst the community. Consequently, it provided an incentive to the community to contribute to the collective maintenance of the water bodies. Affirmative complementing actions to support capacity building, skill development, training on larger developmental issues and specific issue-based support is continuing that is strengthening the created infrastructure and upgrading incomes and increasing real access to natural and productive resources.

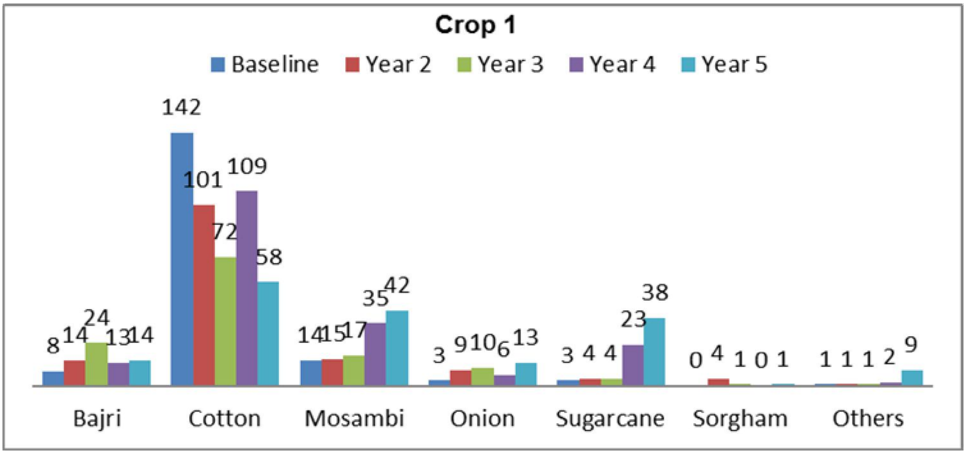
Self-help groups were formed and the community's capacity was built around diverse livelihoods issues and empower them towards education, health and decision making. Regular savings were initiated and linkages with the Banks were built.

3.3 Cropping Pattern

There has been a steady increase in the use of land for agriculture with increased availability of water conserved. While the area under cultivation during first cropping season (crop1) has increased from 626 ha during the first year to 692 in the second year, the second season cropping registered even higher area under cultivation from 623 ha to 723 ha in the fourth year. However, the most impressive change has been noted in the third season where from a meagre 104 ha, the cultivation has reached to 606 ha.

If we look closely at the cropping pattern of season 1 (crop 1), we could find certain crops being increasing cultivated like sweet lime, onions and sugar cane while some others like cotton are being gradually reduced. It not only positively affects the income of the farmers, but also saves the amount of water utilized for the crops. It has the double benefit of water conservation as well as income improvement.

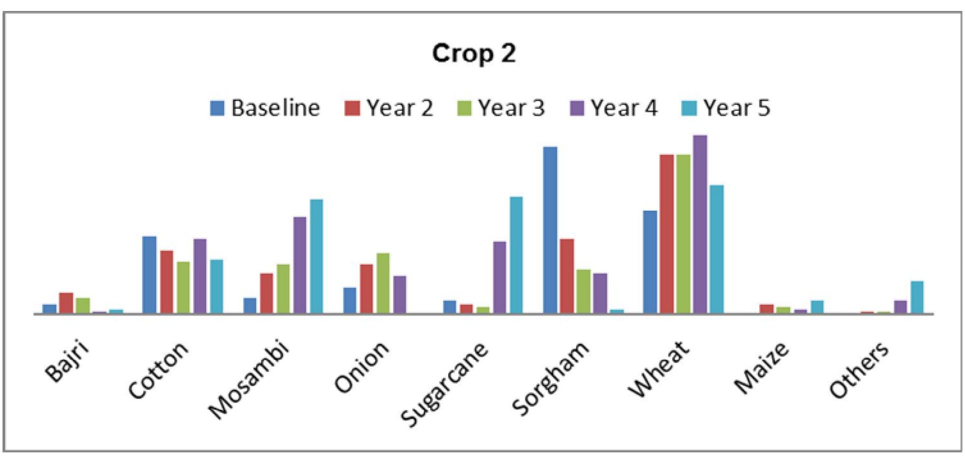
Diagram 1



The number of farmers undertaking cropping in season 1 (crop1) has increased from 170 at baseline to 185 during the fifth year. It also indicates better use of land for agriculture.

This trend seems to continue in the second season (crop2) also as indicated in the graph. Here we can also see the reduction in the cultivation of sorghum considerably from about 60 farmers at the beginning to just two at the end of five years. Another remarkable improvement is the introduction of more varieties of crops being introduced and experimented with the farmers (other crops from zero at baseline to 12 in the fifth year) during season 2.

Diagram 2

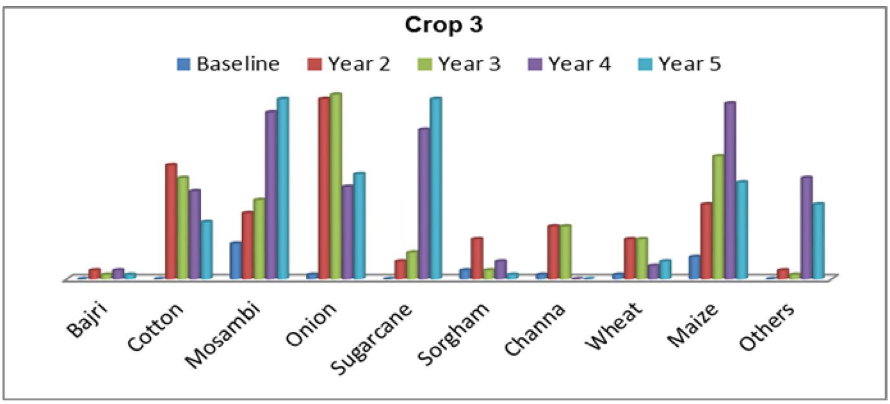


One of the most important results of the intervention was in the number of farmers who went in for the third crop (crop3) during the year. The number has gone up to 144 from a meagre 15 at baseline.

One of the main reasons for the increased utilization of land during the third season (crop3) was because of the introduction of vegetables in more than 260 ha during this season. It was also observed that farmers having started introducing vegetable cultivation during the second season also.

Thus, we observe that the intervention in the area has prompted more farmers engaging in three crops in a year and augmenting their income, especially with the third crop. It was an unexplored area and the right efforts have paid them substantially.

Diagram 3



With the new found interest in cultivating in season 3 (crop 3), the farmers extensively cultivated onion, sweet lime, sugarcane and maize. As shown in the figures below over a period of time the area sown under cotton is reduced and the sweet lime orchards are increasing.

Diagram 4

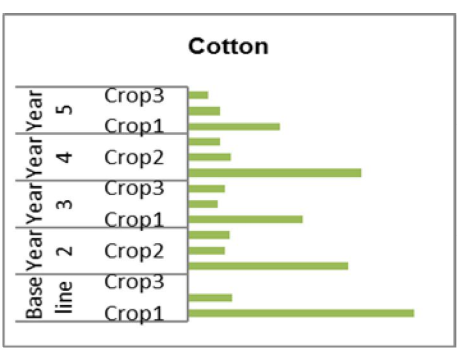
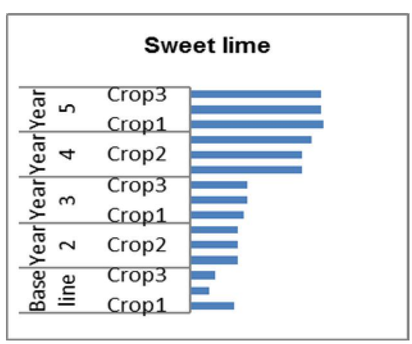


Diagram 5



4. Conclusion

Analysis of the data reveals that, depending on the annual rainfall received by the program region, ground water replenishment ranging from 1500 to 1700 TCM was achieved benefitting around 12,000 people. This can also be correlated with the changing cropping pattern and increased area under irrigated cultivation.

As a result, recharging aquifers enhanced water availability through dug wells in the command area and the intensification and extension of agriculture with incremental increases in cropping intensity was noted. Increase in cropping area from one crop to three crops has been significant and discussed in details above. Discussed above that there has been significant increase in vegetables, onion, sweet lime orchard and gradual reduction in the cultivation of sorghum and cotton.

Thus, significant improvement is noted in the income levels of farmers. During less rainfall years and drought conditions also farmers in the micro watershed were taking regular three crops and were being able to sustain themselves. This could happen with the combination of increase in ground water levels and increase in awareness towards management of water resources. Over the years there has been considerable increase in use of drip irrigation system along with change in cropping pattern. Also many farmers have invested in creating small water ponds in their farm ponds. There have been considerable benefits from allied activities i.e. establishment of dairy, goat rearing and poultry units.

A series of in-house and on-job trainings and exposure visits were organised for the community on water management, appropriate agricultural practices and other issue based income generating initiatives. The convergence with other government based programs allowed the community to further improve their income.

Self-help groups were formed and the community’s capacity was built around diverse livelihoods issues and empower them towards education, health and decision making. Regular savings were initiated and linkages with the Banks were built.

Community members, Gram Panchayat, various forms of user groups and WUAs capacities have been built around various issues and towards larger development perspective. An institutional mechanism was evolved for maintenance of the created assets and towards group based marketing.

This helped to build an improved understanding of the groundwater regime and ownership amongst the community. Consequently, it provided an incentive to the community to contribute to the collective maintenance of the water bodies. Affirmative complementing actions to support capacity building, skill development, training on larger developmental issues and specific issue-based support is continuing that is strengthening the created infrastructure and upgrading incomes and increasing real access to natural and productive resources.

SWRDM strategy for community-based water conservation is aligned with PepsiCo's water stewardship efforts to create Positive Water Balance in its areas of operation.

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