Analyzing the Impacts of the Various Land & Water Based Interventions and Non-land-based interventions carried out by Lalitpur Power Generation Co. Ltd. (LPGCL) CSR in Wardha and Lalitpur Districts during the Financial Year 2023 – 2024

Impact Study & Report
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1 Introduction

During the financial year 2023-2024, the Lalitpur Power Generation Company Ltd, (LPGCL) based in Lalitpur district of Uttar Pradesh, has carried many activities at both Wardha and Lalitpur districts respectively under Corporate Social Responsibility, through Kamalnayan Jamnalal Bajaj Foundation. The Hydrological interventions are: construction of check dams, rejuvenation works of the streams and rivers, well deepening, group wells, rainwater recharge ponds etc. The other interventions include Natural farming, horticulture farming, promotion of cows and Agri implements, Gram Panchayat (GP) Organization development, solar pumps for irrigation (3HP and 5HP), construction of rural godowns, skill development of rural youth and women, Community mobilization activities and many more. This report is outlined to capture the major impacts due to the above-mentioned interventions. The data is collected both at beneficiary and village levels. In total about 34 activities (Please refer Annexure-1) were carried out under the LPGCL's Corporate Social responsibility.

2 Objectives of the Study

The objective of the study is to assess the physical and socioeconomic impacts of the several land and water-based interventions and non-land-based interventions carried out by LPGCL CSR in Wardha district of Maharashtra and Lalitpur district of Uttar Pradesh.

3 Scope and Methodology

The scope of the impact study is as follows:

3.1 Study the impacts of various land and water-based interventions (check dams, river rejuvenations work, group well, well deepening, rainwater recharge ponds, natural farming, horticulture) on the farming enterprise of the adopter farmers (beneficiaries).

3.2 Study the impacts of various non-land-based interventions on the beneficiaries at village and block level

In the case of check dams, the physical impacts on the water levels in the farm wells are assessed in terms of yield of the wells and area irrigated. The physical impacts of river rejuvenation work include impact on the groundwater levels in the farm wells and average well yields. The physical impacts of the group wells include changes in area irrigated, changes in cost of cultivation and gross & net income from various crops, changes in overall net income from farming. Physical impacts from well deepening intervention include changes in the well yield and area irrigated, gross and net income from various crops and overall net income from farming. The physical impacts from rainwater recharge pond includes area irrigated, changes in the ground water levels in the farm wells and well yields.

In addition to the above, the overall impacts of implementing natural farming and wadi/horticulture are assessed at the individual beneficiary level by the means of changes in gross and net income from these practices. In this study, secondary data about the district, block and project villages are included. Using survey instruments, primary data from individual farmers / beneficiaries was collected. The impact assessment involves analysis of pre and post intervention scenarios.

However, in the case of non-land-based interventions like capacity building, community participation, promotions of cows, promotion of natural farming, infrastructure development, skill development of rural youth and women etc., focus group discussions (FGDs) will be the means of collecting the information and the synopsis of the same will be documented in this report.

4 Characteristics of the Selected Districts

The characteristics of Wardha district in Maharashtra and Lalitpur district in Uttar Pradesh are discussed in this section, which include, geographical location, geographical area, geology, topography, rainfall, climate, socio-economics etc.

4.1 Characteristics of Wardha District:

Wardha District is having an area of 6309 sq. km and geographically lies between latitudes 20°18'N and 21°21'N and longitudes 78°30'E and 79°15'E in the eastern part of Maharashtra state. Administratively the district is sub divided into eight tehsils or development blocks viz., Wardha, Deoli, Seloo, Arvi, Ashti, Karanja, Hinganghat and Samudrapur are the 8 Tehsils which fall under Wardha District. According to 2011 Census the district had a population of 13,00,774 of which 668385 are males and 632389 are females. The district had a sex ratio of 946 females to every 1000 males. Nearly 26.3% of the district population live in urban areas.

Geologically, Wardha is composed of Upper Cretaceous-Eocene basalt (Deccan Trap) with patches of inter-trappean beds. There are small pockets (along the banks of Wardha River and Yashoda River) of alluvium in the southwestern part of the district.

Topographically, the north eastern parts of the district are at a high altitude (above 440-600m above MSL), and the south eastern parts are at low altitude (around 180-250 m above MSL). These topographical features define the drainage pattern of the area, with most streams flowing in the south-eastern directions.

The soil profile mapping of the district shows two distinct soil types, viz., Lithosols and Chromic Vertisols. The Lithosols are shallow soils consisting of imperfectly weathered rock fragments, mostly found in the steep slopes. The Chromic Vertisols are heavy, clayey soils that shrink and swell

with change in moisture content. They are suitable for cotton growing and are also known as black cotton soil. Out of the two, Chromic Vertisols occupy a slightly larger proportion of the districts' area. The soil of the Wardha Valley is deep black in colour. Medium black soil is found in the eastern part of the district. In the northern upland, soil is coarse and shallow. Reddish brown soil is found in the patches in the catchment area of the Wunna River.

The climate is tropical monsoon type characterized by hot summer and general dryness of weather for most part of the year, excepting the monsoon season. Southwest monsoon rain commences in the middle of June and ends in September. The normal annual rainfall ranges between 900-1400 m, increasing from northwest to southeast.

The Land Use and Land Cover for Wardha District is given in Table 1 below. The natural vegetation is dry mixed deciduous type. About 14 percent of the total geographical area is under cover mostly lying in the uplands of the Arvi tehsil. Nearly 65% of the total area is cultivated. The major kharif crops are cotton, jowar, chickpea, groundnut, oilseeds, rice, pulses other than chickpea and bajra. Major Rabi crops are wheat, gram and oilseeds. Prominent fruit crops are orange, mango, banana, berry and guava. The sources of irrigation are canals and wells.

Table 1: Land Use and Land Cover (2017-18) Wardha District

Classes	**Area in Sq. Km**
Built up	148.34
Kharif crop	1531.19
Rabi crop	6.65
Zaid crop	0.009408
Double / Triple Crop	2566.11
Current fallow	23.35
Plantation	2.59
Deciduous forest	790.64
Degraded / Scrub Forest	112.54
Wasteland	738.21
Water bodies max	103.85
Water bodies min	61.35
Total Area	**6084.82**

Source: https://indiawris.gov.in/wris/#/lulc

4.2 Characteristics of Lalitpur District:

Lalitpur district, which is a part of Jhansi division in Uttar Pradesh has a geographical area of 5039 sq. km. Lalitpur district lies between 24°11' and 25°14' North Latitude and 78°10' and 79°0' East Longitude. Lalitpur is bounded by Jhansi district in the North, Sagar and Tikamgarh districts of Madhya Pradesh in the East, Ashoknagar district of Madhya Pradesh separated by Betwa River in the West. As per 2011 census, the district had a population of 12,21,592, out of which 641011 were male and 580581 were female. Lalitpur district had a sex ratio of 906 females to every 1000 males. About 14.36% of the district population live in urban areas.

Geologically Lalitpur district is characterised by three different geological subdivisions. Norther part of the district is represented by Bundelkhand Gneissic complex, central part by the rocks of the Bijawar group and southern part by the Vindhyan group.

Lalitpur district is a part of the Bundelkhand Plateau. Most of the area is under the average elevation of 300m to 450m from the mean sea level, whereas some portions in the south have an elevation of above 450m. General slope of the district is from South to North. The Betwa, Dashan and Ken flow from south to north and have developed badland topography. Mainly two types of soils, mixed red and black and red sandy soils are found in the district.

The climate is sub-tropical with the district witnessing hot and dry summers and cold winters. The normal annual rainfall in Lalitpur district is 900mm. The Land Use and Land Cover of Lalitpur District is given below in Table 2. About 65% 0f the total area in the district is under cultivation. The major crops are rice, soybean, wheat, oilseeds, maize, pulses, barley, jowar etc.

Table 2: Land Use and Land Cover (2017-18) Lalitpur District

Classes	**Area Sq. Km**
Built up	76.40
Kharif crop	260.56
Rabi crop	1055.04
Zaid crop	0.084672
Double / Triple Crop	2092.66
Current fallow	129.44
Plantation	3.52
Deciduous forest	492.37
Degraded / Scrub Forest	147.10
Wasteland	266.87
Water bodies max	135.25
Water bodies min	194.81
Total Area	**4854.10**

Source: https://indiawris.gov.in/wris/#/lulc

5 Presentation of the Field Data Collected

Sampling size and the different types of schedules used to collect the primary data are discussed in this section.

Wardha District			
S. No	**Intervention**	**No of Samples**	**Mode of Data Collection**
1	Check Dam	24	Primary survey
2	Rejuvenation of Streams and Rivers	24	Primary survey
3	Wadi / Horticulture	41	Primary survey
4	Well Deepening	24	Primary survey
Lalitpur District			
S. No	**Intervention**	**No of Samples**	**Mode of Data Collection**
1	Construction of Group Wells	10	Primary survey

2	Rejuvenation of streams and rivers	12	Primary survey
3	Promotion of Natural Farming	10	Primary survey

Apart from primary data collection, to understand the impacts of activities like GPOD-Gram Panchayat Organization development, promotion of cows and Agri Implements, solar pumps for irrigation, Digital boards supplied to schools, Kisan Pathsala, construction of rural godown, community participation, infrastructure development, income generation activities etc., the information was gathered by the means of FGDs and discussions with beneficiary farmers.

6 Results and Discussion

In this section, the impacts of check dams, river rejuvenation, wadi/horticulture, natural farming and well deepening interventions in Wardha district implemented by Bajaj Foundation will be discussed. Similarly, the impacts of group wells, river rejuvenation works, rainwater recharge ponds, promotion of natural farming and horticulture in Lalitpur district are also discussed. The primary data analysis results are presented here with reasons of the specific impacts.

Wardha District:

6.1 Impact of Check Dams for Irrigation

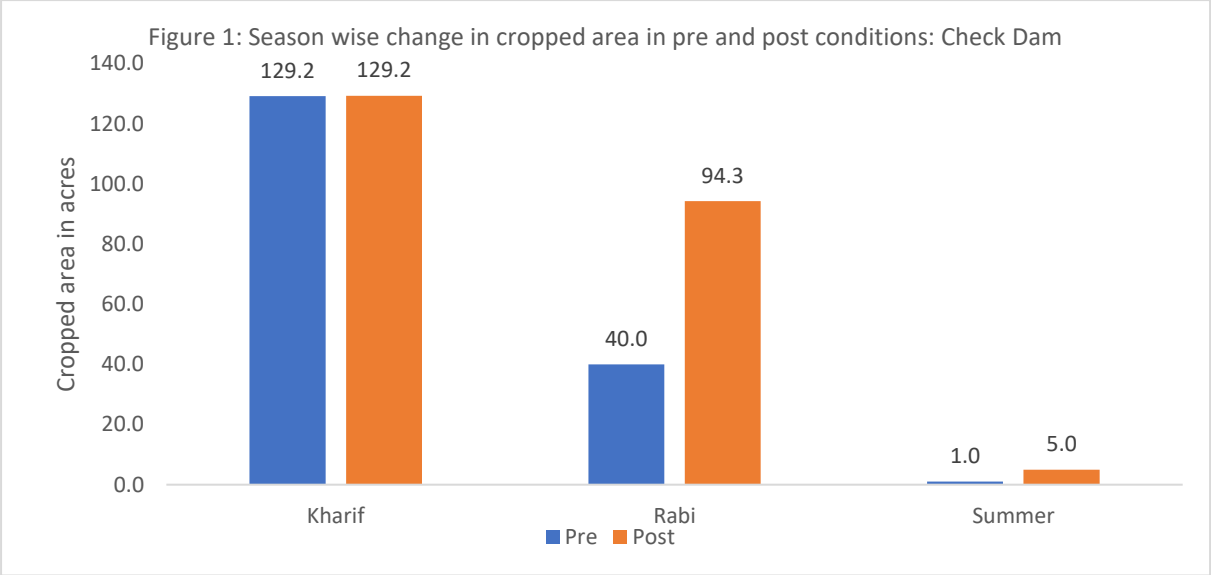
The primary data was collected from 24 farmers in Deoli block, Wardha district, where the check dams were constructed by Bajaj Foundation under the LPGCL corporate social responsibility. In this section, change in cropped and irrigated areas, cropping pattern, changes in input costs of crops, changes in gross and net income per unit area, changes in the yield in quintal per acre and changes in the depth to water level in pre and post conditions of check dam are discussed in detail.

6.1.1 Changes in the Landholding due to increased water availability from tiny reservoirs

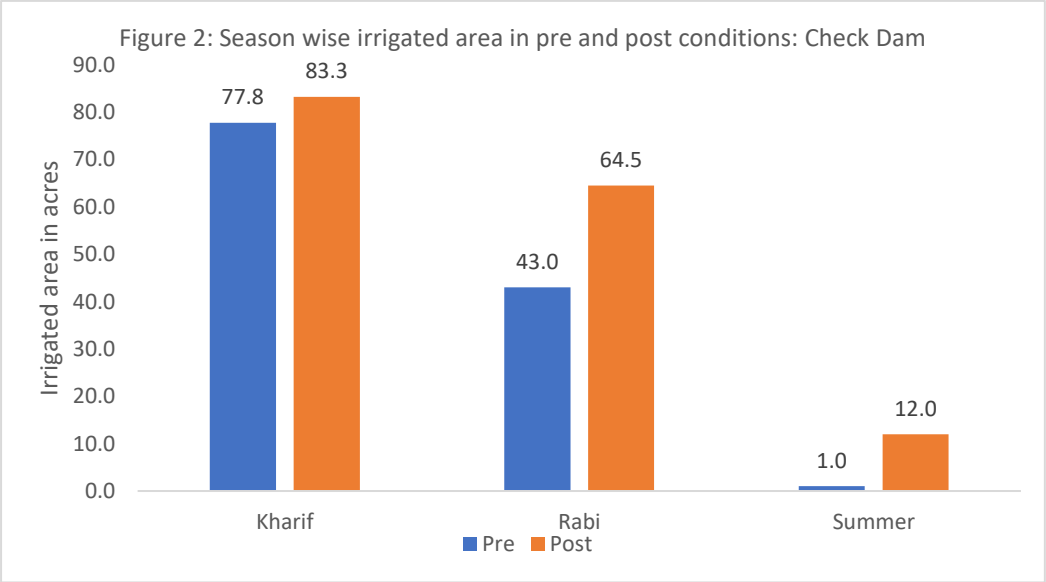
The analysis of the primary data reveals that there is no change in the landholding as it remained 129.2 acres in both pre and post conditions of check dam intervention. The reason for this is that the farmers in this block did not acquire any additional land for agriculture.

6.1.2 Season wise changes in the cropped and irrigated area

The cropped area during kharif season was observed to be 129.2 acres in pre and post scenarios under the check dam intervention. However, the cropped area in rabi season increased from 40 acres in pre intervention condition to 94.3 acres in post intervention condition. Interestingly the cropped are in summer season increased from 1 acre to 5 acres in the pre post conditions respectively. The increase in the cropped area in rabi season is due to the availability of water from both farmers' wells and also lifting from the check dam. The seasonal change in the cropped area in pre and post scenarios for check dam intervention are depicted in the Figure 1 below.



Further, the irrigated area in Kharif season increased from 77.8 acres in pre intervention to 83.3 acres in post intervention. Rabi irrigated area also increased considerably from 43 acres to 64.5 acres in pre and post scenarios respectively. Irrigated area in summer also increases from 1 acre to 12 acres. The increase in irrigated areas is due to availability of water from the farmer owned wells and also check dam. The water stored in the check dam is also entering the open wells due to the local hydrological condition. The season wise irrigated areas are shown in Figure 2 below.



6.1.3 Source of Irrigation and the energizing device details

Almost all the farmers are sourcing water from open wells and also from the check dams. Thy are all using electric pumps to draw the water from the wells and check dam. On an average the electricity charges in pre monsoon were found to be Rs. 800 per month in pre intervention condition and this increased to Rs. 1200 per month in post intervention condition. Similarly in winter the electricity charges per month was observed to be Rs. 1000 and Rs. 1800 respectively in pre and post conditions. During the summer season also the monthly electricity charges were Rs. 900 per month in pre-condition and nearly 1200 per month in post condition. The reason for

increase in the electricity charge is more number of hours of pumping due to additional water availability.

6.1.4 Season wise changes in the cropping pattern

The increase in the cropped area for soybean, channa and wheat are 14, 15 and 3 acres respectively. However, the area under cotton and Toor decreased by 42% and 71% respectively. Main reason for this can be attributed to farmers shifting from cotton to soybean and Toor to Channa. The change in the cropped area under different crops for kharif and rabi season are given in the Table 3 below.

Table 3: Seasonal changes in the cropped area under different crops

Crop Name	Season	Cropped Area in acres		Change in Cropped Area (Post - Pre)
		Pre	Post	
Cotton	Kharif	77	34	-43
Soybean	Kharif	25.5	39.5	14
Toor	Kharif	22.5	16	-6.5
Channa	Rabi	12	27	15
Toor	Rabi	1	0	-1
Wheat	Rabi	10.5	13.5	3
Chara	Rabi	0.5	0.5	0

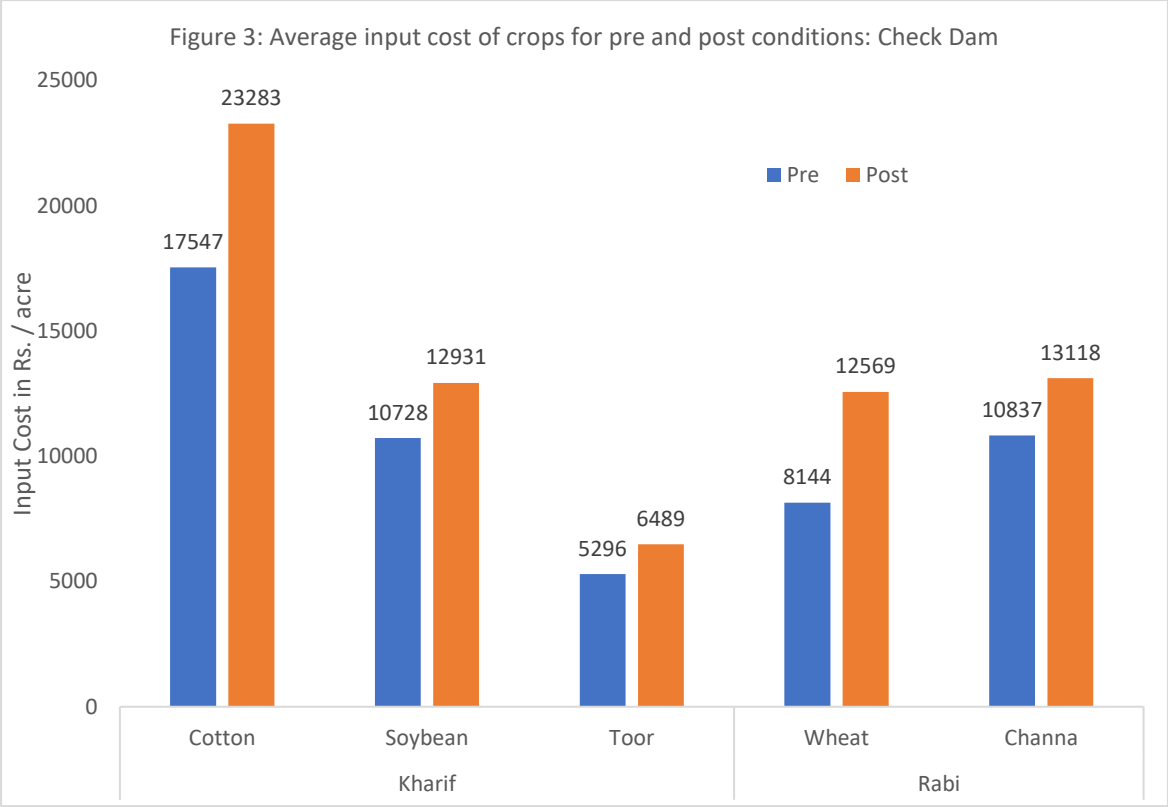
The irrigated areas also increased for soybean, channa and wheat crops by 4.5, 1.5 and 2.5 acres respectively which are 17.3%, 6.25% and 23.58% respectively, increase in terms of percentage. The changes in the irrigated area under different crops are given in the Table 4 below. The increase in the irrigated area may be linked to the availability of water for irrigation, after the check dam intervention.

Table 4: Changes in the irrigated are under different crops

Crop Name	Season	Irrigated Area in acres		Change in Irrigated Area (Post - Pre)
		Pre	Post	
Cotton	Kharif	54.5	29	-25.5
Soybean	Kharif	26	30.5	4.5
Toor	Kharif	18	15	-3
Channa	Rabi	24	25.5	1.5
Toor	Rabi	1	0	-1
Wheat	Rabi	10.5	13	2.5
Chara	Rabi	0.5	0.5	0

6.1.5 Crop wise changes in the input costs per unit area

The average input costs for various crops are presented in Figure 3 below. The input costs for all the crops increase from pre intervention condition to post intervention condition. The average input costs per acre in cotton, soybean and toor increased by 32.7%, 20.35% and 22.5% respectively. Similarly, the average input costs per acre for wheat and channa also increase by 54.3% and 21% respectively. The increase in the inputs costs can be linked to the increase in the labour costs, fertilizer costs and seed costs per acre.



6.1.6 Crop wise changes in the outputs in terms of yield and income generated

The output in terms of average yield of kharif and rabi crops in quintal per acre are presented in Table 5 below. The average crop yield in quintal per acre for cotton, soybean, toor, wheat and channa increase by 42.3%, 37.0%, 63.2%, 28.4% and 42.3% respectively. The change (increase) in the crop yield is due to timely irrigation of all these crops in required amounts. Farmers could irrigate the crops as the water was available in required amounts after the check dam intervention.

Table 5: Changes in the crop yield in pre and post conditions: Check Dam

Crop Name	Season	Average crop yield in quintal / acre		Change in the crop yield (Post - Pre)
		Pre	Post	
Cotton	Kharif	5.2	7.4	2.2
Soybean	Kharif	4.6	6.3	1.7
Toor	Kharif	1.9	3.1	1.2
Wheat	Rabi	7.4	9.5	2.1
Channa	Rabi	5.2	7.4	2.2

The analysis of the primary data on outputs in terms of average gross income per acre and average net income per acre are given in Table 6 below. Both gross and net income increased for all the crops from pre intervention to post intervention. Even though the input costs increased for all the crops, it did not adversely impact the net income, as the yield increased for all the crops, the income generated from the improved yield also increased correspondingly.

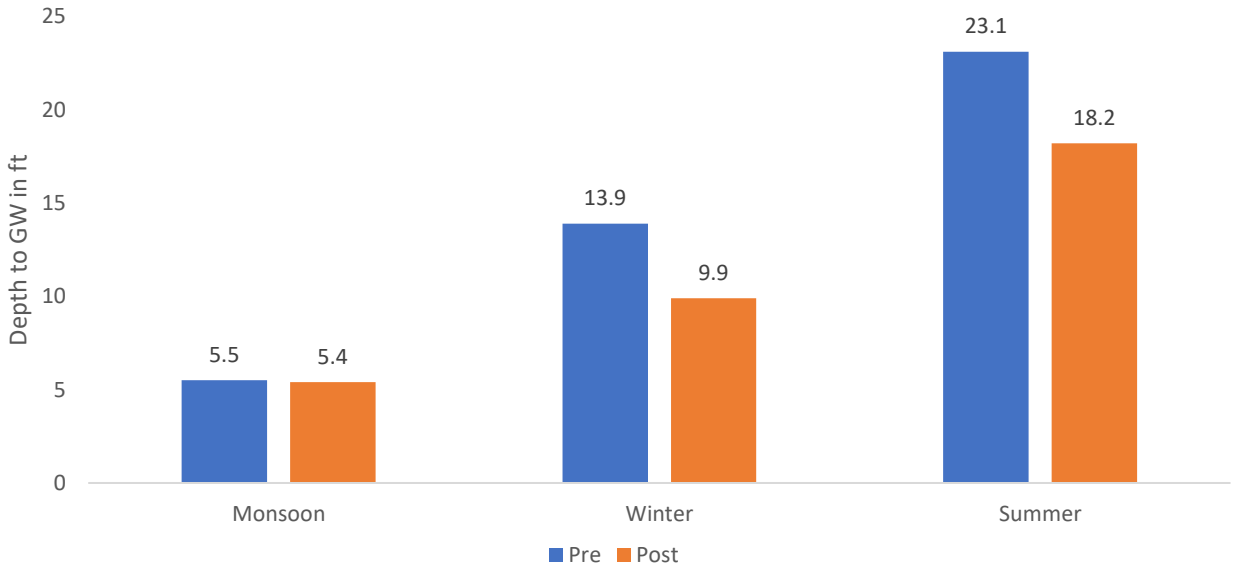
Table 6: Changes in the gross and net income in pre and post conditions: Check Dam

Crop Name	Season	Average Gross Income in Rs. / Acre		Change in the Gross Income (Post - Pre)	Average Net Income in Rs. /Acre		Change in the Net Income (Post - Pre)
		Pre	Post		Pre	Post	
Cotton	Kharif	20921	33950	13029	3374	10667	7293
Soybean	Kharif	11513	20100	8587	785	7169	6384
Toor	kharif	8154	13563	5409	2858	7074	4216
Wheat	Rabi	9190	14506	5316	1046	1937	891
Channa	Rabi	14685	26850	12165	3848	13732	9884

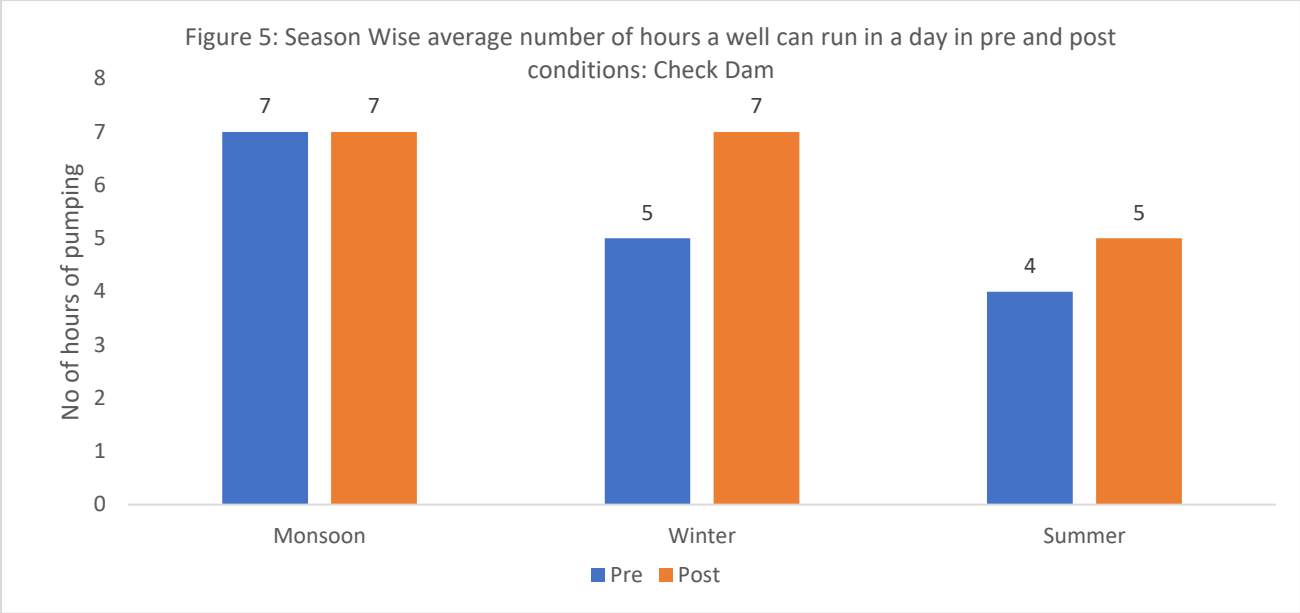
6.1.7 Seasonal changes in the groundwater levels and availability due to Check Dams

Due to the intervention of Check dam construction, the water levels in the farmer wells also increase as the surface and groundwater are interlinked in this area. The wells received water stored in the check dams and as a result the depth to ground water levels also improved in all the seasons. The average depth to groundwater level increase by 4.0 and 4.9 feet respectively in rabi and summer seasons. The seasonal changes in the depth to ground water are depicted in Figure 4 below.

Figure 4: Seasonwise averge depth to GW in pre and post conditions: Check Dam



The analysis of the season wise change in the number of hours of well can run in a day in pre and post conditions due to the check dam intervention are depicted in Figure 5 below. From the analysis it was observed that the wells can run for 2 additional hours in the Rabi season. Even in summer season the wells are running for 1 additional hour when compared to the pre intervention scenario. This increase in number of hours can be linked to recharge of wells from the water available in check dams.



6.1.8 Discussions on overall impacts

Due to the construction of check dams, the cropped and irrigated areas have increased as there was assured water availability for irrigation. Even though the input costs per acre increase, the increase in the yield of crops have led to increase in the gross and net income per acre for all the crops. The individual wells of the farmers were also getting recharged by the water in the check dams due to the surface water and groundwater interlink in that area. In this way the farmers have benefitted from the check dam intervention.

6.2 Impact of River Rejuvenation

In this section the impacts of stream and river rejuvenation are discussed which mainly cover the changes in the cropping pattern, changes in the cropped and irrigated areas season wise, changes in the crop input cost per acre, crop outputs in terms of yield and income generated. The sources of irrigation and the type of energizing devices used along with capacities are also explained in this section. Finally, the impact of river rejuvenation works on the ground water levels season wise is also discussed.

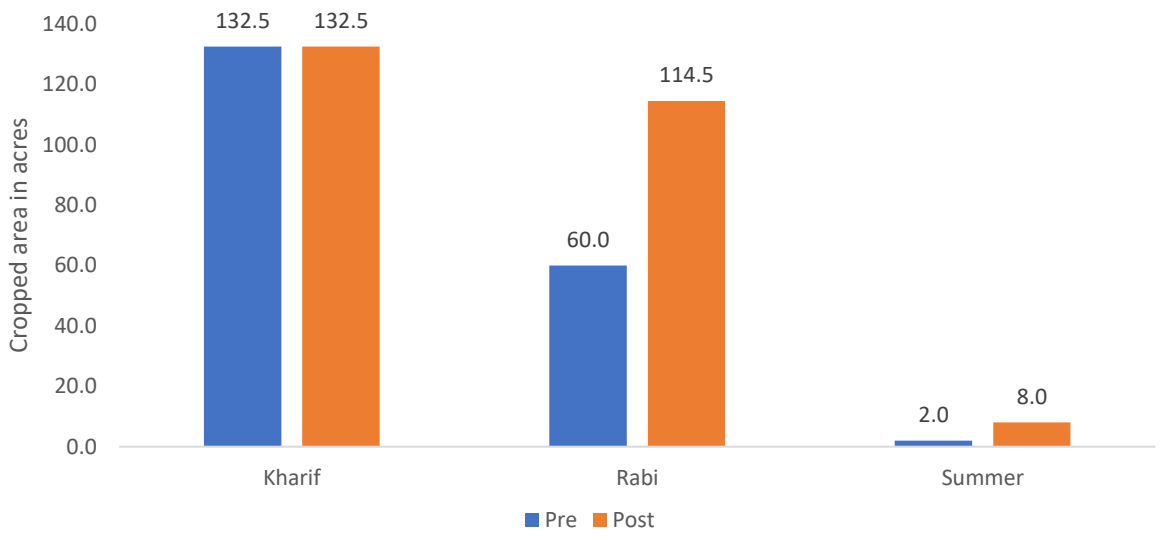
6.2.1 Changes in the Landholding due to Rejuvenation of streams and rivers

Total landholding of 24 farmers surveyed is about 132.5 acres both in pre and post conditions of river rejuvenation intervention. From the primary survey and the discussions with the Farmers it was understood that they did not acquire any additional land in the Deoli block of Wardha district.

6.2.2 Changes in Cropped and Irrigated Area (season wise)

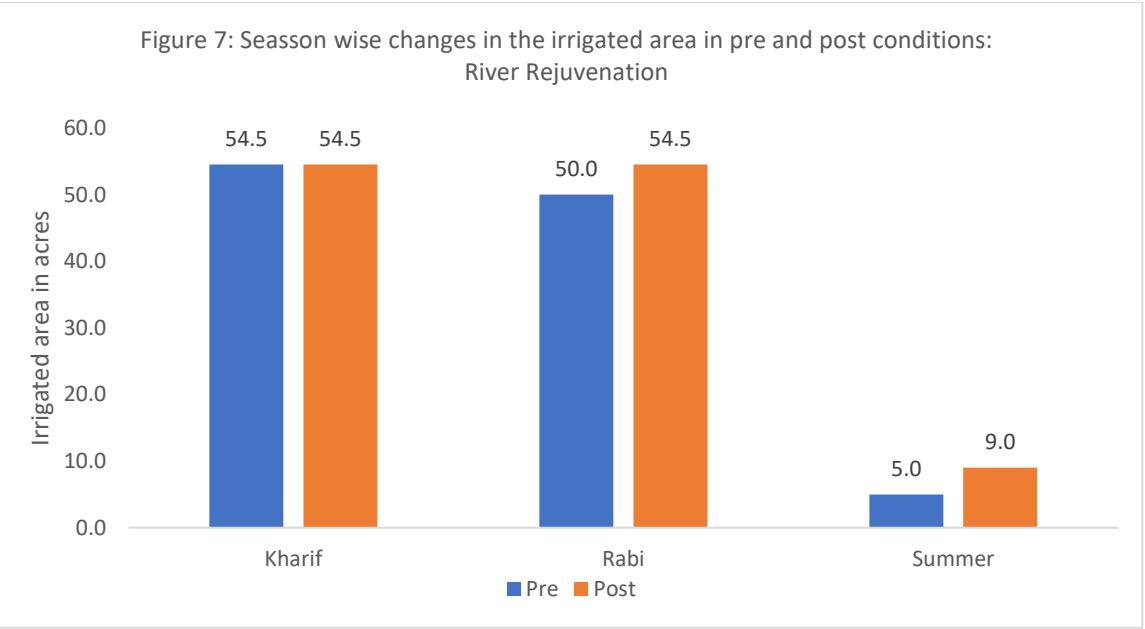
Even though the cropped area in kharif season did not change in the pre and post conditions, the cropped area almost doubled in the rabi season. Cropped area in summer season also increase from 2 acres in pre intervention to 8 acres in post intervention. This is because the farmers were assured of timely irrigation from the water that was available from the rivers after the rejuvenation works by the Bajaj Foundation. Figure 6 below depicts the change in the cropped area season wise in pre and post conditions of river rejuvenation.

Figure 6: Season wise change in the cropped area in pre and post conditions: River Rejuvenation



Season wise change in the area under irrigation is given in Figure 7 below. From the primary data analysis, it was observed that there was not change in the kharif season in terms of irrigated area. However, in rabi and summer season the irrigated areas increased by 4.5 and 5.0 acres respectively. Here the increase in irrigated areas in terms of percentages are 9% and 80% respectively.

Figure 7: Seasson wise changes in the irrigated area in pre and post conditions: River Rejuvenation



6.2.3 Source of Irrigation and the energizing device details

The farmers in the Deoli block are using both surface water and ground water. Nearly 80.5 acres of agricultural land is under river lift irrigation. Most of the farmers are using electric pumps for

lifting the water from the river. About 75% of irrigation is through electric pumps and 25% through diesel pumps as per the primary data analysis.

6.2.4 Changes in the cropping pattern (season wise description)

The analysis results on the season wise change in the cropped are in pre and post conditions of river rejuvenation intervention are presented in the Table 7 below. The cropped areas under cotton and toor reduced by 27acres and 5 acres respectively which are 42% and 22% in terms of percentages. However, the cropped are under soybean, channa and wheat increase by 25.5, 3.5 and 2 acres respectively. This means that the farmers have shifter the area under cotton and toor to soybean and channa. This shifting was done as not much water was required for soybean and channa when compared to cotton.

Table 7: Season wise change in the cropped area in pre and post conditions

Crop Name	Season	Cropped area in acres		Change in the cropped area (post - pre)
		Pre	Post	
Cotton	Kharif	64	37.0	-27.0
Toor	Kharif	22.5	17.5	-5.0
Soybean	Kharif	27	52.5	25.5
Channa	Rabi	20	23.5	3.5
Wheat	Rabi	12	14.0	2.0

The primary data analysis on the season wise irrigated area for various crops are presented in Table 8 below. The irrigated area under cotton, toor and soybean decreased as that year received a good rainfall in the kharif season. However, the irrigated area under channa and wheat increase by 4 and 2 acres respectively which are 26% and 16% in terms of percentages. Water was available in rabi season from the river lift and farmer wells.

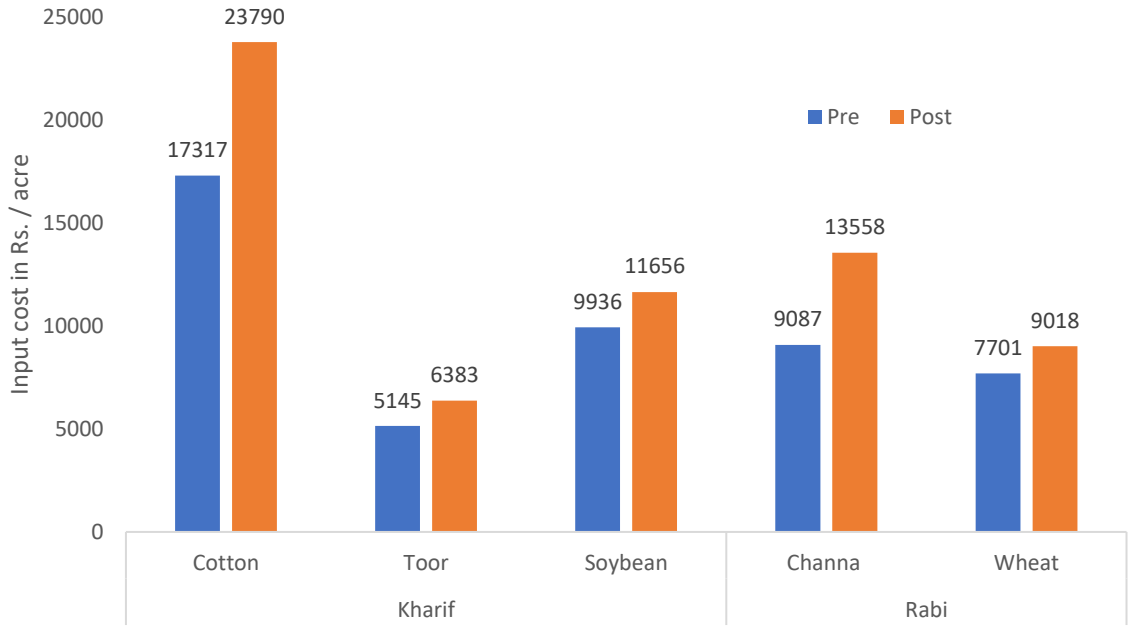
Table 8: Season wise change in the irrigated area

Crop Name	Season	Irrigated area in acres		Change in the irrigated area (post - pre)
		Pre	Post	
Cotton	Kharif	39.5	16.5	-23.0
Toor	Kharif	7	4.0	-3.0
Soybean	Kharif	26	18.5	-7.5
Channa	Rabi	15	19.0	4.0
Wheat	Rabi	12	14.0	2.0

6.2.5 Crop wise changes in the input costs per unit area

In terms of percentage, the input costs for cotton, toor and soybean increased by 37.4%, 24.1% and 17.3% respectively. The input costs for channa and wheat crops per acre increase by 49.2% and 17.1% respectively. The primary data analysis on average input costs in Rs. / Acre for all the crops increased due to increase in the labour costs, fertilizer and pesticides costs. The details on the input costs are depicted in Figure 8 below.

Figure 8: Average input cost of crops for pre and post conditions: River Rejuvenation



6.2.6 Crop wise changes in the outputs in terms of yield and income

The crop yield in terms of quintal / acre increase in all the crops as farmers were able to provide timely irrigation to cotton, toor, soybean, channa and wheat crops. The yield of cotton, toor and soybean increased by 33.3%, 81.1% and 32.6% respectively from pre intervention to post intervention conditions of the river rejuvenation. The details of changes in the crop yield in pre and post conditions are shown in Table 9 below.

Table 9: Crop wise change in the yield in terms of quintal / acre in pre and post conditions

Crop Name	Season	Average Crop Yield in quintal / acre		Change in Crop Yield (Post - Pre)
		Pre	Post	
Cotton	Kharif	5.1	6.8	1.7
Toor	Kharif	1.85	3.35	1.5
Soybean	Kharif	4.3	5.7	1.4
Channa	Rabi	4.2	7	2.8
Wheat	Rabi	5.5	8	2.5

Table 10 below, gives the changes in the average gross income and average net income in terms of Rs / acre for cotton, toor, soybean, channa and wheat crops. The average gross and net incomes increased in all the crops. Even though the input costs increased, the net income also increase in all the crops as there was very good increase in the yield of for all the crops. The average gross income for cotton, toor and soybean increase by Rs. 10698, Rs. 7048 and Rs. 895 per acre respectively. The net income for same crops increased by Rs. 4225, Rs. 5810 and Rs. 6475 respectively. The net income for channa and wheat crops increase by multiple fold which are Rs. 12040 and Rs. 4800 per acre respectively.

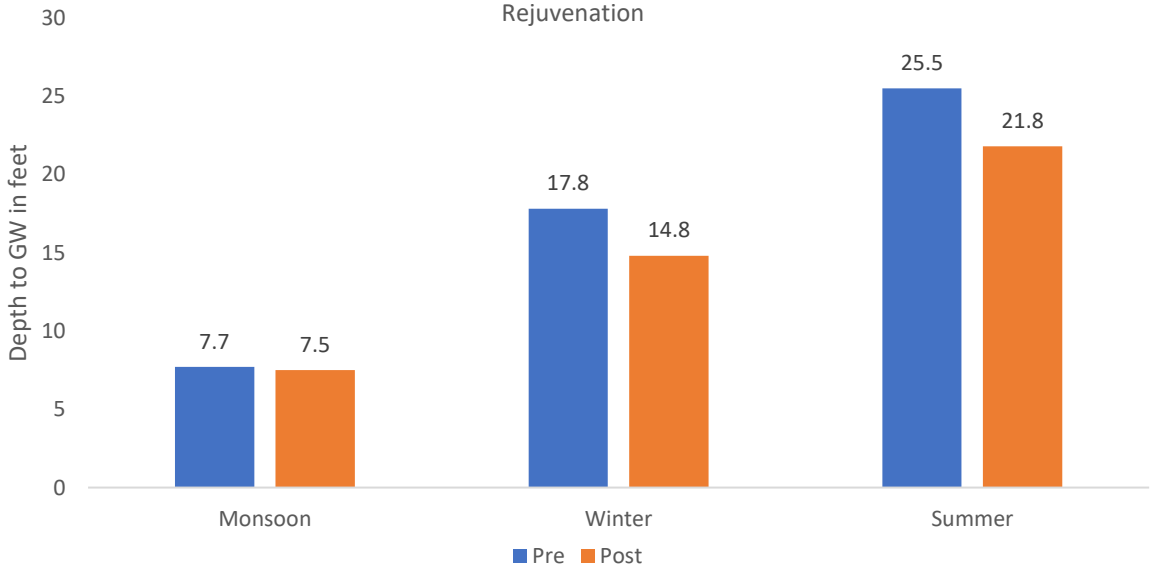
Table 10: Change in the gross and net income from the crops in Rs / acre in pre and post conditions

Crop Name	Season	Average gross income Rs / acre		Change in Gross Income (Post - Pre)	Average net income Rs / acre		Change in Net Income (Post - Pre)
		Pre	Post		Pre	Post	
Cotton	Kharif	20758	31456	10698	3441	7666	4225
Toor	Kharif	6232	13280	7048	1087	6897	5810
Soybean	Kharif	11026	19221	8195	1090	7565	6475
Channa	Rabi	11955	28466	16511	2868	14908	12040
Wheat	Rabi	7164	13281	6117	-537	4263	4800

6.2.7 Seasonal changes in the groundwater levels and availability due to the river rejuvenation

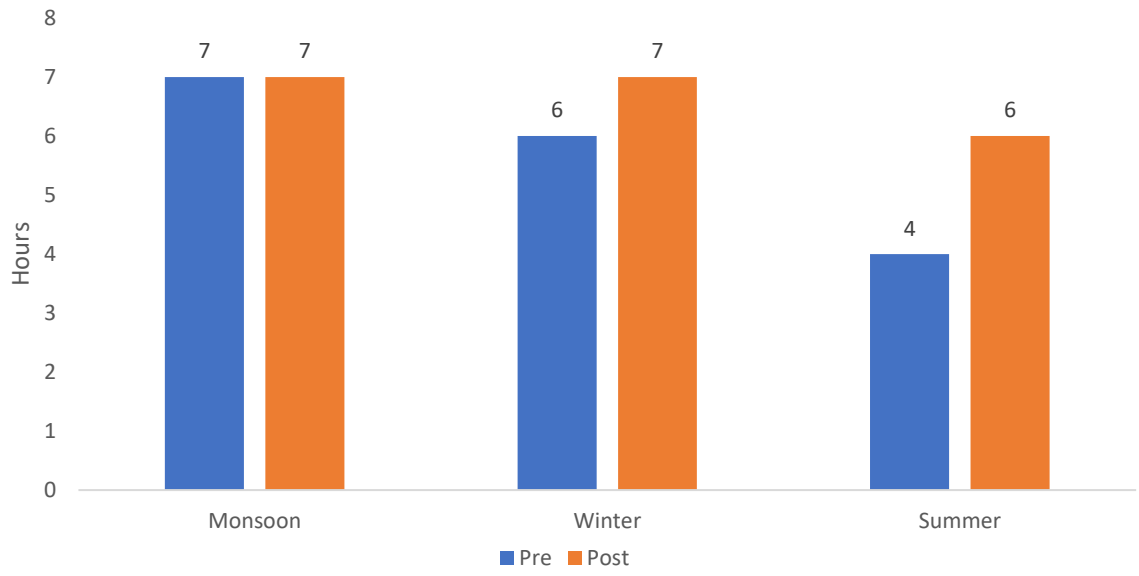
From the primary data analysis, it was evident that due to the river rejuvenation works, the depth to groundwater levels increases in winter and summer seasons by 3 feet and 3.7 feet respectively.

Figure 9: Seasonal change in Average depth to GW in pre and post conditions: River Rejuvenation



In addition to this, there was an improvement in number of hours a well can run in a day for winter and summer seasons respectively. In winter season the average number of hours a well can run in a day increased by 1 hour and in summer season increased by 2 hours. The main reason for this can be linked to the recharge of the farmer wells due to availability of sufficient water in the streams and river. The details of the same are depicted in Figure 10 below.

Figure 10: Season change in average number of hours a well can run in a day in pre and post conditions: River Rejuvenation



6.2.8 Discussions on overall impacts

The cropped and irrigated areas increase in winter and summer season respectively. As it was a good rainfall year, not much irrigation was required for cotton, toor and soybean crops. However enough water was available for irrigation post intervention for channa and wheat crops in Rabi season. Even though the input costs for all the crops increase from pre intervention to post intervention condition, the average yield in quintal / acre increase in all the crops as farmers could timely irrigated the crops form the river lift and well irrigation. The gross and net income from all the crops also increase by a great extent.

6.3 Wadi / Horticulture Farming

This section highlights the overall impact on the farmers who adopted wadi / horticulture farming. As part of LPGCL CSR, Bajaj Foundation has promoted horticulture farming in Karanja, Arvi and Ashti blocks in Wardha district. Required training was imparted to the farmers who were interested in wadi/horticulture. Nearly 41 farmers from 3 blocks were surveyed as a part of Primary data collection in this study. Further the changes in the cropping pattern, cropped area and irrigated areas under horticulture, yield, gross and net income are discussed here.

6.3.1 Changes in the Landholding due to Wadi/horticulture practices

Table 11 below depicts the land holding in pre intervention and post intervention. It is clear from the table below that there is no change in the landholding due to wadi/horticulture practices. However, from the primary survey it was understood that there was no major cultivation before the intervention. Only after the intervention, the farmers with the support of Bajaj Foundation have started horticulture crops.

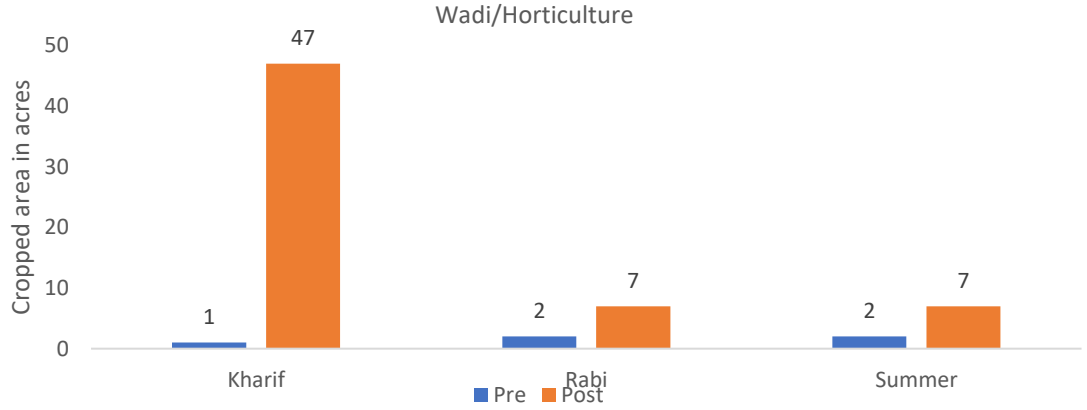
Table 11: Change in the Landholding in pre and post intervention

Block Name	Total Landholding in acres	
	Pre-Intervention	Post-Intervention
Karanja	61.5	61.5
Arvi	42.5	42.5
Ashti	67.5	67.5

6.3.2 Seasonal changes in the cropped and irrigated area

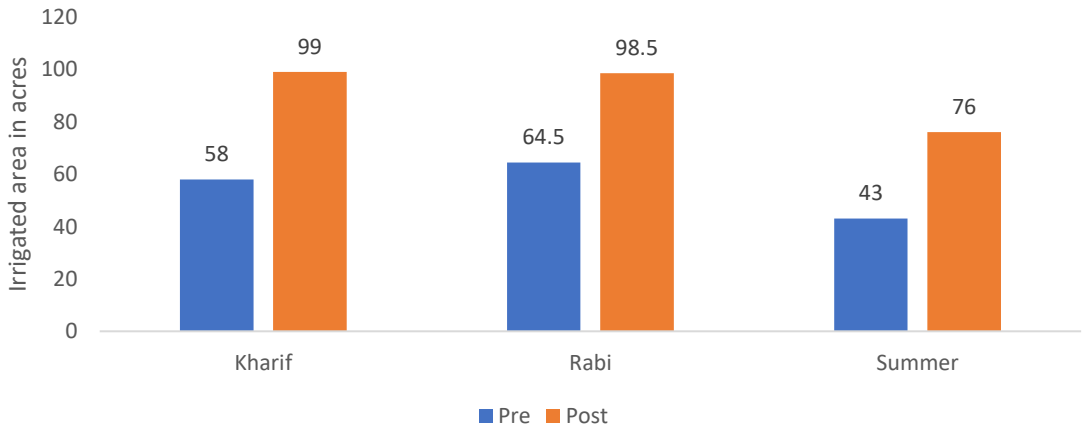
A sharp increase in the cropped area was observed in kharif season from 1 acre in pre intervention condition to 47acres in post intervention condition. The cropped area increases by 5 acres in both rabi and summer seasons respectively. This is because the farmers received the support from Bajaj Foundation. Figure 11 below shows these season wise changes in the cropped areas in pre and post conditions of wadi/horticulture intervention.

Figure 11: Season wise change in cropped area in pre and post conditions: Wadi/Horticulture



The irrigated areas in kharif, rabi and summer seasons almost increased by double from pre to post intervention condition. Figure 12 below depicts these season wise changes in the irrigated areas. This is because the farmers received the required support and encouragement from Baja Foundation for horticulture.

Figure 12: Changes in the Irrigated area in pre and post conditions: Wadi/Horticulture



6.3.3 Cropping / saplings details from the three blocks

Type and number of saplings from the primary data collection across the three blocks in Wardha district are given below in Table 12.

Table 12: Block wise, Horticulture details

Name of the Sapling	Total No of Saplings Planted		
	Karanja Block	Arvi Block	Ashti Block
Mango	125	211	155
Amla	83	36	0
Custard Apple	0	36	78
Lemon	79	99	132
Mosambi	140	0	0
Orange	80	110	800
Sweet Orange	0	0	1297
TOTAL	507	422	2462

6.4 Impact of Well Deepening

In this section, the impacts and benefits of well deepening are explained which include changes in cropping pattern, cropped and irrigated areas, changes in the crop wise input costs, changes in the crop outputs in terms of yield and income (gross and net). The primary data was collected from 24 farmers who were benefitted by this intervention and received support from Bajaj Foundation.

6.4.1 Changes in the Landholding due to well deepening

Total landholding of the 24 farmers surveyed was found to be 101.5 acres in both pre and post condition of Well Deepening intervention. The farmers who were surveyed in the primary data collection, in Wardha block did not acquire any additional land.

6.4.2 Changes in Cropped and Irrigated area (season wise)

The season wise changes in the cropped area are presented in Figure 13 below. From the primary data analysis, it was observed that the cropped are under kharif did not change. However, the cropped are in rabi and summer season increased by 46.4% and 62.5% respectively. This is due to the assured water availability for the crops in rabi and summer season from the well deepening intervention.

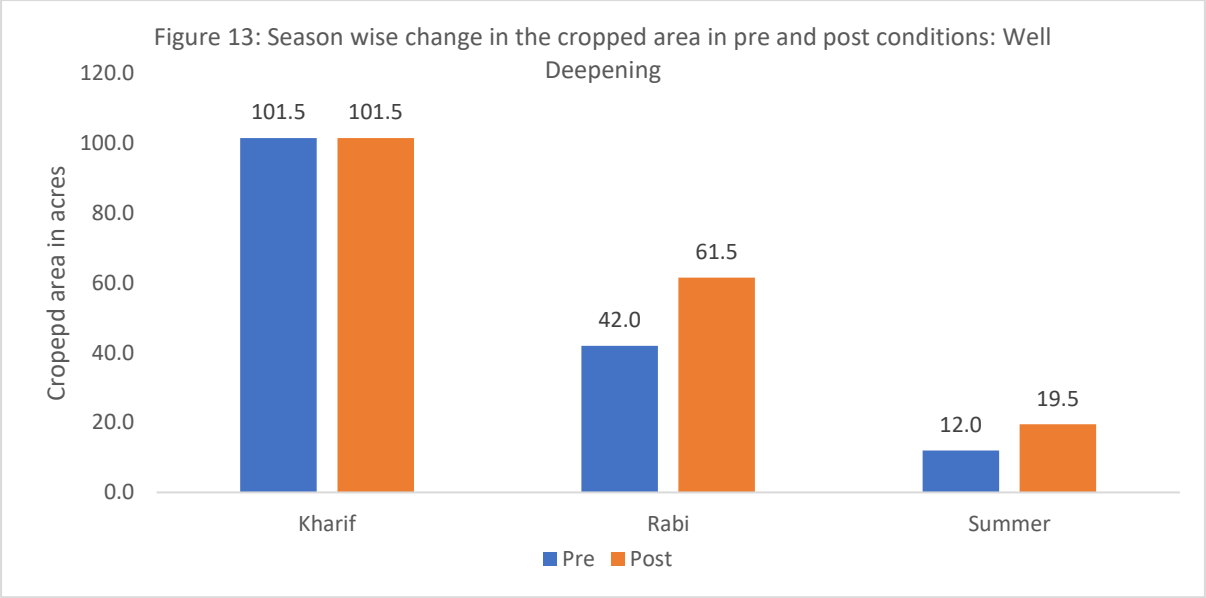
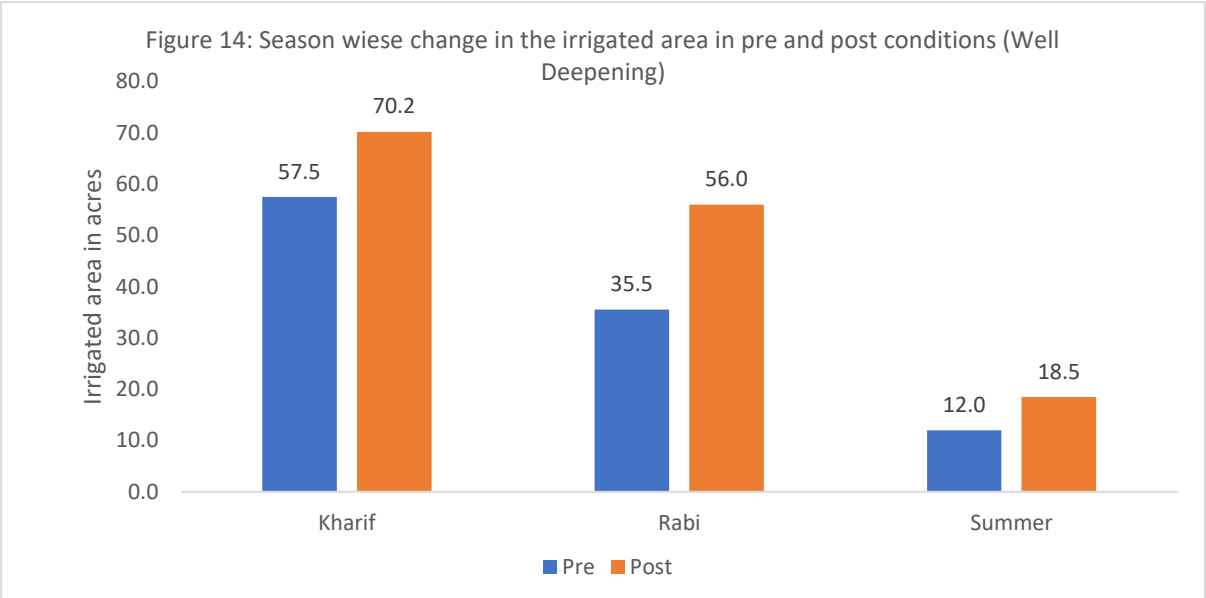


Figure 14 below gives the season wise change in the irrigated area due to the well deepening interventions. From the analysis of the primary data, it was observed that the irrigated area under kharif, rabi and summer increased by 22.1%, 57.7% and 54.2% respectively. Water availability for irrigation, after the intervention of well deepening works done by Bajaj Foundation is the main reason for the increase in the irrigated area in all the seasons.



6.4.3 Changes in the cropping pattern (season wise)

The changes in the cropping patter are presented in Table 13 below. The cropped area for all the crops increased except for cotton, soybean and onion. The cropped area in pigeon pea, channa and wheat increases by 33.3%, 52.9% and 150% respectively. Timely water availability for irrigation from the deepened well is the main reason for the increase in cropped are from pre intervention to post intervention.

Table 13: Season wise change in the cropped area in pre and post conditions: Well Deepening

Crop Name	Season	Cropped area in acres		Change in Cropped area (Post-Pre)
		Pre	Post	
Cotton	Kharif	61.5	61.5	0
Soybean	Kharif	35	32	-3
Pigeon pea	Kharif	10.5	14	3.5
Channa	Rabi	25.5	39	13.5
Wheat	Rabi	13	32.5	19.5
Brinjal	Summer	2.5	3.5	1
Groundnut	Summer	2	5	3
Ladyfinger	Summer	1.5	2.5	1
Onion	Summer	1	1	0

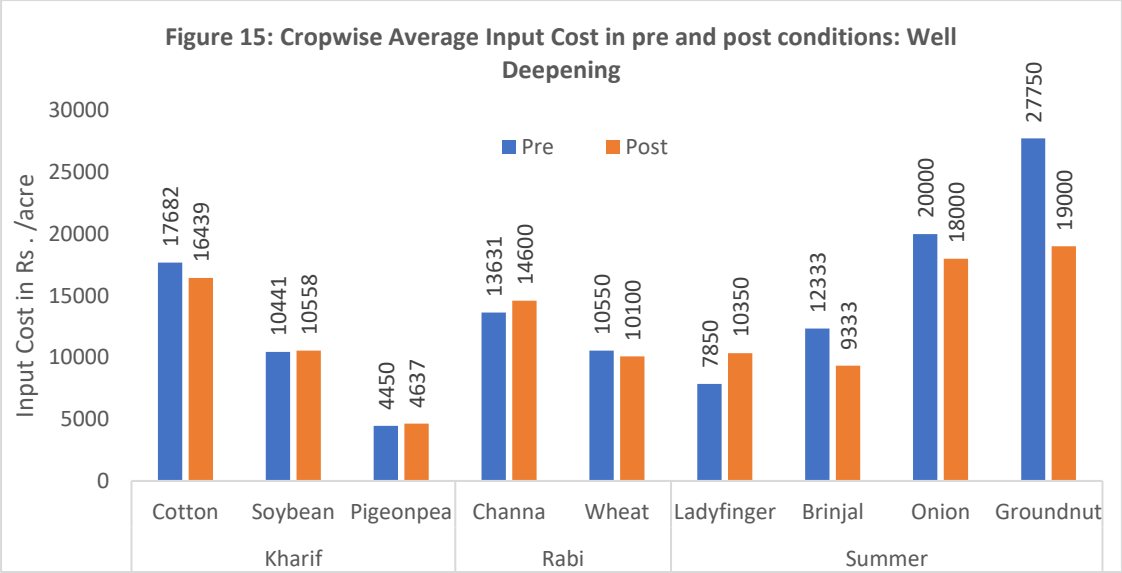
From Table 14 below, it is evident that the area under irrigation for all the crops except onion, increased from pre intervention to post intervention condition. Farmers were able to irrigated the crops in time from the wells which had improved water availability due to the well deepening intervention with the support of LPGCL CSR through Bajaj Foundation.

Table 14: Season wise change in the irrigated area in pre and post conditions: Well Deepening

Crop Name	Season	Irrigated area in acres		Change in Irrigated area (Post-Pre)
		Pre	Post	
Cotton	Kharif	9	35	26
Soybean	Kharif	3	12.5	9.5
Pigeon pea	Kharif	6.5	12	5.5
Channa	Rabi	14.5	29.5	15
Wheat	Rabi	13	32.5	19.5
Brinjal	Summer	2.5	3.5	1
Groundnut	Summer	2	5	3
Ladyfinger	Summer	1.5	2.5	1
Onion	Summer	1	1	0

6.4.4 Changes in the Crop Wise input costs per unit area

Figure 15 below shows the changes in the crop wise input costs in terms of Rs / acre. Except for soybean, channa and ladyfinger the input costs per acre decreased as given in Figure 15 below. Main reason for decrease in the input costs is that farmers are no longer dependent on others for water and in this way the labour charges also decreased.



6.4.5 Changes in Crop Wise out puts in terms of yield and income generated

The crop yield for all the crops increased except for brinjal and onion. Timely irrigation of crops is the main reason for the improve crop yields. The yield in terms of quintal / acre for cotton, pigeon pea, soybean, channa, what and ladyfinger increased by 26.9%, 20.0%, 2.2%, 17.6%, 9.5% and 5.0% respectively. Table 15 below depicts the changes in the yield for all the crops.

Table 15: Change in the crop yield in quintal / acre in pre and post conditions

Crop Name	Season	Average Crop yield in quintal / acre		Change in crop yield (Post - Pre)
		Pre	Post	
Cotton	Kharif	7.8	9.9	2.1
Pigeon pea	Kharif	1.875	2.25	0.375
Soybean	Kharif	6.5	6.64	0.14
Channa	Rabi	6.8	8	1.2
Wheat	Rabi	10.5	11.5	1
Ladyfinger	Summer	10	10.5	0.5
Onion	Summer	15	20	5
Brinjal	Summer	20	20	0
Groundnut	Summer	10	10	0

From the primary data analysis, the changes in the gross income and net income in terms of Rs / acre for all the crops are presented in Table 16 below. Form the data it was observed that the except for brinjal and groundnut the gross income increased in all the crops. However, the net income increases in all the crops except for ladyfinger. The gross income in cotton, soybean, pigeon pea, channa, ladyfinger and onion increased by 23%, 2%, 13%, 26%, 1%, 6% and 33% respectively. However, the net income for cotton, soybean, pigeon pea, channa, wheat, brinjal, onion and groundnut increased by 37%, 3%, 15%, 35%, 4%, 14%, 120% and 27% respectively. The main reason for increase in the net income is decrease in the input costs for some of these crops.

Table 16: Changes in the average gross and net income in pre and post conditions: Well Deepening

Crop Name	Season	Average Gross Income in Rs / acre		Change in gross income (Post - Pre)	Average Net Income in Rs / acre		Change in net income (Post - Pre)
		Pre	Post		Pre	Post	
Cotton	Kharif	56652	69869	13217	38970	53430	14460
Soybean	Kharif	25411	26000	589	14970	15442	472
Pigeon Pea	Kharif	20000	22500	2500	15550	17863	2313
Channa	Rabi	40533	50875	10342	26902	36275	9373
Wheat	Rabi	25600	25800	200	15050	15700	650
Ladyfinger	Summer	40000	42500	2500	32150	32150	0
Brinjal	Summer	33333	33333	0	21000	24000	3000
Onion	Summer	30000	40000	10000	10000	22000	12000
Groundnut	Summer	60000	60000	0	32250	41000	8750

6.4.6 Overall Impacts of Well-deepening

Overall, the well deepening intervention resulted in increase in cropped and irrigated areas in rabi and summer seasons respectively. The crop yield also improved in terms of quintal / acre significantly due to the improved irrigation facilities. The gross and net income also increase almost in all the major crops and the farmers link this directly to the well deepening intervention supported by LPGCL CSR through Bajaj Foundation.

Lalitpur District:

6.5 Impact of Group Wells

In this section, the impact of group well intervention on the beneficiaries in Lalitpur District were assessed by analyzing the changes in cropping pattern, season wise cropped and irrigated areas, crop wise input cost, crop wise yield, crop wise income (gross and net). The group well intervention was completed in the year 2022 and the primary data was collected for the year 2023.

6.5.1 Changes in the Landholding due to construction of group wells

The group well farmers were surveyed as a part of the primary data collection in about 4 villages in Barr block of Lalitpur district. From the survey it was observed that there was a marginal increase in the total land holding of the farmers (10 farms), from 74.5 acres (before intervention) to 76.5 acres (after intervention). The increase in the landholding can be attributed as a positive impact as additional land has come under irrigation due to the group well intervention.

6.5.2 Season wise changes in cropped and irrigated areas

As per the primary survey conducted, it is observed that the cropped area of the group well beneficiaries increased from 74.5 acres to 76.5 acres in Kharif and 69.5 acres to 76.5 acres in Rabi Season as shown in Figure 16 below. Before group well intervention, due to prolonged dry spells not enough water was available for agriculture. As a result, the farmers did not take the risk of increasing the cropped area in kharif season. However, after the group well intervention, required water is available for both kharif and rabi seasons. This is the main reason for increase in the

cropped area post intervention. Similarly, there was no cropping in summer season before intervention. However, post intervention, an area of about 4.9 acre is the cropped area in the summer season.

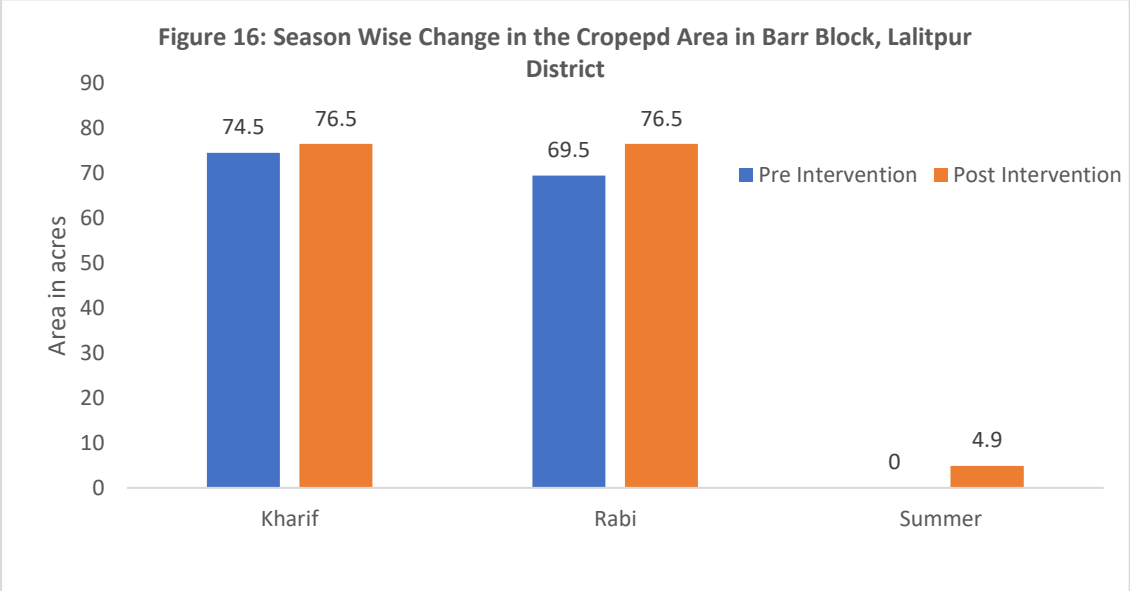
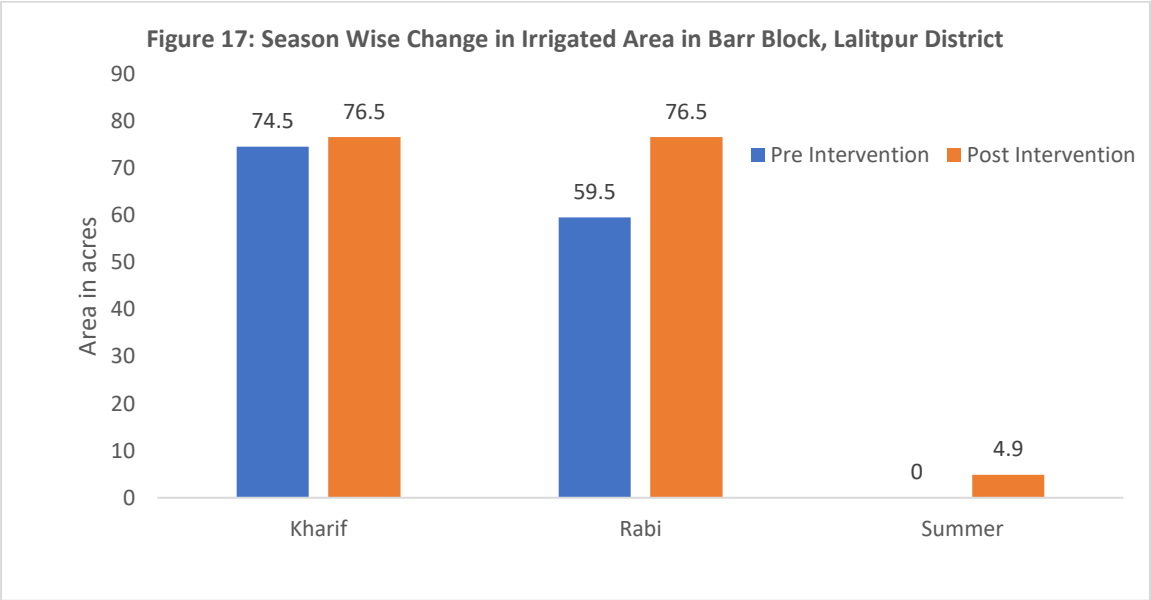


Figure 17 below depicts the changes in the irrigated area between pre and post conditions of group well intervention. Here the irrigated area under kharif season was 74.5acres in the pre intervention scenario, which increased to 76.5acres in the post intervention scenario. The irrigated area under Rabi season was only 59.5 acres before the intervention. However, post intervention, in the same season, nearly 76.5 acres of the agricultural land has come under irrigation which is about 28.5% increase in the area. During summer season, post intervention about 4.9 acres of land is under irrigation. Here, the main reason for the increase in the irrigated area during post intervention is availability of required amount of water for the crops form the group well. Water is available in the summer season as well for black gram, vegetables and groundnut.



6.5.3 Changes in the Cropping Pattern

As regards to cropped area, the results of the analysis are presented in Table 17, for group well intervention. The Kharif cropped area for the crops namely groundnut, corn increased during post intervention. The cropped area under black gram and green gram, remained unchanged. Area under Linseed decreased by 1 acre. Similarly in the case of Rabi crops, cropped area under wheat, peas have increased by 27% and 55% respectively. In the case of chickpea, the area decreased by 1 acre. The cropped area under barley and mustard remained unchanged. Interestingly, post intervention, the cropped area under summer was nearly 4.7 acres which included groundnut, vegetables and black gram. The reason for increase in cropped area may be attributed to farmer's interest in high value crops like groundnut, wheat etc. and assured water availability form the group wells. From the primary survey it was noticed that farmers are not so keen in crops like linseed and barley as not much demand in the local market. There is high demand for high value crops like groundnut and wheat.

Table 17: Changes in cropped area under different crops between pre and post conditions: Group Well

Crop Name	Season	Cropped Area (acres)		Change in Cropped Area (Post-Pre)
		Pre	Post	
Black gram	Kharif	54	54	0
Groundnut	Kharif	5.5	9.5	4
Green gram	Kharif	1	1	0
Corn	Kharif	5	6	1
Linseed	Kharif	7	6	-1
Wheat	Rabi	40.5	51.5	11
Barley	Rabi	1	1	0
Peas	Rabi	11	17	6
*Mustard	Rabi	5	5	0
Chickpea	Rabi	3	2	-1
Groundnut	Summer	0	1	1
Vegetables	Summer	0	2.7	2.7
Black gram	Summer	0	1	1

Source: Author's own analysis of the primary data

The results of the analysis for individual crops under irrigation are presented in Table 18 below, for the group well intervention. Except for Linseed, green gram, mustard and chick pea, the area under irrigation for all other crops have increased. Assured water is available from the group wells for the high value crops like groundnut, wheat etc. As there is demand in the market, farmers are also showing interest in vegetables and groundnut during summer season, post intervention.

Table 18: Changes in Irrigated area under different crops between pre and post conditions: Group Well

Crop Name	Season	Irrigated Area (acres)		Change in Irrigated Area (Post-Pre)
		Pre	Post	
Black gram	Kharif	54	54	0
Groundnut	Kharif	5.5	9.5	4
Green gram	Kharif	1	1	0
Corn	Kharif	5	6	1

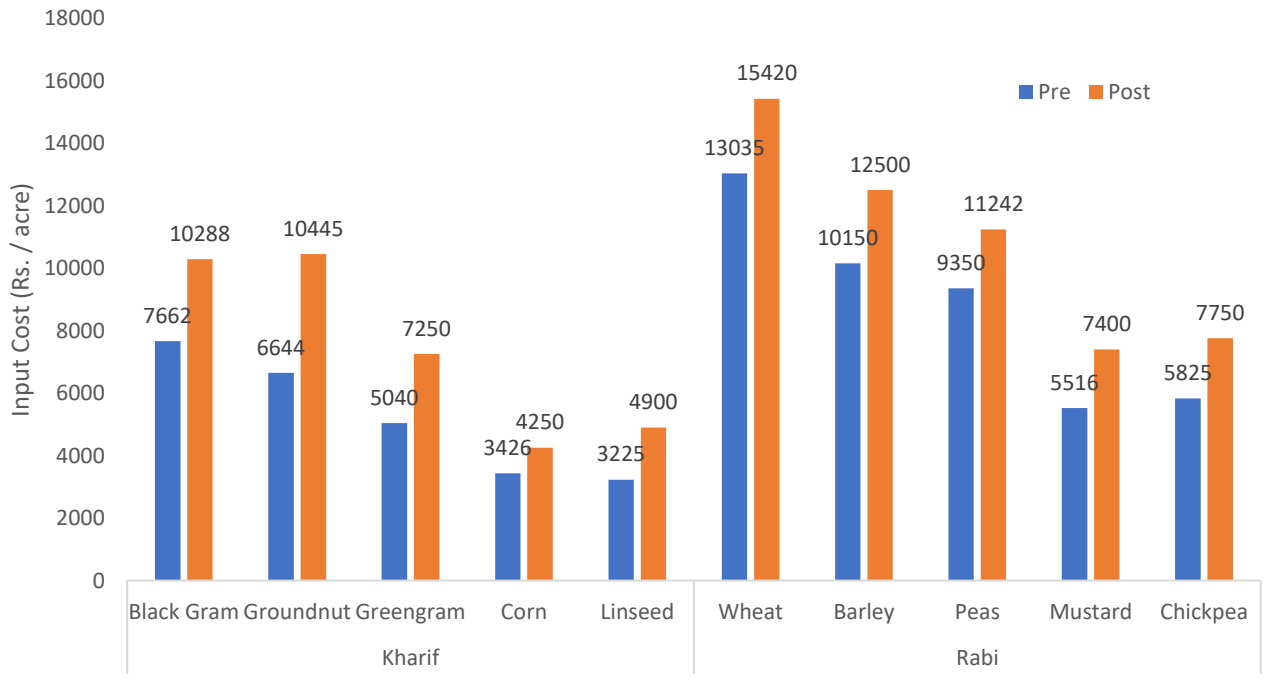
Linseed	Kharif	7	6	-1
Wheat	Rabi	35.5	51.5	16
Barley	Rabi	0	1	1
Peas	Rabi	10	17	7
Mustard	Rabi	5	5	0
Chickpea	Rabi	2	2	0
Groundnut	Summer	0	1	1
Vegetables	Summer	0	2.7	2.7
Black gram	Summer	0	1	1

Source: Author's own analysis of the primary data

6.5.4 Comparison of crop wise input cost (season wise) pre intervention and post intervention

The analysis on the average input cost for various crops is presented in Figure 18 below. The average input costs for all the crops increased as given in Figure 3. It was observed that the average input cost in Rs / acre for black gram increased from Rs. 7662 / acre (pre intervention) to Rs. 10288 / acre post intervention, which in nearly 34.28% increase. The average input cost for kharif groundnut increased by 57.22%. Similarly for green gram, corn, linseed and wheat crops the average input costs per acre had increased by 43.85%, 24.05%, 51.94%, and 18.30% respectively. Barley, peas, mustard and chickpea crops have also seen increase in the average input cost by 23.15%, 20.24%, 34.16%, and 33.05% respectively. The increase in the input cost may be linked to the rise in the labour charges and machine hiring charges.

Figure 18: Average input cost of crops for pre and post conditions: Group Well



Source: Author's own analysis of the primary data

6.5.5 Changes in the crop wise outputs in terms of yield and income generated

The results with regards to the changes in the average crop yield in quintal / acre are given in Table 19 below. The analysis of the results shows that all crops have shown improvement in the yield in terms of quintal / acre (Average values). In the case of ground nut, the crop yield increase by 69.7% post intervention. Similarly, the crop yields for black gram, green gram, corn, wheat, barley, peas, mustard and chickpea increased by 9.43%, 33.33%, 15.15%, 28%, 21.83%, 17.65%, 12.29%, 7.5% and 25% respectively. Prior to the intervention the farmers were not able to provide sufficient number of irrigations required depending on the crop type. However, post intervention, assured amount of water was available from the group well for irrigation and farmers were able to provide required number of irrigations to the crops on time. This led to the increase in the yield across various crops.

Table 19: Change in crop yield (Quintal / acre) between pre and post conditions: Group Well

Crop Name	Season	Average Crop Yield in quintal / acre		Change in the Crop Yield (Post - Pre)
		Pre	Post	
Black Gram	Kharif	2.65	2.90	0.25
Groundnut	Kharif	4.13	7.00	2.88
Green Gram	Kharif	3.00	4.00	1.00
Corn	Kharif	3.30	3.80	0.50
Linseed	Kharif	1.25	1.60	0.35
Wheat	Rabi	14.20	17.30	3.10
Barley	Rabi	17.00	20.00	3.00
Peas	Rabi	8.14	9.14	1.00
Mustard	Rabi	4.00	4.30	0.30
Chickpea	Rabi	4.00	5.00	1.00
Groundnut	Summer	Farmers Did not cultivate these crops	8	8.0
Vegetables	Summer		4	4.0
Black gram	Summer		2	2.0

Source: Author's own analysis of the primary data

Analysis on changes in the crop outputs in terms of average gross income and average net income in Rs/ acre are presented in Table 20 below. From the primary data analysis, it was observed that the average gross income had increased for all the crops. However, in the case of average net income, all crops have shown an increasing trend except for black gram in which the average net income decreased by Rs. 312 per acre. The main reason for the increase in the gross income is due to the increase in the market price of the main products (Rs / quintal) during post intervention when compared to the pre intervention. In addition to this, the overall quality and yield of the crops also improved from pre intervention scenario to post intervention scenario.

Table 20: Change in average gross and net income for different crops between pre and post conditions: Group Well

Crop Name	Season	Average Gross Income Rs/acre		Change in Gross Income (Post - Pre)	Average Net Income Rs / acre		Change in Net Income (Post - Pre)
		Pre	Post		Pre	Post	
Black gram	Kharif	11515	13830	2315	3854	3542	-312
Groundnut	Kharif	23083	30980	7897	16439	20535	4096
Green gram	Kharif	18000	26000	8000	12960	18750	5790
Corn	Kharif	6620	9040	2420	3194	4790	1596
Linseed	Kharif	9833	16333	6500	6608	11433	4825
Wheat	Rabi	26320	38060	11740	13285	22640	9355
Barley	Rabi	25500	36000	10500	15350	23500	8150
Peas	Rabi	36228	41428	5200	26878	30186	3308
Mustard	Rabi	15600	18400	2800	10084	11000	916
Chickpea	Rabi	18000	27500	9500	12175	19750	7575

Source: Author's own analysis of the primary data

6.5.6 Overall impacts of group wells

Overall, a marginal increase in the land holding was observed from the primary data analysis. Similarly, the cropped area also increased. However, the irrigated area in Rabi season increased by 28.5% post intervention (Group well) which can be a projected as a positive impact on the agricultural farms. In the case of summer crops, a small area was under irrigation post intervention. Increase in the input costs for all the crops was observed during post intervention scenario. The average gross and net incomes have increased for all the crops except for Black gram crop where the average net income decreased by Rs. 312/acre. The site photographs for the group well intervention is shown in Figure _ below.

Figure 19: Site Photographs of the Group Well, Mirchwara Village, Baar Block, Lalitpur District

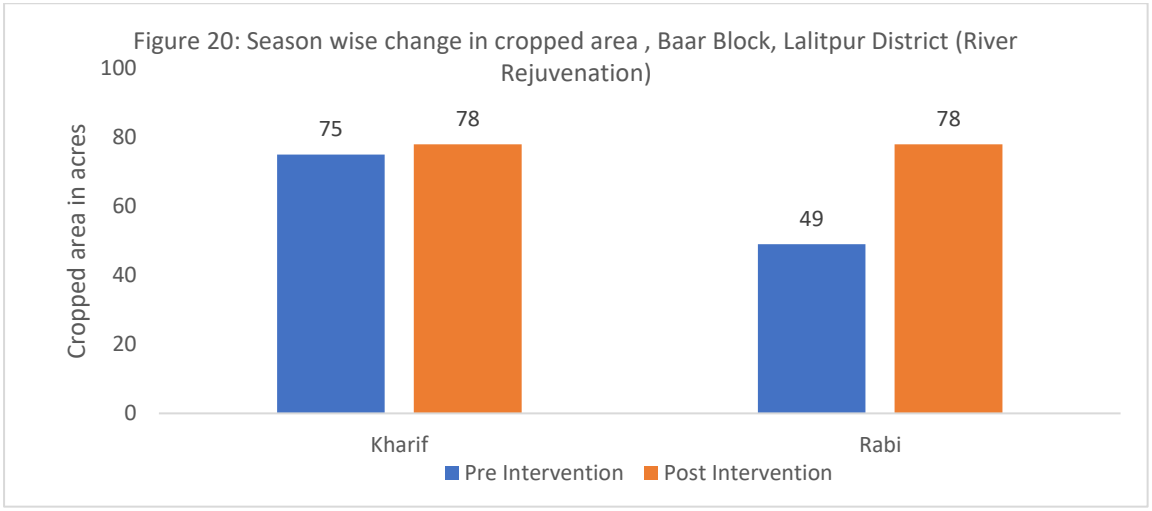
6.6 Rejuvenation of Streams and Rivers

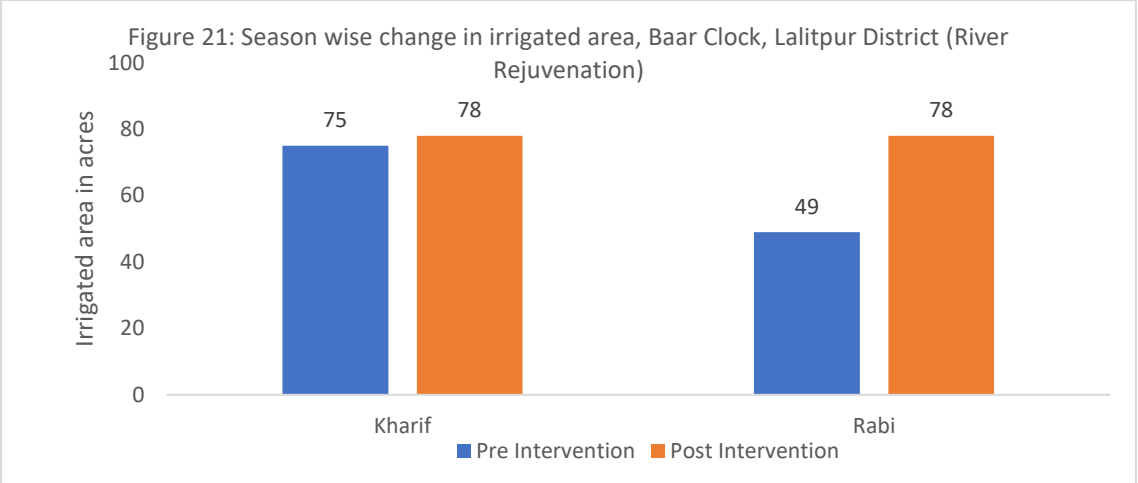
6.6.1 Changes in the Landholding

From the primary data collection and analysis, it was observed that the total landholding increased from 75acres in pre intervention to 78 acres in post intervention condition. One farmer in Mirchwara village has acquired an additional land of 3 acres which led to the overall increase in the landholding under this intervention. Additional land was acquired as sufficient water was available for irrigation for the crops.

6.6.2 Changes in Cropped and Irrigated Area (season wise)

Figure 20 below shows the change in the cropped area in Baar block of Lalitpur district in pre and post conditions of River Rejuvenation intervention. In Kharif, the cropped area increased from 75acres in pre intervention to 78acres in post intervention. The cropped area increased in rabi season by nearly 60% in post intervention. Similar trends were observed in the irrigated areas under kharif and rabi season as given in Figure 21 below.





6.6.3 Source of Irrigation and the water lifting devices details

Total irrigated area under well irrigation is 51acres with an average depth of well of about 34.3 ft. Similarly, the total irrigated area under river lift is nearly 26 acres and the average lift required 27.1 ft. All the farmers use diesel engines for irrigation. During winter season the average diesel consumption per day was 2.8 liters during pre-intervention. This has increased to 4.1 liters per day during post intervention. The main reason for this extra consumption of diesel is that the farmers are able to run the pump for more time due additional availability of water from both river lift and also individual wells during post intervention scenario.

6.6.4 Changes in the cropping pattern (season wise description)

Table 21 below gives the season wise change in the cropped area in pre and post conditions. The cropped area in groundnut, corn, wheat, peas and mustard increased by 80%, 50%, 78% and 50% respectively. The increase in the cropped area here may be linked to the water availability from the river which was rejuvenated by Bajaj Foundation. Similar trends were observed in the change in the irrigated areas under various crops in pre and post conditions of River Rejuvenation intervention. Table 22 below gives the season wise changes in the irrigated area in pre and post conditions.

Table 21: Season wise change in the cropped area in pre and post conditions

Crop Name	Season	Cropped Area (acres)		Change in cropped area (Post - Pre)
		Pre	Post	
Black gram	Kharif	59	59	0
Groundnut	Kharif	2.5	4.5	2
Sesame	Kharif	5.5	5.5	0
Soybean	Kharif	1	1	0
Corn	Kharif	6	7	1
Green gram	Kharif	1	1	0
Wheat	Rabi	39.5	59.5	20
Peas	Rabi	9.5	17	7.5
Mustard	Rabi	1	1.5	0.5

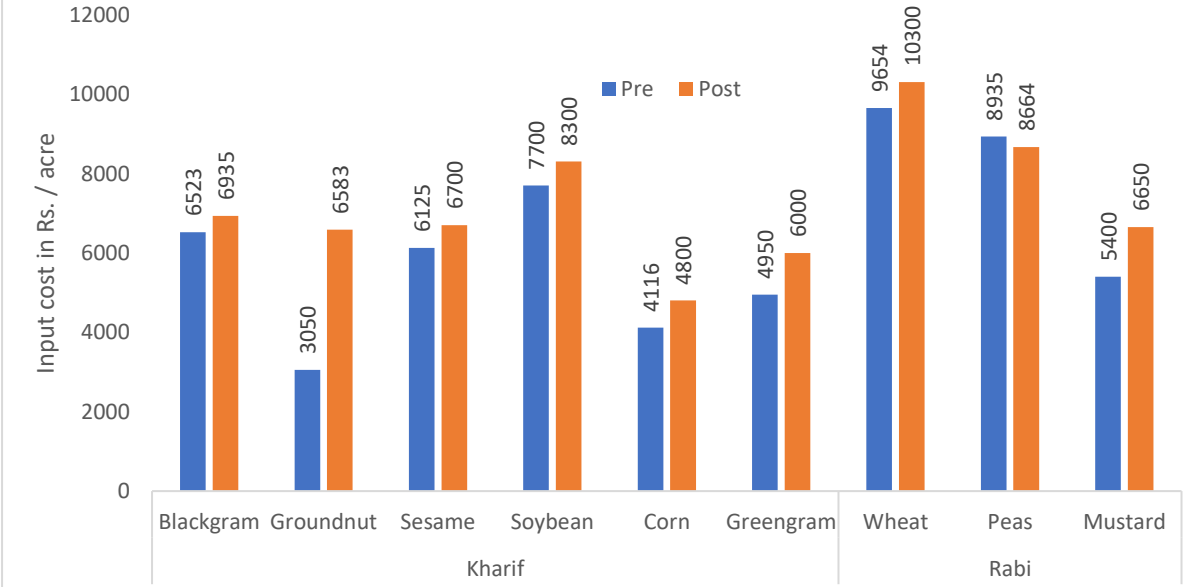
Table 22: Season wise changes in the irrigated area in pre and post conditions

Crop Name	Season	Irrigated Area (acres)		Change in irrigated area (Post - Pre)
		Pre	Post	
Black gram	Kharif	59	59	0
Groundnut	Kharif	2.5	4.5	2
Sesame	Kharif	5.5	5.5	0
Soybean	Kharif	1	1	0
Corn	Kharif	6	7	1
Green gram	Kharif	1	1	0
Wheat	Rabi	39.5	59.5	20
Peas	Rabi	9.5	17	7.5
Mustard	Rabi	1	1.5	0.5

6.6.5 Crop wise changes in the input costs per unit area

Figure 22 below depicts the change in the average input cost in Rs / acre. The input costs for all the crops were observed to be increase in the post intervention scenario due to increase in the labour charges and fertilizer and machine charges per acre. The average input costs for black gram, groundnut, sesame, soybean, corn, green gram, wheat and mustard increased by 6%, 116%, 9%, 8%, 17%, 21%, 7% and 23% respectively.

Figure 22: Average input cost of crops for pre and post conditions: River Rejuvenation



6.6.6 Crop wise changes in the outputs in terms of yield and income

Table 23 below gives the change in the yield of all the crops in pre and post conditions. The yield in terms of quintal / acre for black gram, groundnut, sesame, soybean, corn, green gram, wheat, peas and mustard increased by 23%, 29%, 100%, 40%, 57%, 33%, 29%, 43% and 50% respectively. The increase in the yield of all these crops may be attributed to the timely irrigation

in post intervention scenario and this was possible because of the river rejuvenation intervention supported by Bajaj foundation.

Table 23: Change in the yield in terms of quintal / acre in pre and post conditions

Crop Name	Season	Average Crop Yield in quintal / acre		Change in the Crop Yield (Post - Pre)
		Pre	Post	
Black gram	Kharif	4.4	5.4	1.0
Groundnut	Kharif	3.5	4.5	1.0
Sesame	Kharif	1.0	2.0	1.0
Soybean	Kharif	5.0	7.0	2.0
Corn	Kharif	2.1	3.3	1.2
Green gram	Kharif	3.0	4.0	1.0
Wheat	Rabi	14.5	18.7	4.2
Peas	Rabi	4.0	5.7	1.7
Mustard	Rabi	2.0	3.0	1.0

The gross and net income in all the crops increased in the post intervention scenario. Table 24 below give the change in the gross and net income in terms of Rs / acre in pre and post conditions of river rejuvenation intervention supported by the Bajaj Foundation. The gross income in black gram and ground nut increased by 39% and 43% respectively. Whereas the net income for the same crops increased by 59% and 29% respectively. The gross income for soybean, corn, green gram, wheat and peas increased by 58%, 75%, 44%, 57% and 79% respectively.

Table 24: Change in the gross and net income in terms of Rs/acre in pre and post conditions

Crop Name	Season	Average Gross Income Rs./Acre		Change in Gross Income (Post - Pre)	Average Net Income Rs./Acre		Change in Net Income (Post - Pre)
		Pre	Post		Pre	Post	
Black gram	Kharif	17500	24375	6875	10977	17440	6463
Groundnut	Kharif	15750	22500	6750	12700	15917	3217
Sesame	Kharif	8000	19000	11000	1875	12300	10425
Soybean	Kharif	16000	25200	9200	8300	16900	8600
Corn	Kharif	4766	8333	3567	650	3533	2883
Green gram	Kharif	18000	26000	8000	13050	20000	6950
Wheat	Rabi	26250	41250	15000	16596	30950	14354
Peas	Rabi	14400	25714	11314	5465	17050	11585
Mustard	Rabi	6000	12600	6600	600	5950	5350

6.6.7 Seasonal changes in the groundwater levels and availability due to the river rejuvenation

The river rejuvenation intervention increased the water availability across the seasons. The average depth to groundwater level increased by 3.6 feet in monsoon season. Whereas the average depth to groundwater level in rabi and summer seasons increased by 4.4 feet and 3.3 feet respectively. Figure 23 below shows the changes in the average depth to groundwater levels in monsoon, winter and summer seasons respectively. This increase may be linked to the river rejuvenation works which recharged the farmer wells as well.

Figure 23: Season wise average depth to GW in Pre and Post Scenarios: River Rejuvenation

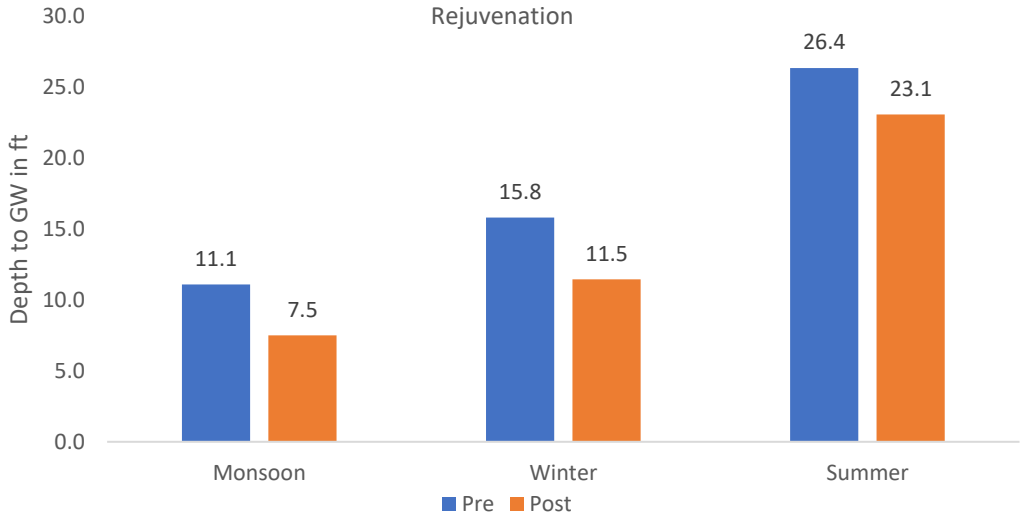
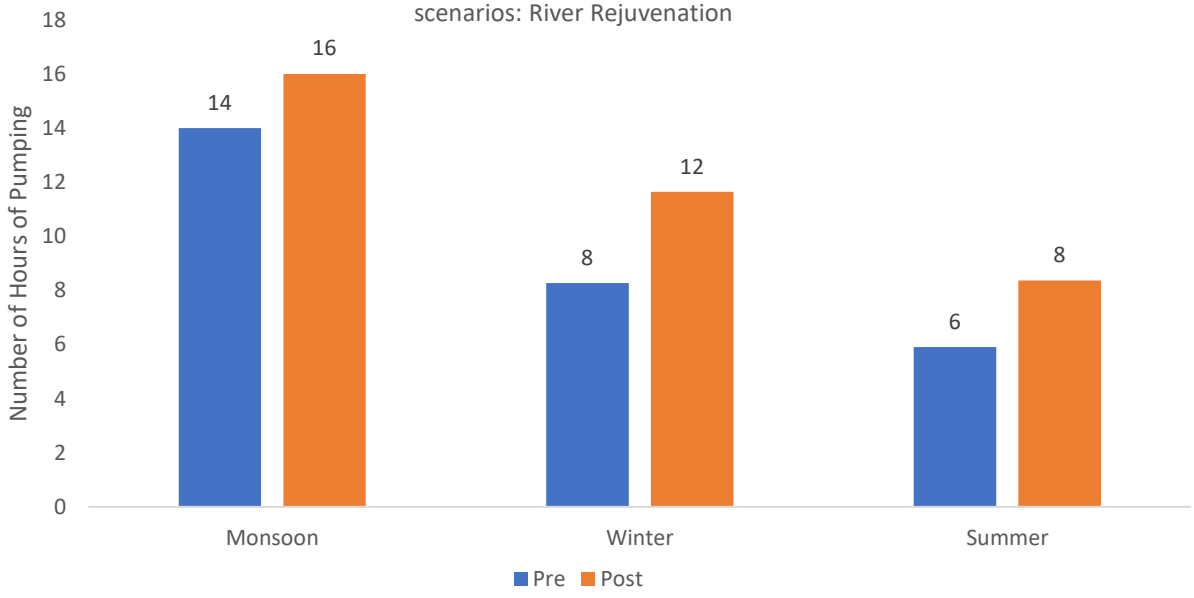


Figure 24 below depicts the increase in number of hours a well can run in a day in monsoon, rabi and summer seasons respectively. The additional hours a well can run in a day in monsoon, winter and summer seasons are 2, 4 and 2 respectively. This is due to the wells getting recharge from the rejuvenated rivers.

Figure 24: Season wise average number of hours a well can run in a day in pre and post scenarios: River Rejuvenation



6.6.8 Discussions on overall impacts

Overall, the river rejuvenation works carried out by LPGCL CSR through Bajaj foundation has led to increase in the cropped and irrigated areas as the river water recharged the wells. The assured water availability also led to timely irrigation to all the crops in required amount and the yield of all these crops also increased drastically. Even though the input costs in some crops increased in the post condition, the gross and net income from all the crops increased significantly. The farmer wells also received water from the river, which not only increased the water availability in all the seasons, but also the number of hours a well can run in a day.

6.7 Impact Natural Farming

In this section the change in the cropped and irrigated areas in pre and post conditions are explained. The changes in the yield of the crops, changes in the gross and net income from all the crops are also mentioned here in pre and post natural farming intervention.

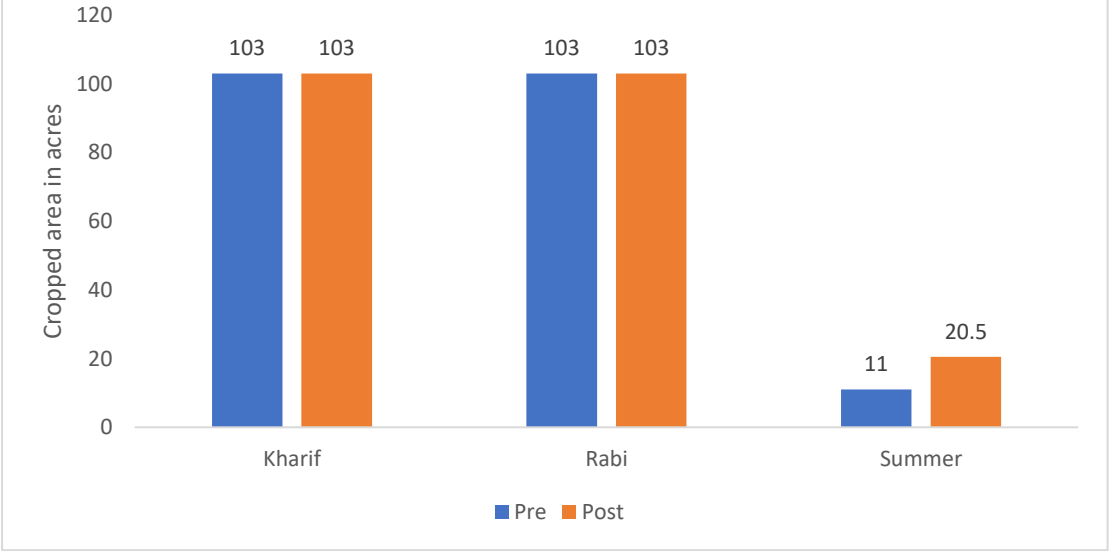
6.7.1 Changes in the Land holding due to promotion of Natural Farming

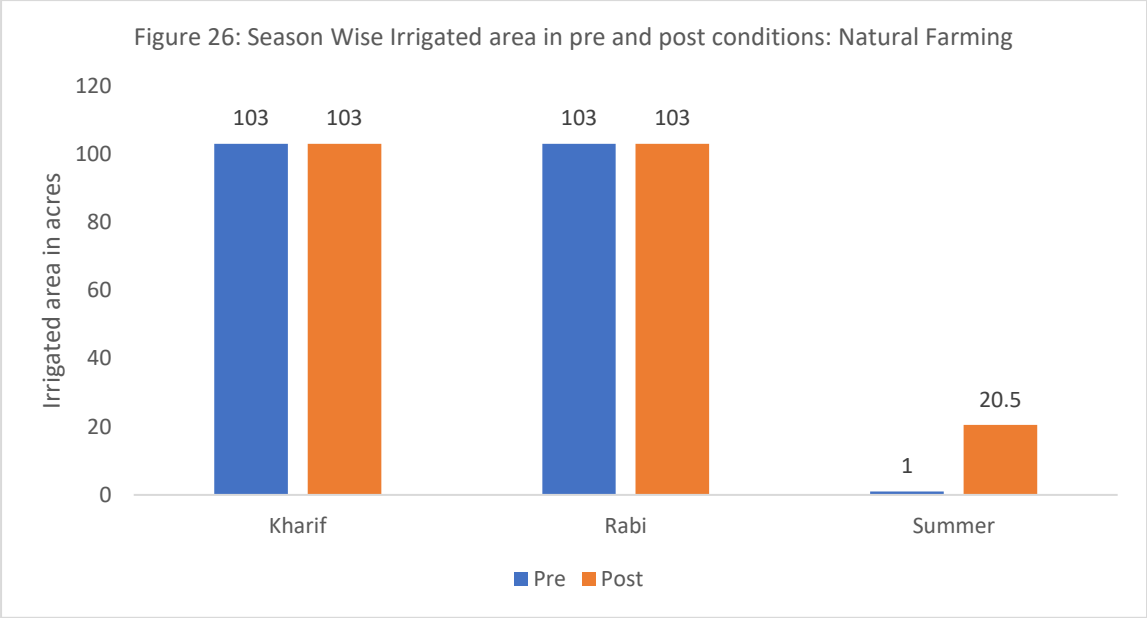
Total landholding of the 10 farmers surveyed was observed to be 106 acres in both pre and post scenarios of Natural Farming intervention. No change in landholding was observed as per the primary survey data. Farmers did not acquire additional land even after the intervention of natural farming.

6.7.2 Seasonal changes in the cropped and irrigated area

No changes in the cropped and irrigated areas were observed in kharif and rabi seasons respectively as shown in Figure 25 and 26 below. However, the cropped and irrigated areas in summer season increased significantly. The increase in cropped and irrigated areas may be linked to the natural farming practices where significant reduction in input costs are observe as mentioned in the upcoming sections.

Figure 25: Season Wise Cropped area in pre and post conditions: Natural Farming





6.7.3 Seasonal Changes in the cropping pattern

Table 25 below captures the changes in the cropped area for all the crops in pre and post conditions. The cropped area under vegetables is 8 acres in the post intervention and there was no cultivation of the same in the pre intervention scenario. Similar trends were observed in the irrigated area as given in Table 26 below.

Table 25: Season wise change in the cropped area in pre and post conditions

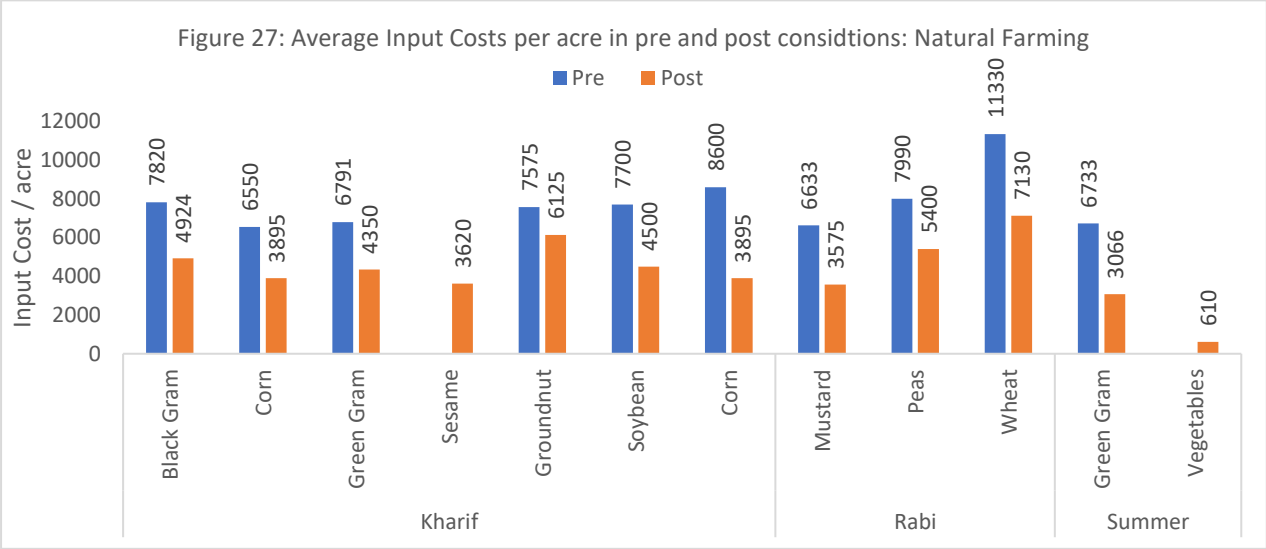
Crop Name	Season	Cropped Area in acres		Change in Cropped Area (Post - Pre)
		Pre	Post	
Black Gram	Kharif	82.5	80.5	-2.0
Corn	Kharif	1.0	2.5	1.5
Green Gram	Kharif	11.5	11.5	0.0
Groundnut	Kharif	2.0	2	0.0
Soybean	Kharif	3.0	3	0.0
Sesame	Kharif	0.0	1.5	1.5
Mustard	Rabi	10.0	10	0.0
Peas	Rabi	14.5	12	-2.5
Wheat	Rabi	78.5	78.5	0.0
Green Gram	Summer	8.0	9	1.0
Vegetables	Summer	0.0	8	8.0

Table 26: Season wise change in irrigated area in pre and post conditions

Crop Name	Season	Irrigated Area in acres		Change in Irrigated Area (Post - Pre)
		Pre	Post	
Black Gram	Kharif	82.5	80.5	-2.0
Corn	Kharif	1.0	2.5	1.5
Green Gram	Kharif	11.5	11.5	0.0
Groundnut	Kharif	2.0	2	0.0
Soybean	Kharif	3.0	3	0.0
Sesame	Kharif	0.0	1.5	1.5
Mustard	Rabi	10.0	10	0.0
Peas	Rabi	14.5	12	-2.5
Wheat	Rabi	78.5	78.5	0.0
Green Gram	Summer	8.0	9	1.0
Vegetables	Summer	0.0	8	8.0

6.7.4 Comparison of Crop wise input costs pre and post intervention

The crop wise input cost for all the crops reduces drastically as farmers not using fertilizers, chemicals and pesticides in the post intervention condition. LPGCL under CSR supported these farmers through Bajaj Foundation for natural farming practices where the farmers used '*jeewamrut, beejamrut, dashparni ark'* etc. and other natural farming materials.



6.7.5 Changes in crop wise outputs in terms of yield and income generated

Table 27 below depicts the change in the crop yield for all the crops in pre and post conditions of natural farming. Due to the practice of natural farming, the yield of black gram, corn, green gram, groundnut, soy bean, mustard, peas, wheat and green gram increased by 15%, 25%, 9%, 43%, 40%, 15%, 29%, 22% and 20% respectively. The main reason for this in the post intervention scenarios is increase in the soil fertility due to natural farming practices and non-usage of chemical and fertilizers which other wise reduce the fertility of soils over the years.

Table 27: Change in the crop yield in quintal / acre in pre and post conditions

Crop Name	Season	Average Crop Wise Yield in Quintal / acre		Change in Yield (Post - Pre)
		Pre	Post	
Black gram	Kharif	4.8	5.5	0.7
Corn	Kharif	8.0	10.0	2.0
Green Gram	Kharif	4.6	5.0	0.4
Groundnut	Kharif	3.5	5.0	1.5
Soybean	Kharif	5.0	7.0	2.0
Mustard	Rabi	6.5	7.5	1.0
Peas	Rabi	6.6	8.5	1.9
Wheat	Rabi	14.2	17.3	3.1
Green Gram	Summer	5.0	6.0	1.0
Vegetables	Summer	0.0	4.5	4.5

Table 28 below shows the increase in the gross and net income in all the crops in pre and post conditions of the intervention of natural farming. The gross income in black gram, corn, green gram, groundnut, soy bean, mustard, peas, wheat and green gram increased by 30%, 39%, 15%, 59%, 58%, 31%, 59%, 41% and 38% respectively. Similarly, the net income for all these crops also increased significantly as mentioned in Table 28 below.

Table 28: Cahnge in the gross and net income in terms of Rs / acre in pre and post conditions

Crop Name	Season	Average Gross income / acre		Change in Gross Income (Post - Pre)	Average Net income / acre		Change in Net Income (Post - Pre)
		Pre	Post		Pre	Post	
Black gram	Kharif	26560	34500	7940	18740	29576	10836
Corn	Kharif	14400	20000	5600	7850	16105	8255
Green Gram	Kharif	30083	34666	4583	23292	30316	7024
Groundnut	Kharif	15750	25000	9250	8175	18875	10700
Soybean	Kharif	16000	25200	9200	8300	20700	12400
Mustard	Rabi	28600	37483	8883	21967	33908	11941
Peas	Rabi	31466	49950	18484	23476	44550	21074
Wheat	Rabi	27840	39360	11520	16510	32230	15720
Green Gram	Summer	32500	45000	12500	25767	41934	16167
Vegetables	Summer	0	9140	9140	0	8530	8530

6.7.6 Overall Impacts of Natural farming

Overall impacts of natural farming are significant in terms of yield, gross and net income as the inputs costs have reduced drastically as the farmers were not using any fertilizers, chemicals or pesticides in the post intervention condition.

7 Impacts of all other interventions

In this section the non-land interventions implemented, and their impacts are discussed in details for both Wardha and Lalitpur districts.

7.1 Wardha District:

7.1.1 Gram Panchayat organization Development (GPOD)

Bajaj Foundation, Mission samruddhi and Anode Governance Lab, Bengaluru jointly run the GPOD project with main focus on capacity building of Gram Panchayat members and Gram Sabha for developing visionary plan for sustainable village development with inclusion of all sections of the community, ultimately leading to Attmanirbhar villages with self-sustained economy. This work had spread across 15 villages in Seloo, Deoli and Wardha blocks. This is a 2.5 years project which has been divided into 4 phases as following:

Phase-I – Context and Enrolment: This phase includes legal framework study, developing memorandum of understanding with selected Gram Panchayats, Gram Panchayat Profiling, Identifying and working on quick wins.

Phase-II – Diagnosis and Reflection: This includes mainly Organization Mapping

Phase-III – Design, Planning and Operation: This phase mainly includes development of Vision and Mission of Gram Panchayat and Gram Panchayat Structure.

Phase-IV – Handholding Implementation: Phase – IV includes handholding, planning, budgeting and implementation.

Following GP profiling, Gram Panchayat members reflected on their understanding of the role and power of being an elected representative. This process helps to forge relationships with elected members of Gram Panchayats and to gain an understanding of the Gram Panchayat eco-system, which includes gathering information about various projects and getting to know the community and opinion makers that impact the village's overall culture and development. This has helped members to be more self-aware of his or her strengths and sense of being part of an institution. The interactions positively changed the attitude of the member to instigate thought to plan relevant activities in their respective ward. Similarly, the identify the scope for improvement led to categories the area into short term improvement i.e. quick wins and long-term improvements.

In this project, Bajaj Foundation implemented organization mapping process with GP members. Initially, about 75% of the GP members reported that they were not aware of Panchayati Raj Act in detail. However, after imparting training and organizing workshops about this project, the GP members gained sufficient knowledge on the same.

Table below enumerates the progress and the Impact made over the years under various parameters:

S. No	Parameters	Dec-21	Jan- Aug 22	Jan to June 2023	July 23- March-24
1	Regularity in monthly meetings	NO- 35%	YES – 50%	YES – 60%	Yes-80%
2	% of male members who attend monthly GP meetings	30%	40%	55%	65%
3	% of women members who	35%	45%	60%	70%

	attend monthly GP meetings				
4	Secretary shares the monthly income and expenditure	NO	YES- Almost	Yes – quality of the shared data to improve	Yes – quality of the shared data to improve
5	Ward members organizing ward level meeting	NO	YES	31% of the ward members have conducted ward level meetings	50% of the ward members interested in ward meeting
6	Standing committees are formed	NO	NO	NO	Yes (15)
7	Standing committees are active	NO- 1 Village Health Standing Committee is active	NO	NO	15- Agri standing Committee, 10- Health standing Committee, 8- Educational standing committee
8	Special Gram Sabha being conducted	NO	NO	Only Jan 26th and May 1st in some GPs	31- Jan-2024 for election campaigning
9	Collaboration with Block departments	NO	NO	Still not prevalent	Some linkage is built with Block Departments now
10	Funds leveraged from government schemes (state and centre)	No information	No	To be tracked	MLA funds of about Rs. 1.75 crore, from the MLA in 15 villages.

Figure 28: Training and Workshops being Organized to the GP members

Impact Case Study of GPOD in Junona Village, Seloo Block, Wardha District: Junona is a village in Seloo block located in Wardha District. This Gram Panchayat was formed after the 2019 elections. This entity has 10 members out of which 5 are women members. Initially when the Panchayat coordinator approached the Sarpanch of the Village, he did not show any interest in the GPOD

project intervention. A meeting was also organized at the Gram Panchayat office, in which the response was very low with only 30%-member participation. Subsequently the Panchayat Coordinator changed the strategy and met all the members separately in person and discussed about the project. Interestingly the Women GP members had shown keen interest in this project intervention and their voices were found quite promising. Interactions of the panchayat coordinator made the members aware of their roles and responsibilities. Subsequently the Women members became active in the Gram Panchayat meetings. They further developed interest in the objectives and benefits of Gram Spandan (GPOD) and also got convinced and signed the MOU. The Women Gram Panchayat members took the initiative of organizing meetings and explaining the details of GPOD to the remaining members which was a success in the end.

Figure 29: Photograph capturing the Gram Panchayat Meeting

7.1.2 Chaff Cutter and Agricultural Equipment Support

The Bajaj Foundation through LPGCL CSR supported 217 beneficiaries for purchasing agricultural equipment, including chaff cutters, seed drillers, rotavators, ploughs, harrows, and cultivators. These beneficiaries are from 151 villages across 8 blocks in the Wardha district. The financial assistance aimed to enhance agricultural productivity and efficiency, reduce costs, and improve the livelihood of farmers. Data was collected through personal interviews and focus group discussions (FGDs) with the 217 beneficiaries. A stratified random sampling method ensured representation from each of the 8 blocks and various types of equipment. Both quantitative and qualitative data analyses were employed.

The support provided by the Bajaj Foundation had a significant economic impact on the beneficiaries. In terms of cost saving, each piece of agricultural equipment with a price of Rs. 30,000/- the farmers received 10% subsidy from the foundation. This reduced the financial burden on the farmers to a great extent. There was also reduction in labour cost by using the agricultural equipment. Traditionally farmers spent around Rs. 2000 per acre on labor and with the agricultural equipment, the cost has reduced to Rs. 1500 per acre. There was a direct saving of Rs. 500 per acre. With 217 farmers directly getting benefit from this support, the equipment was also made available for additional 600 farmers and collectively cultivating nearly 2500 acre of land. The total savings accounted to nearly Rs. 12.5 lacs.

The use of chaff cutters reduced fodder waste by 10-15%. Animals consumed the chaff fodder completely, further reducing wastage by an additional 10%. Agricultural equipment like seed drillers and other tractor-driven tools significantly reduced the time required for various farming

activities. The cost savings and increased efficiency allowed farmers to reinvest in their farms and improve their living standards. The benefits extended beyond the direct recipients, as the equipment was shared among neighbouring farmers, enhancing the overall agricultural productivity.

A farmer from a Block reported a 15% reduction in fodder loss after acquiring a chaff cutter. This efficiency led to healthier livestock and reduced feed costs. Another beneficiary from another Block used a seed driller, which reduced the planting time by half and ensured uniform seed distribution, resulting in a higher crop yield. By reducing labor costs, increasing efficiency, and improving fodder management, the initiative has paved the way for more sustainable and profitable farming practices in the Wardha district.

Figure 30: Agricultural Equipments supported to the farmers

Figure 31: Focus Group Discussion-FGD with the beneficiaries

7.1.3 Promotion of Indigenous Cow

During the financial year 2023-24, Bajaj Foundation through LPGCL CSR supported 321 beneficiaries for purchasing indigenous cows. The indigenous cow breeds include Geer, Sahiwal, Gaulao, and Tharparkar from 236 villages and 8 blocks in Wardha District. The cost of each cow varied between Rs. 30,000 to 1,00,000. Some of the farmers got the financial support from NDDB Govt agency and 321 farmers got 10% financial support from KJBF.

In order to understand the impact of this support, a focus group discussion was organized with farmers who were directly benefitted. During the discussions it was understood that from a single cow about the average milk production was 4 to 10 liters in a day for at least 7 to 8 months. On an average each family was able to earn a net income of Rs. 4000 to 5000 per month. The Bajaj Foundation's support for indigenous cow purchasing has positively impacted the economic, social, and environmental well-being of farmers in Wardha district. By providing financial assistance and supporting sustainable agricultural practices, the initiative has contributed to improved income stability, enhanced community cohesion, and environmental sustainability.

Figure 32: Supported Indigenous Breed of cows

7.1.4 Rural Godown in Madani Village

A rural godown with a capacity of 100MT was established in Madani Village in Wardha Taluka and District. Bajaj Foundation contributed a grant of Rs. 2.0 lacs, PoCRA Project supported with a grant of Rs. 12.0 lacs and FPO contributed nearly Rs. 6.0. lacs. The total cost of the project was nearly Rs. 20 lacs. Expected beneficiary farmers under this support are nearly 150 farmers per year. The discounted rate of shareholder farmer is about Rs. 10 / quintal per month. The expected annual profit from this is about Rs. 1.2 lacs. The additional benefits from storage include increased sale price of stored produce which is nearly Rs. 2.00 lac per season and there is also a potential for 70% pledge loan against stored commodity.

Economic Impact: The discounted storage rate for shareholder farmers (50% of Rs. 20/qtl per month) leads to considerable savings. For example, storing 10 quintals for a month would cost Rs. 100 in the rural godown compared to Rs. 200 in a private godown, saving Rs. 100. At full capacity, the godown will generate an annual profit of Rs. 1.20 lakh. This profit can be reinvested into the FPO for further development or distributed among shareholders. Farmers can sell their produce 2-3 months post-harvest when prices are higher. Assuming an increase of Rs. 200 to Rs. 300 per quintal, storing 100 MT can potentially generate an additional Rs. 2.00 lakh per season (100 MT * Rs. 2000/MT).

Social Impact: The godown supports 150 farmers, allowing them to store their produce safely and reduce post-harvest losses. The FPO-led initiative fosters a sense of community ownership and empowerment, encouraging more farmers to join and benefit from collective initiatives.

Environmental Impact: Secured storage helps reduce wastage of agricultural produce, contributing to better resource utilization and food security.

The establishment of the rural godown in Madani Village implemented by the Warda Shetkari Utpadak Producer Company Ltd is a pivotal project with significant benefits for the local farming community. The godown provides cost-effective storage solutions, enhances the sale price of produce, and generates additional revenue for the FPO. By addressing economic, social, and operational aspects, the project promotes sustainable agricultural practices and strengthens the local economy. Proper awareness, maintenance, and management are essential for maximizing the benefits and ensuring the long-term success of the initiative.

Figure 33: Rural Godown in Madani Village

7.1.5 Silage Bales Making Unit

The Bajaj Foundation, with financial support from the National Dairy Development Board (NDDB), established the Suchara Fodder Farmer Producer Company Ltd (Suchara FPO) on April 18, 2023. With 750 farmers as shareholders, the FPO raised an equity amount of ₹10 lakh and received an equity matching grant of ₹10 lakh from NDDB. The primary focus of Suchara FPO is on fodder crops, specifically the cultivation and processing of multicut sorghum (Mega Sweet). The table below depicts the details of the intervention.

Table: Details of the Intervention

Financial Contribution and Setup	
Equity Raised by Farmers	Rs. 10 Lac
Equity Matching Grant	Rs. 10 Lac
Total Equity	Rs. 20 Lac
Cost of Silage making unit and storage shed (3600 sq. ft)	Rs. 25 Lac
Support from Bajaj Foundation	Rs. 2.68 Lac
Net investment for silage Unit setup	Rs. 22.32 Lac
Cultivation and Production	
Kharif	Cultivated 50 acres of multicut sorghum, producing 29 MT of green fodder
Summer Season	Cultivated 50 acres of Mega Sweet sorghum involving 27 farmers
Silage Production (April to May 2023)	
No of Silage Bales	4301
Total Weight	226MT
Benefits and Impacts	

Extended Shelf Life	Silage bales can be stored and used for up to 18 months, ensuring fodder availability during scarcity
Increased Milk Production	Feeding silage to milch animals can increase milk production by 10% to 15%
Cost Savings	Reduced concentrate feed cost by ₹100 per animal
Economic and Social Impact	
Income Generation	
Increased Milk Production	Assuming a conservative 10% increase in milk yield, farmers will have higher income from milk sales
Cost Savings	With reduced feed costs, farmers will have lower expenses, contributing to better profitability
Fodder Security	Ensuring a reliable supply of quality fodder through the year, especially during off-seasons or periods of drought, mitigates risks associated with fodder scarcity
Community Empowerment	The initiative encourages community participation and ownership, fostering a sense of empowerment among the farmers; and with 750 farmers as shareholders, the FPO promotes cooperative principles and mutual support
Sustainability	By producing and storing silage, the FPO promotes sustainable agricultural practices, ensuring efficient utilization of fodder crops

The establishment of the silage making unit by Suchara FPO has significantly benefited the farmers by enhancing fodder availability, increasing milk production, and reducing feed costs. These initiatives contribute to increased income, improved fodder security, and sustainable agricultural practices, positively impacting the economic and social well-being of the farming community. The support from NDDB and the Bajaj Foundation have been instrumental in achieving these outcomes, demonstrating the effectiveness of collaborative efforts in rural development.

Figure 34: Fodder Silage Bales Making Machine & Support Equipment established at Dhanoli village Ta. Karanja Dist. Wardha

Figure 35: Pictures from Dhanoli Village

7.1.6 Design for change (DFC)

Design for Change (DFC) is an initiative that empowers children to envision a better world and take action to make it a reality. Through the four-step process of Feel, Imagine, Do, and Share, students slow down to understand situations, brainstorm solutions, take timely action, and cultivate an abundance mentality. This initiative fosters confidence, character development, and life skills such as independence and empathy among children, unveiling their hidden potential while bringing smiles and happiness to their lives.

Figure 36: Digital Interactive Boards provided to Schools in Wardha

As a part of Corporate Social Responsibility, Bajaj foundation conducted various activities like teachers training for DFC concepts, DFC I can schools' students and teachers gathering, provided 58 Digital interactive learning boards to schools and computers to schools. As a result of this, 4,575 students from 111 villages have been benefitted. Also, Bajaj foundation have trained 75 teachers in the concepts of DFC from 75 schools from all the eight blocks of Wardha district. DFC Program is very effective in providing good education and enable students to become successful, and this program is a medium to inculcate courage in children and brings long term positive change in the Society.

7.1.7 Crop Cultivation with Rain Pipe

Under this initiative Bajaj foundation had supported 1750 farmers with rain pipes which are used for irrigation of vegetables crops. As a result of rain pipe support 1750 acres of farming land brought under vegetable cultivation by farmers in 315 villages of eight blocks of Wardha district.

Impacts and benefits of using rain pipes:

1] Efficient water use: Rain pipes conserve water by delivering it directly to the roots, significantly reducing wastage.
2] Reduced Labor: Automation in irrigation minimizes the need for manual watering, saving time and labor.
3] Consistent water supply: Provides a regular and even distribution of water, promoting healthier crop Growth.
4] Prevention of Soil Erosion: Direct water application helps prevent soil displacement, maintaining

soil Integrity.

5] Suitable Crops: Ideal for crops with a height of 1 to 2 feet, such as vegetables, gram, and early-stage Wheat.

6] Rain effect: Irrigation with rain pipes simulates rainfall, which is beneficial for crop growth, and Proper irrigation can enhance crop health and increase yields.

7] Cost-effective: Support from the Bajaj Foundation makes rain pipes affordable for farmers.

8] Portability: Rain pipes are easy to install and can be conveniently shifted from one plot to another.

Figure 37: Farmer using rain pipe for irrigation

7.1.8 Natural Farming Kisan Pathsala

To promote natural farming, farmer to farmer training on the natural farming techniques were organized with the help of Bajaj foundation in 436 villages, where nearly 599 Kisan Pathsala were successfully completed. In about 8 blocks in Wardha district, nearly 14975 farmers were imparted hands-on training on the Natural Farming Practices.

Figure 38: Farmers attending the Kisan Pathsala

Natural farming techniques including Jiwamrit, Bijamrit, Dashparni Arka and Agniastra were trained to the farmers during the Kisan Pathshala. During the FGD, it was learnt that farmers are now aware of how these natural farming techniques need to be implemented in the farms. It was also revealed that success stories of natural farming techniques were discussed with other farmers in order to gain confidence. The experienced farmers with knowledge on these techniques were involved in field trips along with other farmers to practically impart the Natural Farming techniques.

7.1.9 Promotion of Millets Cultivation

Promotion of Millets like Sorghum were promoted among the farmers under Natural Farming. Under the natural farming initiative, Bajaj Foundation had promoted Sorghum with 469 farmers spread across 77 villages of all the eight blocks in Wardha district. Bajaj foundation had supported seeds to these 469 farmers covering about 235 acres of farming land under millets.

Figure 39: Farmer Cultivating Millets

Climate resilience is the main reason for promoting millets under Natural Farming. The other advantages of cultivating millets include low input costs, improved soil fertility, increasing market demand for millets as people have become health conscious. In this way, promotion of millets has positive impact in overall development of farmers.

7.1.10 Forestry Plantation

During the financial year 2023-24, Bajaj foundation distributed total 30527 plants of 10 species among 47 villages of 8 blocks which include, custard apple, Aonla, Jamun, Neem, Wad, Pipal, bamboo, Bakul, Karonda, and Kadamb. School children, farmers and social worker, across 43 schools, 8 Gram panchayat and 3 local NGO were involved in the forestry plantation programme which was crucial for environmental sustainability and community engagement.

This initiative not only promoted environmental conservation but also educated and engaged school children in sustainable practices. Here 10 types of plants were selected for their ecological benefits and suitability to the local environment. This project not only enhances biodiversity and ecosystem services but also instils a sense of environmental responsibility and community ownership among school children. Through hands-on participation in tree planting and maintenance, the initiative aims to foster a greener, healthier future for the nation. Forestry plantation is essential for maintaining ecological balance, supporting livelihoods, enhancing resilience to climate change, and improving overall quality of life. It represents a proactive measure in addressing global environmental challenges and securing a sustainable future.

Figure 40: School children actively participating in the plantation program

7.1.11 Solar pumps for irrigation (3HP and 5HP)

Bajaj Foundation supported Farmers with 89 solar pumps of 3HP capacity each in about 62 Villages. Similarly, about 87 solar pumps of 5 HP capacity each were given to the farmers in 59 villages. As a result, with the support of these solar operated pumps, 658 acres of rainfed farming land was brought under irrigation in eight blocks of Wardah district. The government has now subsidised the solar irrigation system for the farmers making it affordable even for small and marginal framers. The role played by Bajaj Foundation in promotion of this scheme is unique in converging farmers facing the challenge of creating irrigation facilities and making the farming systems energy sufficient. Bajaj Foundation funded the beneficiary for his contribution in converging the government scheme.

Figure 41: Beneficiaries with Solar Pumps

The impacts of this intervention are as follows:

Cost saving – About Rs. 6000 on diesel and electricity expenses were saved due to this intervention. The substantial reduction in operating expenses not only lessened the financial strain, but also allowed the farmer to allocate resources towards other critical aspects of farming operations, ultimately enhancing the productivity and profitability.

Increased income – The installation of these solar pumps led to a remarkable increase in farmer's income. With a reliable water supply, the crop yield improved by 30%, enabling the farmer to grow three crops per year instead of just one per family. This significant boost in agricultural productivity added Rs. 60,000 to the Farmer's annual income per beneficiary.

Environmental Impact – About 4000 KWh of electricity per year was saved which would have been otherwise used for electrical pump sets. This energy saving equates to the reduction of around 4 metric tons of CO2 emissions annually, assuming 0.8 kg CO2 per kWh of electricity generated from fossil fuels.

7.1.12 Marketing Support to Produce under Natural farming:

Under the marketing initiatives Bajaj foundation had supported about 410 farmers to initiate their marketing points at village, block and district levels. This has boosted the farmers confidence in selling their Agri-produce. Supports like campaign umbrella with display materials, weighing scale, packing machines, etc. were provided to these farmers. Farmers also appreciated this support and are able to save on transportation and storage as well.

Figure 42: Farmer Selling the Agriculture produces

7.1.13 Support to Needy families for strengthening their livelihood:

SN	No. of family member	No. of Beneficiary			Expenses 2023-2024			Total
		Education	Medical	Upliftment	Education	Medical	Upliftment	
1	2500	17	2	456	487000	52500	11395000	11934500

During the fiscal year 2023-24, Bajaj foundation on behalf of Lalitpur Power Generation Company limited (LPGCL) have helped the needy 475 families to strengthening their livelihood, Freaching a total of 2,500 family members. This support spanned across 24 states and 35 districts, including 40 cities within India.

Support for Daily Needs:

Bajaj Foundation on behalf of LPGCL have extended support to 456 families to meet their immediate daily needs, primarily focusing on groceries and house rent. The total expenditure for this support amounted to ₹1,13,95,000.

Support in Education:

Seventeen families received support for educational expenses. This included the purchase of books, stationery, school fees, uniforms, and bicycles for students. The total amount spent on educational support was ₹4,87,000.

Support in Medical Treatment:

Bajaj Foundation on behalf of LPGCL provided medical support to two families. One family member was suffering from a lung ailment, while another was dealing with a heart condition. The total amount provided for medical treatments was ₹52,500.

7.2 Lalitpur District:

7.2.1 Infrastructure Development

As a part of CSR activities, Bajaj Foundation on behalf of LPGCL helped in infrastructure development in Udaipura Village, Barr Block, Lalitpur district. During the focus group discussions with the residents of Udaipura village, consolidated feedback was collected regarding various infrastructure development interventions and to understand the impacts of the same. The infrastructure development interventions at a glance are presented in the Table below.

Table: Infrastructure development at a glance, Udaipura Village, Barr Block, Lalitpur district

S. No	Activity	Unit	Cumulative Progress
1	Construction of biogas plants	No	40
2	Construction of Crematorium	No	4
3	School Renovation/Digitization	No	16
4	Construction of Kartik Ghat (bathing Ghat)	No	2
5	Mandir Renovation	No	16
6	Mobile Dispensary (Health Camp)	No	490
7	Construction of Road	KM	10.8
8	Installation of Solar Light	No	10
9	Community Assets (Community Training Center, Culvert)	No	2
10	Stadium Play Ground Development	No	1
11	Temple Support Items	No	10
12	One Color House White Wash (Burogaon)	No	1

Source: Information collected at the time of FGD with the Residents of the Udaipura Village

The following table illustrates the consolidated feedback received from the respondents / residents of the Udaipura Village.

Table: Consolidated Feedback on Infrastructure Development

Intervention	Benefits /Impact
Renovation of School Building	The condition of the government schools in the village was not very good and this adversely affected the academic activities. The situation became even worse during the rainy season. On the request of the school management and parents of the students, Bajaj Foundation renovated and upgraded 4 government schools, creating safe and comfortable teaching-learning environment/facilities for 360 students from 3 villages.
Construction of Road	Due to the poor condition of the roads inside the village, pedestrians and animals had to face a lot of inconvenience. This problem becomes even more severe during the rainy season. On the request of the villagers, Bajaj Foundation built 2 cement-concrete roads, which has provided a lot of relief.
Construction of Crematorium	A community crematorium has been constructed in the village by the Bajaj Foundation which is a good thing as it had developed the infrastructure required for cremation

Renovation of Temple	The temple in the village has been renovated by Bajaj Foundation, which has created a good arrangement and favourable environment for worship and other religious-cultural activities for the people of the area.
Revival of Pond	The villagers were not able to take advantage of the ancient pond located in the village due to the accumulation of silt for years. On the repeated requests of the villagers, Bajaj Foundation deepened the pond with the active participation of the villagers and renovated and expanded it by removing the silt. Benefits included 1] Water storage capacity of the pond has increased unprecedentedly; 2] Drinking water has become available for humans and cattle throughout the year; 3] Increased direct irrigation from pond; 4] The water level of 40 wells in the downstream area has increased by 5-7 feet, which has increased the agricultural area, increased production and promoted crop diversification.
Health Camp (Mobile Dispensary)	Bajaj Foundation organizes health camps through mobile dispensary with the aim of providing community health services, so that villagers can get health facilities near their homes. This is very much beneficial for the villagers. Apart from this, training and awareness activities on health and hygiene are also conducted by Bajaj Foundation from time to time

The following Figures depict the FGD activity with the Udaipura Village residents about the infrastructure development.

Figure 43: Focus group discussions on Infrastructure Development - Udaipura Village

Figure 44: Resident of Udaipura Village sharing his views during the FGD

7.2.2 Supporting the Farmer Groups by distributing Diesel Engines

A focus group discussion was organised in Semra Bhagnagar Village, Barr block in Lalitpur district. The main purpose of the discussion was to understand the impact of Diesel Engines in terms of irrigation of the agricultural fields. Due to erratic power supplies, lack of power supply connections in the agricultural fields, the farmers could not irrigate their agricultural fields. This affected the agricultural production and the farmers had to depend on others. Bajaj foundation had distributed diesel engines to 5 farmer groups in this village. Bajaj foundation had contributed 50% of the total cost and remaining 50% by the group of farmers. In total 80 farmers got benefitted from this intervention. Nearly 15 – 20 acres of land was brought under irrigation with the help of one diesel pump set. The Table below illustrates the change in the cropping pattern due to the intervention. It is evident from the table below that more crops have come under irrigation post intervention.

Table: Change in the Cropping Pattern

Season	Pre-Intervention	Post-Intervention
Kharif	Black Gram, Maize	Black Gram, Groundnut, Sesame
Rabi	Wheat, Chickpea	Wheat, Green Pea, Chickpea, Vegetables
Summer	-	Vegetable, Green Gram

The following are the benefits of group diesel engine:

1] Easy access of water from the irrigation source to the field is made possible.
2] Timely irrigation is made possible.
3] By evenly distributing water from wells and water sources to the fields, these pumps provide ideal moisture for crop growth.
4] No dependence on others. No rental expenses
5] Increase in irrigated area
6] Increase in crop area
7] Improvement in crop yield and profitability

8] Crop diversification

Figure 45: Group Diesel Engine Semra Bhagnagar Village, Barr Block, Lalitpur District

7.2.3 Community Mobilization

Under the intervention 'Community Mobilization', nearly 200 farmers have participated from 5 villages. Picture below depicts Community health awareness camp at Buragaon Village in Lalitpur district. Bajaj Foundation had organized meetings, trainings and workshops to these farmers. Community training on health & sanitation under NABARD support Wadi Development Project was organized at village Burogaon. Bajaj Foundation had distributed Filter/ Strain and Mugs to the participants and explained the importance of safe drinking water.

Figure 46: Community Health Awareness Camp organized at Buragaon Village, Lalitpur

Meetings were also organized with Women SHG as seen in Figure 47 below. The farmers who attended the Kisan Pathsala (See Figure 48) were also trained on Natural farming techniques, soil and water conservation and Horticulture.

Figure 47: Interaction with the Women SHG

Figure 48: Kisan Pathsala- 'Farmer to Farmer agriculture extension' on Natural Farming techniques

8 Findings and Conclusions

Findings from Wardha District:

1] Due to the **construction of check dams**, the cropped and irrigated areas have increased as there was assured water availability for irrigation. Even though the input costs per acre increase, the increase in the yield of crops have led to increase in the gross and net income per acre for all the crops. The individual wells of the farmers were also getting recharged by the water in the check

dams due to the surface water and groundwater interlink in that area. In this way the farmers have benefitted from the check dam intervention.

2] **River Rejuvenation** in Wardha: The cropped and irrigated areas increased in winter and summer season respectively. As it was a good rainfall year, not much irrigation was required for cotton, toor (pigeon pea) and soybean crops. However enough water was available for irrigation post intervention for channa (gram) and wheat crops in Rabi season. Even though the input costs for all the crops increase from pre intervention to post intervention condition, the average yield in quintal / acre increased in all the crops as farmers could timely irrigate the crops form the river water lifting and well irrigation. The gross and net income from all the crops also increased by a great extent.

3] **Well Deepening**: The well deepening intervention resulted in increase in cropped and irrigated areas in rabi and summer seasons respectively. The crop yield also improved in terms of quintal / acre significantly due to the improved irrigation facilities. The gross and net income also increase almost in all the major crops and the farmers link this directly to the well deepening intervention supported by Bajaj Foundation

4] **GPOD**: Bajaj Foundation has imparted various trainings to the GP members along with the various standing committees in the villages. The project activity benefitted 3505 families in 15 village of Wardha, Seloo and Deoli blocks of Wardha district

5] **Chaff Cutter and Agricultural Equipment Support:** The support provided by the Bajaj Foundation had a significant economic impact on the beneficiaries. In terms of cost saving, each piece of agricultural equipment with a price of Rs. 30,000/- the farmers received 10% subsidy from the foundation. The total savings accounted to nearly Rs. 12.5 lacs. The use of chaff cutters reduced fodder waste by 10-15%. Animals consumed the chaff fodder completely, further reducing wastage by an additional 10%. Agricultural equipment like seed drillers and other tractor-driven tools significantly reduced the time required for various farming activities.

6] **Promotion of Indigenous Cows**: The Bajaj Foundation's support for indigenous cow purchasing has positively impacted the economic, social, and environmental well-being of farmers in Wardha district.

7] **Rural Godown in Madani Village**: The establishment of the rural godown in Madani Village implemented by the Warda Shetkari Utpadak Producer Company Ltd is a pivotal project with significant benefits for the local farming community. The godown provides cost-effective storage solutions, enhances the sale price of produce, and generates additional revenue for the FPO.

8] **Silage Bales Making Unit:** Silage bales can be stored and used for up to 18 months, ensuring fodder availability during scarcity. Feeding silage to milch animals can increase milk production by 10% to 15%. This support, reduced concentrate feed cost by ₹100 per animal. With reduced feed costs, farmers will have lower expenses, contributing to better profitability. Ensuring a reliable supply of quality fodder through the year, especially during off-seasons or periods of drought, mitigates risks associated with fodder scarcity. The initiative encourages community participation and ownership, fostering a sense of empowerment among the farmers; and with 750 farmers as shareholders, the FPO promotes cooperative principles and mutual support. By producing and storing silage, the FPO promotes sustainable agricultural practices, ensuring efficient utilization of fodder crops.

9] **Design for Change (DFC):** DFC Program is very effective in providing good education and enable students to become successful, and this program is a medium to inculcate courage in children and brings long term positive change in the Society. DFC has resulted in positive attitude behavior change among the school children and they are increasingly becoming problem resolvers rather than problem raisers.

10] **Crop cultivation with rain pipe**: Main impacts and benefits of crop cultivation using a rain pipe include viz. effective water use, reduced labour, consistent water supply, prevention of soil erosion, ideal for vegetable and grams, irrigation with rain pipes simulate rain effect which is good for crops, cost effective as this is supported by Baja Foundation, and portability.

11] **Natural Farming Kisan Pathsala:** Natural farming techniques including Jiwamrit, Bijamrit, Dashparni Arka and Agniastra were trained to the farmers during the Kisan Pathshala. Over a period of time the health of soil improves which resulted in improved health of crops and consumers thereby sustainable agriculture and eco-system.

12] **Promotion of Millets Cultivation**: Climate resilience is the main reason for promoting millets under Natural Farming. The other advantages of cultivating millets include low input costs, improved soil fertility, increasing market demand for millets as people have become health conscious. In this way, promotion of millets have positive impact in overall development of farmers.

13] **Forestry Plantation**: This initiative not only promoted environmental conservation but also educated and engaged school children in sustainable practices

14] **Solar Pumps for Irrigation (3 and 5 HP):** Direct cost saving of Rs. 6000 on diesel and electricity was observed due to this intervention. The crop yield increased by 30% and thereby the net income of the farmers also improved. This significant boost in agricultural productivity added Rs. 60,000 to the Farmer's annual income per beneficiary. About 4000 KWh of electricity per year was saved which would have been otherwise used for electrical pump sets. This energy saving equates to the reduction of around 4 metric tons of CO_2 emissions annually, assuming 0.8 kg CO_2 per kWh of electricity generated from fossil fuels

15] **Marketing Initiative**: This has boosted the farmers confidence in selling their Agri-produce. Supports like campaign umbrella with display materials, weighing scale, packing machines, etc. were provided to these farmers. Farmers also appreciated this support and are able to save on transportation and storage as well.

Findings from Lalitpur District:

1] **Group Wells**: The irrigated area in Rabi season increased by 28.5% post intervention (Group well) which can be a projected as a positive impact on the agricultural farms. In the case of summer crops, a small area was under irrigation post intervention. Increase in the input costs for all the crops was observed during post intervention scenario. The average gross and net incomes have increased for all the crops except for Black gram crop where the average net income decreased by Rs. 312 / acre.

2] **Rejuvenation of Stream and Rivers**: The river rejuvenation works carried out by Bajaj Foundation has led to increase in the cropped and irrigated areas as the river water recharged the wells. The assured water availability also led to timely irrigation to all the crops in required amount

and the yield of all these crops also increased drastically. Even though the input costs in some crops increased in the post condition, the gross and net income from all the crops increased significantly. The farmer wells also received water from the river, which not only increased the water availability in all the seasons, but also the number of hours a well can run in a day.

3] **Natural Farming**: Overall impacts of natural farming are significant in terms of yield, gross and net income as the input costs have reduced drastically and the farmers were not using any fertilizers, chemicals or pesticides in the post intervention condition.

4] **Infrastructure Development**: Renovation of school buildings, construction of road, construction of crematorium, renovation of the temple, revival of the pond Health camp with mobile dispensary are the major interventions under infrastructure development carried out by Bajaj Foundation. All these activities have directly benefitted the society as the facilities have improved.

5] **Supporting the Farmer groups by distributing Diesel Engines**: Nearly 15 – 20 acres of land was brought under irrigation with the help of one diesel pump set. Due to this intervention more crops have come under cultivation in post intervention. Some of the benefits include easy access to water for irrigation, timely irrigation made possible, farmers are able to provide ideal moisture to the crops, no dependency on others and no rental expenses, increase in irrigated area, increase in crop area, improvement in crop yield and profitability and crop diversification.

6] **Community Mobilization**: As a part of this initiative, Bajaj foundation had identified and organized Kisan Pathsala, workshops on natural farming and soil and water conservation. Farmer to farmer exchange of experiences regarding natural farming techniques have also encouraged more farmers to implement the same in their fields.

Conclusions:

The Land and water-based interventions carried out by Bajaj Foundation as part of LPGCL CSR in both Wardha and Lalitpur districts during the financial year 2023 – 24 had positive impacts on the farming society and over all development in the livelihoods of the people as a whole. The need based land and water-based interventions including check dam, river rejuvenation, well deepening, rainwater recharge ponds, group wells, natural farming, wadi and horticulture etc., have helped in the overall increase in the cropped and irrigated areas of all the crops in the post intervention scenarios. In some cases, even though the input costs in Rs/acre of the crops increased, timely availability of water for irrigation helped in increase in the yield of the crops. As a result, the farmers could increase their gross and net income per acre significantly due to these interventions. Natural farming interventions had shown a significant decrease in the crop input costs per acre as there was no need of using external chemical inputs like fertilizers, pesticides and insecticides in the post intervention. Bajaj Foundation had imparted good training to all these Farmers on practicing natural farming, wadi/horticulture etc. Further the farmers have also gained enough knowledge on crop rotation and cropping pattern as per the availability of water in different seasons.

All other interventions such as GPOD, Promotion of indigenous cows, Design for change, promotion of millet cultivation, kisan Pathsala, support for Diesel Engined, support for solar pumps, Infrastructure development, Market support, Promotion of indigenous cows, construction of rural godown, skill development programs, community mobilization etc., have also made a significant impact in overall livelihood development of the farming communities. All this was

possible only because of the valuable contribution and the initiatives of Bajaj Foundation under the LPGCL CSR.

Annexure 1
List of CSR Activities

S. No	Intervention / CSR Activity	Beneficiaries
1	Construction of Check Dams	231 Farmers
2	Rejuvenation of Streams and Rivers	236 Families
3	Horticulture Initiative in collaboration with NABARD	25 Wadi farmers
4	Natural farming Initiatives in collaboration with NABARD	100 Farmers
5	GPOD-Gram Panchayat Organisation Development Project	3505 Families
6	Promotion of Cows	231 Farmers
7	Promotion of Agri implements	151 Farmers
8	Solar pumps for irrigation 3HP and 5HP	176 Solar pumps
9	Design For Change (Training to Teachers) Digital Boards supports to Schools	58 Digital interactive boards
10	Horticultural Planation with Farmers	335 Farmers
11	Support to Farmers for Well Deepening	782 Wells in 53 Villages
12	Promotion of Natural Farming (Kharif Season)	1076 Farmers
13	Promotion of Natural Farming (Rabi Season)	2148 Farmers
14	Promotion of Natural Farming (Kisan Pathsala)	14975 Farmers
15	Promotion of Natural Farming Practices (Cultivation of Millets)	469 Farmers
16	Promotion of Natural Farming (Crop Cultivation and Rain Pipes)	1750 Farmers
17	Promotion of Natural Farming (Forestry Plantation)	40528 Plants in 53 Villages
18	Promotion of Natural Farming (Marketing Initiatives of NF Produce)	410 Farmers
19	Construction of Rural Godown	Storage Facility for 320 Shareholder Farmers
20	Support to Fodder Silage Bells Making Unit	Initially 50 farmers and cover 50 acres of land
21	Skill Training for Rural Women and Youth	231 Male/Female from 15 villages in 7 blocks
22	Income Generation Activity	516 Families
23	E-Auto Rikshaw for Income Generation / strengthening of Livelihood	240 Families
24	Support to Most Needy Families	362 Families in 212 villages
25	Community Mobilization Activities	64091 Families from 567 villages
26	Support to needy families to strengthen their livelihood	475 families from 24 states 35 districts
27	Construction of Group Well	32 Group wells, 128 farmers
28	Support to Group of Farmers for Diesel Engine	5 Diesel Engines
29	Rainwater Recharge Ponds	36000 M^3 storage capacity
30	Rejuvenation of Strems and River	795 Mtr length and 14 farmers
31	Dam maintenance including Volunteers	Kachnauda Dam Maintained
32	Promotion of Wadi, Natural farming, promotion of cow	956 Families
33	Infrastructure Development	Roads, Hospitals, Schools and Temples
34	Community Mobilization	200 Farmers
35	Horticulture Development with Farmers	1000 Farmers

Note: 1 to 25: Wardha District, 26 across 24 states and 27 to 35: Lalitpur District

Annexure 2

Impact assessment – Financial Year 2023-24

Details of CSR projects under evaluation:

Sr. No.	Purpose of CSR Funding	Location / State	Implementing Agency	Area	Amount	Impact Assessment report covered in point no.
1.	Existing well deepening / construction	Wardha / Maharashtra	KJBF	Environmental sustainability	1.13 crore	6.4 782 Farmers supported.
2.	Community Mobilization- Training, meeting, Exposure, Village Volunteer, Workshop, Women Gathering, IEC, MIS Updates, Impact Study, Consultancy charges for program, Street play	Wardha / Maharashtra	KJBF	Skill and Entrepreneur ship Development	1.03Crore	7 64091 Families covered from 567 villages under various initiatives of Community Mobilisation
3.	Support to Needy families for strengthening their livelihood	India	KJBF	Skill and Entrepreneur ship Development	1.19 Crore	7.1.13 475 families from 24 states 35 districts
4.	Water Resource Development- Rejuvenation of Rivers	Wardha / Maharashtra	KJBF	Environmental Sustainability	0.80 Crore	6.2 & 6.6 Rivers and Streams Rejuvenation
5.	Water Resource Development- Construction of Check dams	Wardha / Maharashtra	KJBF	Environmental Sustainability	0.61 Crore	6.1 Check Dams
6.	Infrastructure Development -Road Repair, Hospital Renovation, Mandir Renovation, School Renovation. Cow	Lalitpur / Uttar Pradesh	KJBF	Environmental Sustainability	0.53 Crore	7.2.1 Village level Infrastructure development

	Shed, Sports and Cultural Activities					
7.	Design For Change - Digital Interactive Boards to Schools	Wardha / Maharashtra	KJBF	Education	0.45 Crore	7.1.6 Digital Interactives Boards
8.	Water Resource Development- Construction of Group wells	Lalitpur / Uttar Pradesh	KJBF	Environmental Sustainability	0.42 Crore	6.5 Group wells

A Study Report on Geo-hydrology and comprehensive Water Resources Scenario for Lalitpur Power Generation Company Limited, Lalitpur (U.P.)

Report Prepared for:

Lalitpur Power Generation Company Limited (LPGCL)

By:

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1 Background

Lalitpur Power Generation Company Limited (LPGCL), a subsidiary of Bajaj Group, is operating a 3x 660MW (1,980 MW) supercritical thermal power plant in Lalitpur district, Uttar Pradesh. To reduce its carbon footprint, the plant is equipped with modern technologies and advanced automatic monitoring and control with high-efficiency electrostatic precipitators. The first unit was commissioned in 2015, and the second and third ones in 2016.

The thermal power plant depends on public reservoirs in the district for meeting its water demands, viz., *Rajghat* and *Kachnoda*. An ash pond constructed by the company acts as a landfill for the coal combustion products released from the plant, i.e., bottom ash and fly ash. If not designed and operated properly, leachate from the ash pond can pollute nearby water resources especially groundwater. In line with the statutory requirement, LPGCL has undertaken water harvesting and water pollution control interventions around its power plant to reduce the adverse impact on the local water environment. On request of LPGCL, a study was conducted to assess the impact of water harvesting and water resource development interventions on the local water resources (in terms of quantity) and changes (if any) in them with respect to the baseline conditions. This report presents the findings of the study.

2 Objective of the Study

The two main objectives of the study were:

i. Analyze the historical and present groundwater trend for the area surrounding the Lalitpur Thermal Power Plant.

ii. Analyze the effectiveness of the water harvesting interventions taken up by LPGCL to augment surface water resources and groundwater recharge at the local scale and suggest further improvements, if required.

3 Approach and Methodology

The approach used for the study is eclectic. It involved: i) analysis of both macro and micro level data on hydrology (drainage characteristics, rainfall, topography, soils), climate, geology and geohydrology; 2) analysis of micro level information available from the data collected by LPGCL as a part of their environmental monitoring on historical trends related to ground water levels, including pre and post monsoon water levels, water storage in reservoirs, area irrigated by farmers with the use of pumps and wells; and, 3) field visits undertaken to the project sites of LPGCL, where interventions for water resources development, water harvesting were undertaken by the agency during the past seven years, to understand the physical features of the structures (size, water spread area, area irrigated, number of farmers benefited, number of wells recharged, etc.) and the suitability of the locations chosen for building them in terms of their ability to benefit the communities for irrigation, cattle drinking and domestic uses, recharge to wells and positively impact the local environment; and 4) discussion with the implementing agency staff and the local beneficiaries of the project. The specific methodology followed for realizing the intended goal is discussed under section 3.2.1, 3.2.2 and 3.2.3. This is followed by a description of the site visit in Section 3.2.4.

3.2.1 Overall suitability of the interventions

The overall suitability of the interventions, taken up by LPGCL, was examined through physical verification of the structures, the installations and the places where they are located, and a rapid review of the local water situation, especially the water availability in the structures built (reservoirs, ponds/tanks, local streams and wells), the farmers' fields where agricultural water management interventions (such as drip irrigation and high value crops) and socioeconomic environment (presence of habitations, cultivable land), complimented by analysis of the macro and micro level situation with regard to topography, drainage features, rainfall, geology and geohydrology.

3.2.2 Assessment of the impact of water harvesting on local groundwater regime

The data on depth to groundwater levels obtained from the Central Ground Water Board (CGWB) and LPGCL monitored wells were analyzed to determine the groundwater trends over time. Groundwater fluctuation for each monitored well, i.e., the difference between the pre- and post-monsoon groundwater levels, was estimated. The groundwater level trend and groundwater fluctuation were compared with the annual average rainfall to ascertain the impact of water harvesting interventions on the groundwater regime.

3.2.3 Suggest measures to improve the effectiveness of water harvesting interventions

Measures are suggested to further improve the effectiveness of interventions on the local groundwater environment based on the following: i) results of the analysis of the data on hydrology, climate, topography and geohydrology; ii) the observations made during the field visits vis-à-vis the conditions of the hydraulic structures (the embankments, spillways, walls of the dam, abutments); and iii) an understanding of the local topography and groundwater conditions developed during the field visits. These mainly relate to the appropriateness of the types of structures and the designs, and the overall feasibility of the interventions.

3.2.4 Site Visit

A site visit to the Lalitpur Thermal Power Plant (LTPP) and the areas where the water harvesting interventions have been taken up by LPGCL was undertaken during June 23 and June 24, 2024. Figure 1 and Figure 2 provides the geographical location of the LTPP and the interventions visited.

Figure 1: Geographical location of Lalitpur Thermal Power Plant and the interventions visited on 23rd and 24th June 2024

During the site visit, information on LPGCL's water harvesting interventions in areas surrounding the plant site was collected. Further, data monitored by LPGCL on the water storage in the water harvesting structures, and groundwater level were collected. Further, discussions were held with the representatives of those involved in the planning and implementation of various water harvesting interventions to understand the purpose and design considerations of such interventions. Also, brief discussions were held with the local community/beneficiaries, especially the farmers for a qualitative assessment of the impact of various water-related interventions on the local water situation and agriculture.

4 Characterisation of District Lalitpur

The district of Lalitpur is in the south-western part of the Uttar Pradesh state (Figure 2). The geographical area of the district is about 5,098 sq. km and it lies between 24°11' to 25°13' north latitude and 78°11' to 79°00' east longitude. For administrative purposes, the district is divided into three tehsils and six development blocks. The latter include *Bar, Birdha, Jakhaura, Mahrauni, Mandawara, Mahrauni,* and *Talbehat*. Lalitpur is the main town and administrative headquarters. As per the 2011 census, the total population in the district is 12.21 lac, out of which about 85% is rural.

The major part of the district is rain-fed, under-invested, vulnerable to climate-induced risks (mainly droughts), and lacks infrastructure. Agriculture and livestock rearing are the main occupation in rural areas and contribute to more than 90% of the rural income.

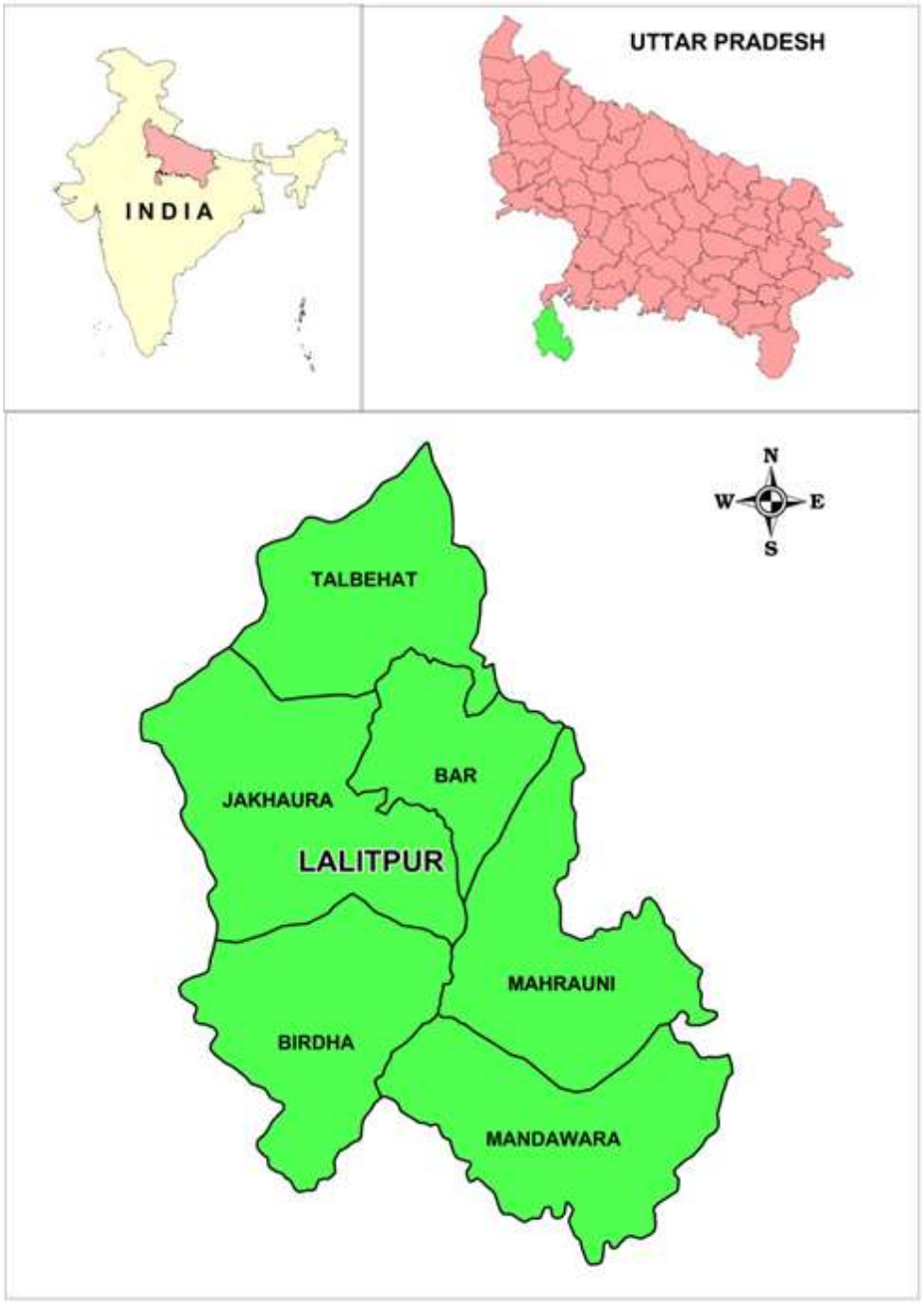

Figure 2: Index Map of Lalitpur District, Uttar Pradesh

The Lalitpur thermal power plant is located about 35 km to the north-east of the Lalitpur town in the Bar block of the district. The plant is between river Sanjam and its tributary. The former is a tributary of the river Betwa. Utari dam and its reservoir is very near to the plant site.

4.1 Geomorphology

The district is a part of the southern Bundelkhand plateau, sloping down from the outliers of the Vindhya Range on the south to the tributaries of the Yamuna River on the north. The extreme south is composed of parallel rows of long and narrow-ridged hills. The rivers flow down through the intervening valleys over ledges of granite or quartz. North of the hilly region, the granite chains gradually turn into clusters of smaller hills.

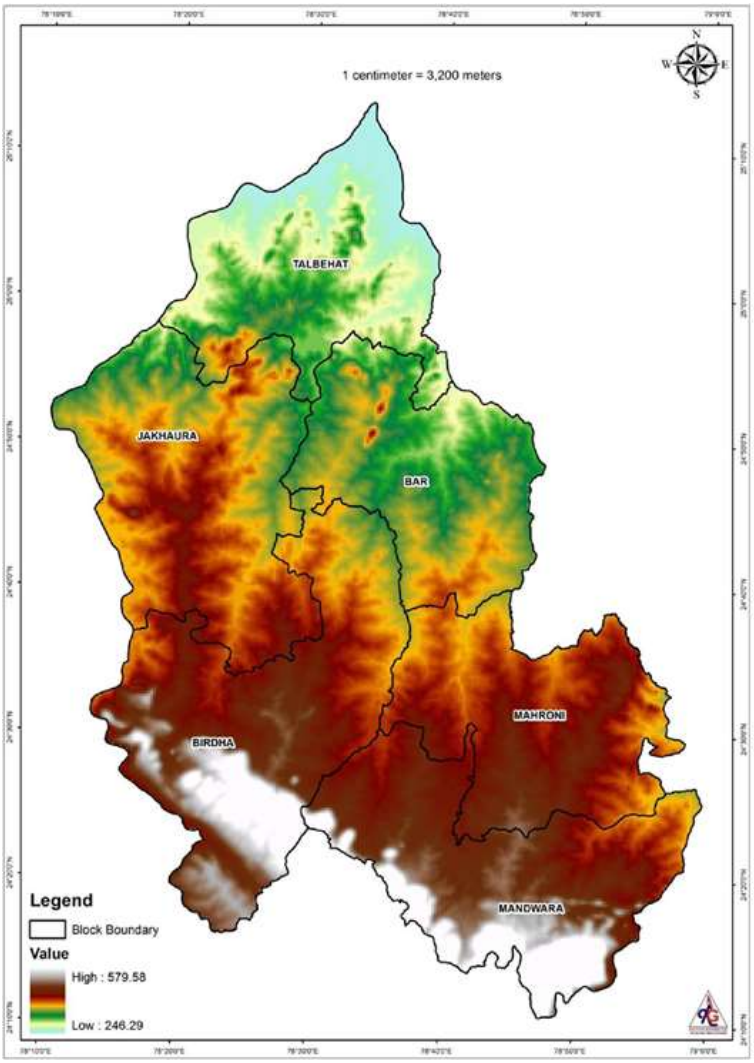

Figure 3: Elevation Map of Lalitpur District, Uttar Pradesh

The district has two distinct physiographic features: 1] the northern Bundelkhand massives which is characterised by the gently rolling land; and, 2] the southern Vindhyan ranges comprising table lands of the dissected plateau. The rolling lands of the Bundelkhand massives in the north have an average altitude of 350m above mean sea level (msl), and slope northwards with a gradient of 1.5m/km. Abruptly rising on to the rolling land, the table lands attain an average height of 450 m above msl (refer to Figure 3).

4.2 Climate and Rainfall

The district has a sub-humid climate which is characterized by hot dry summer months and cold winter months. January is coldest with a mean daily maximum temperature of 24.10°C and the mean daily minimum temperature is 9.2°C. The hottest month is May with a mean daily maximum temperature of 42.6°C and the mean daily minimum temperature of 28.8°C. Overall, the long-term mean monthly temperature during January is 16.1°C and during May is 34.1°C.

The mean monthly relative humidity varies from 24% in April to 83% in August. During the summer season, the air is very dry and during the monsoon season, the moisture content of air is

high. The mean annual wind velocity is 4.8 km per hour and the potential evapotranspiration is about 1603 mm.

The long-term normal rainfall is 1062 mm. About 91% of rainfall occurs during the monsoon months, i.e., between June and September. The rainfall exhibits high inter-annual variability. The analysis of annual average rainfall for the district from 1990 to 2022 (33 years) shows that the maximum rainfall during this period was 1497 mm in 2013 and the minimum was 420 mm in 2007 (refer to Figure 4). The coefficient of variation in annual rainfall for this period was 26%. Over the last two decades, the frequency of rainfall below the normal level has increased. Since 2000, in 15 out of 20 years, the annual average rainfall was below the long-term normal. As a consequence, the district has experienced meteorological drought more frequently during the last 20+ years than in the previous decades.

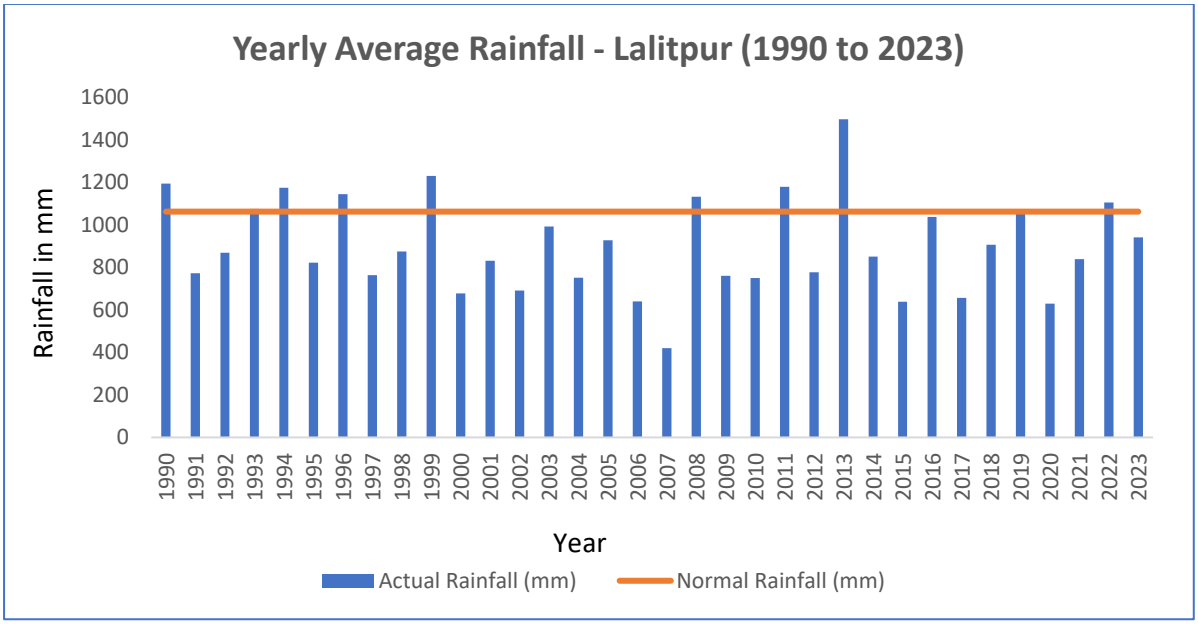

Figure 4: Average annual rainfall (1990-2023) in district Lalitpur
(Source: India WRIS)

4.3 Soils

The district has three soil types which are classified based on colour, texture, and topography. These soil types include black (low land soil), red (upland soil), and alluvial soils. The red soil is found on uplands and is formed by the weathering of granite and gneisses. The black soil is mainly in low land and is formed partly in situ and partly transported. Its parent material is limestone and granite. The alluvial soil is found along the rivers as the valley fills and comprises coarse sand of quartz and feldspars.

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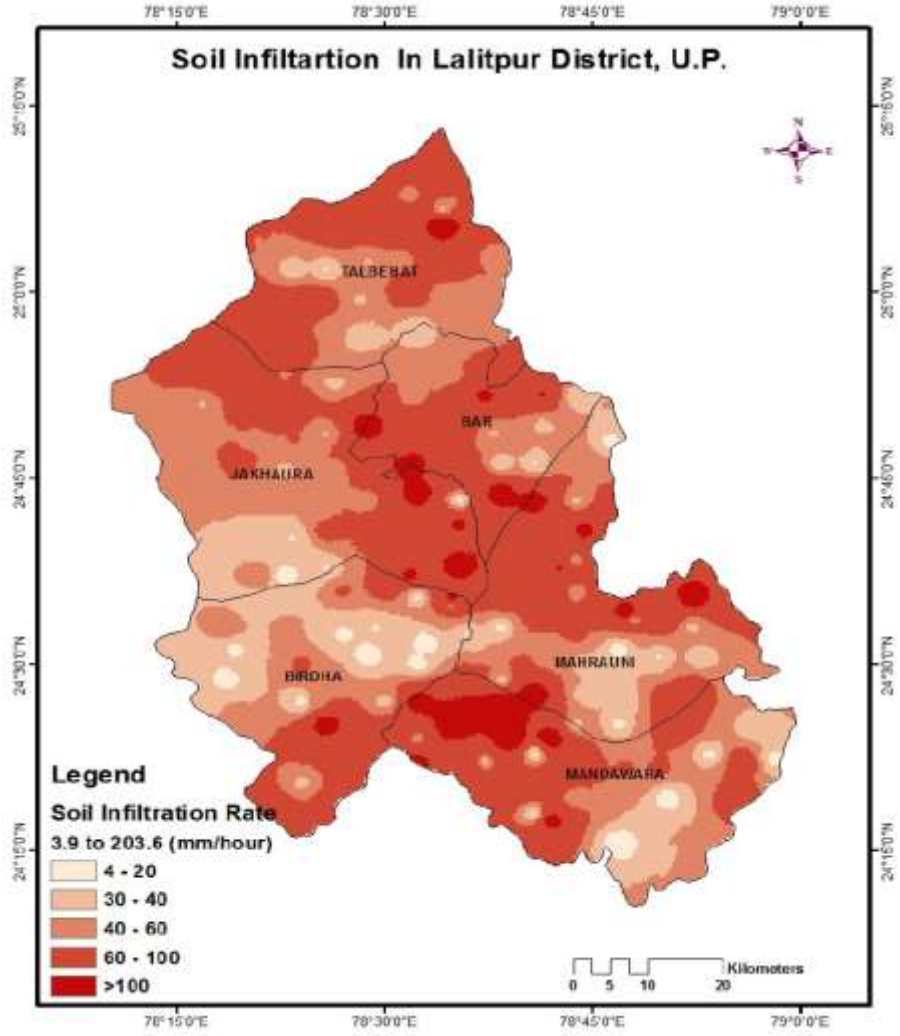


Figure 5: Soil infiltration rate map of district Lalitpur
(Source: CGWB, 2017)

The black soils inhibit the infiltration of surface water underground. Overall, the soil infiltration rate varies from 4 mm/hour to more than 100 mm/hour (refer to Figure 5). The low infiltration rate is common in northern parts comprising areas in Birdha, Jakhaura, Mahrauni, Talbehat, and Bar blocks Block having clay dominant soil (older alluvium area). A high infiltration rate is observed in areas in Bar, Mahrauni, Jakhaura, Talbehat, and Mandawara blocks having coarse grain soil (weathered granite). Areas with soils having low Infiltration rates lead to an increase in the overall volume of runoff. This excess runoff contributes to local and regional flooding of streams and rivers during the monsoon and also results in accelerated soil erosion of fields or stream banks.

4.4 Drainage, Surface Water Resources and Storage Reservoirs

The drainage of district Lalitpur is a part of the Yamuna River sub-basin. The river Betwa forms the northern and western boundary of the district, and most of the district lies within its catchment. The river Jamni which is a tributary of Betwa forms the eastern boundary. The river Dhasan forms the district's south-eastern boundary. The terrain between river Betwa and Dhasan is drained by the rivers Sajnam, Shahjad, and Jamini. The general flow direction of rivers is towards north to north-east following the slope of the area. In general, the drainage pattern is dendritic to sub-parallel in nature (refer to Figure 6).

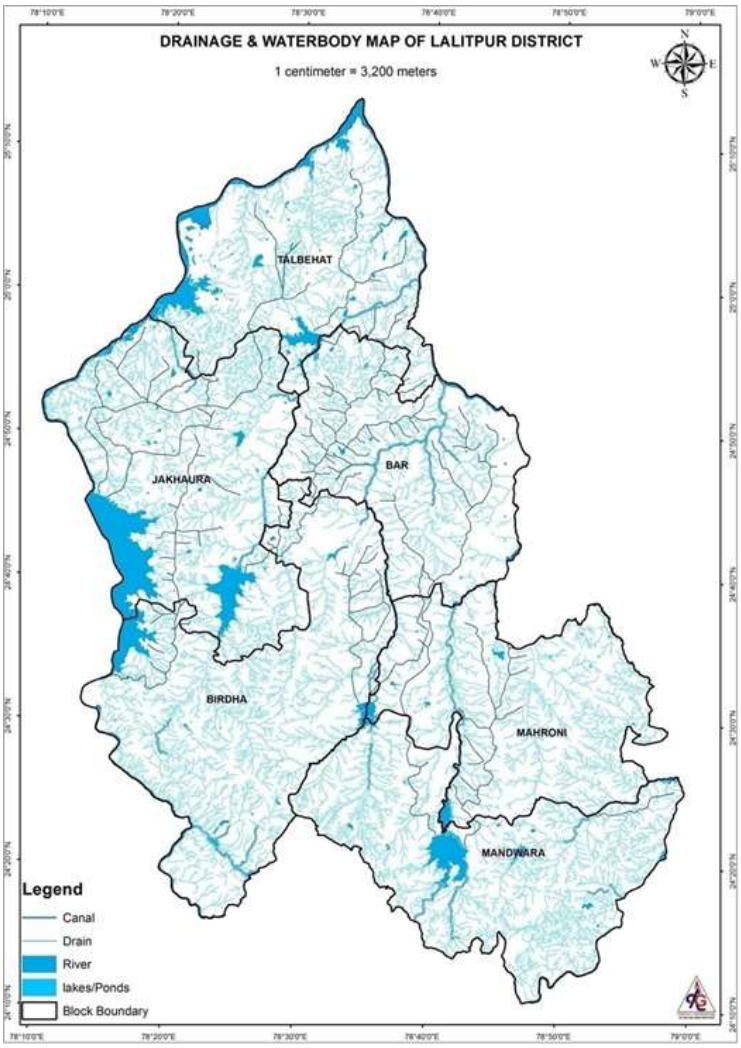


Figure 6: Drainage map of district Lalitpur

4.5 Geology and Geohydrology

The geo-morphology and topography of the area with high drainage density offer good scope for harnessing excess runoff generated during monsoon by building medium to large dams. The district has 14 such dams, major ones include Sajnam, Jamini, Govind Sagar, Shahjad, Matalila, Utaari, and Rajghat dams. The gross storage capacity of the reservoirs formed by such dams is about 23,472 MCM and their effective storage is 20,638 MCM (refer to Figure 7). The district is reported to have the highest density of large dams in the world.

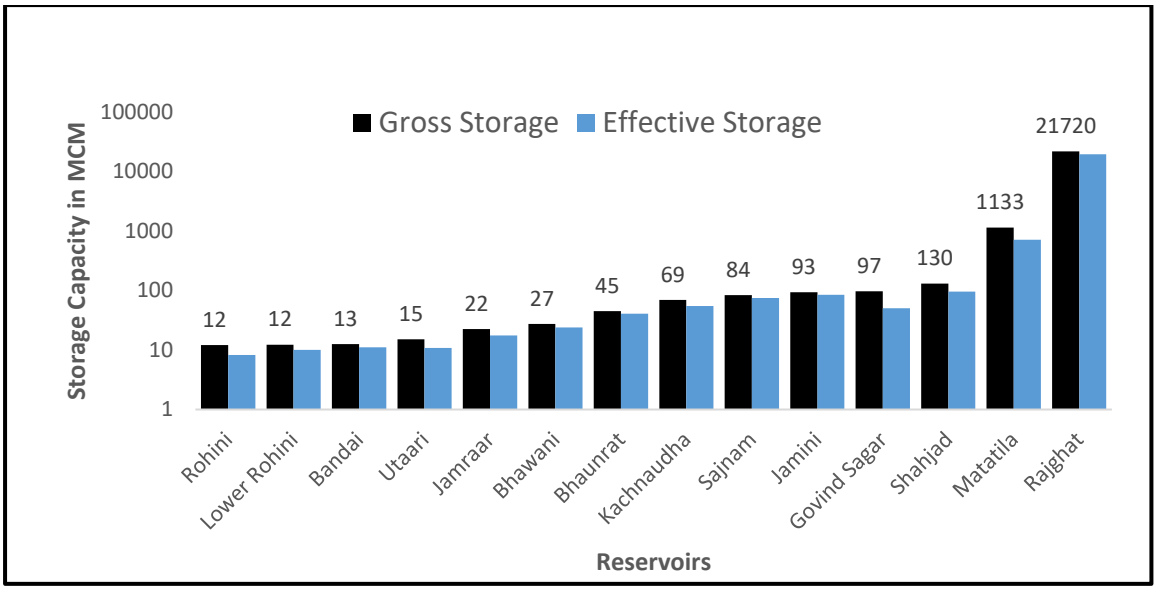
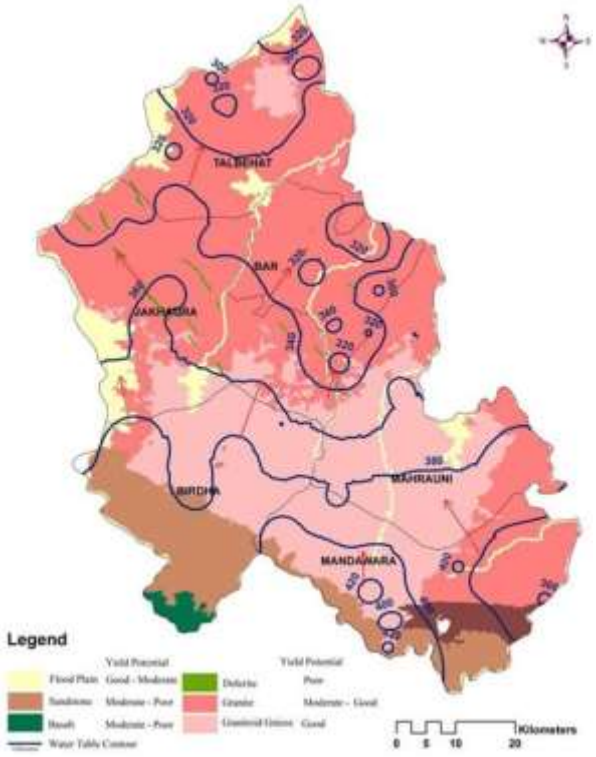


Figure 7: Storage capacity of reservoirs in Lalitpur District
(Source: Based on data from Irrigation and Water Resources Department, Government of Uttar Pradesh)

The geological formations in district Lalitpur are largely consolidated (hard rocks). Such formations include granites, gneisses, schists, quartz reefs, mafic rocks, sandstones, shales, traps, and laterites, and occupy about 80% of the district area (refer to Figure 8). The unconsolidated formations mainly include alluvium, valley fills, and soils which occupy about 18% of the area. The remaining 2% area is occupied by the unconsolidated alluvial valley fill formations.



The hard rock aquifer system exhibits heterogeneity due to the impervious nature of frequently occurring outcrops, hillocks, and linear quartz reefs. The dug wells and bore wells in such formations yield poor to moderate quantities of groundwater (refer to Figure 8) as the thickness of the weathered zone is not uniform and good interconnected fractured zones do not exist at many places. The yield of a deep bore well (up to 200 m deep) varies from 20 to 500 litres per minute at normal drawdown. In southern parts of the district, the weathered zone of Bundelkhand granite-gneissic complex of Archaean age and overlying residual soils largely form a distinct aquifer system.

Figure 8: Geohydrology, groundwater potential, and water table contour map of district Lalitpur
(Source: CGWB, 2017)

In the unconsolidated alluvium/weathered mantle the groundwater occurs between the interstices of granular particles of sand/rocks and yields are moderate. The transmissivity varies from 20 to 250 sq. m per day. The water table contour elevation ranges from 270 to 440 m above msl having a gradient of 0.70– 2.0 m/km. The general groundwater flow direction is from the south-west to the north-east (refer to Figure 8).

5 Interventions by LPGCL

Most of the water harvesting interventions by LPGCL are undertaken around the plant site and in the Bar block of the district. The block lies in the catchment of river Sanjam which is a tributary of river Betwa. There are small hills at the southern end of the block, reaching an average elevation of up to 360 m above msl. The long-term normal rainfall (mean of 30 years average annual rainfall) is 1034 mm. The block mostly has red soils with an infiltration rate ranging from 40 to 100 mm/hour. Groundwater occurs in consolidated formations mainly composed of granite having moderate to good groundwater yield potential.

The block has a total geographical area of 62,713 hectares (ha), of which about 75% is the net sown area. The total cropped area is 76,848 ha, of which only 46% is irrigated. Out of the total irrigated area of 35,604 ha, wells irrigate about 64% and the remaining is from surface water sources such as reservoir-based gravity irrigation schemes and tanks. Overall, water resources development for irrigation is low in the block. The principal crops cultivated in the block are wheat, pulses, oilseeds, maize, barley, and paddy.

As per the assessment in 2013, the net annual groundwater availability in the block was 66.26 MCM and the stage of groundwater development was 55.9% (CGWB, 2017).

LPGCL has undertaken interventions within the campus of the thermal power plant and area/villages surrounding the plant. Within the LTPP campus, a check dam, a pond with bore, 5 percolation wells, and 24 bore wells have been constructed. A natural drain of length 880 m has also been revived. All these interventions within the campus of LTPP have the potential to harvest 5.98 million cubic metres (MCM) water during a good rainfall year.

In the surrounding area of the plant, LPGCL has rejuvenated 14.5 km of 15 rivers/streams by clearing their drainage channels and removing the silt (with resultant increase in channel depth); constructed 6 check dams and renovated 6 others; renovated 14 large traditional village ponds; converted 4 abandoned sandstones quarry into reservoirs; developed 23 farm ponds; installed 276 *boribandh*s (small bunds) on seasonal streams; covered 1300 acre of land area by rainwater harvesting; deepened 205 existing dug wells; constructed 70 new dug wells; and promoted adoption of micro irrigation (drip system) by farmers who take up orchard crops (Guava, Pomegranate, Mango and Sapote). These interventions which began in 2016 have so far benefitted 4,674 families and 14,159 acres of arable land from 32 villages around the LTPP. The specific details of major interventions are described below.

5.1 Construction of Group (Dug) Wells

Though this area receives high rainfall, since most of the area is underlain by hard rock formations, availability of groundwater is significantly low. As a reason, many Group (Dug) wells are constructed by the agency for the poor and marginalised farmers of the surrounding villages who were either dependent on rain-fed farming or purchasing water from others for irrigation production for storage purpose. The investment involves contribution from LGPCL (60%) and the farmers (40%). Generally, water from surrounding farmland is collected and stored by the force of gravity in a recharge pit and finally poured into a dug well. This helps farmers to store water during the starting of Rabi crops and partially helps in plantation of summer (Zaid) crops. On an average, four beneficiary farmers are benefitted from a group (dug) well. During summer, farmers

generally grow lentils (*Moong*) and some vegetables. During monsoon season, they grow sorghum, lentils (*Moong*, *Urad*) and Mustard and wheat during winter. Wheat production widely fluctuates as it is dependent on the availability of water post monsoon period. After these group wells were introduced, these farmers are able to hold more water as storage and use it for growing crops. One such dug well, constructed in Udaipura village, (Figure 9A) visited by the study team was reported to benefit the farmers by providing irrigation to an area of around 17 acres of land that was earlier completely rain-fed. With adequate irrigation, the expected increase in yield, as reported by the farmers, was nearly 0.50 ton/ha for maize (from 1.3 to1.8 ton/ha), 0.80 ton/ha for wheat (2.7 to 3.5 ton/ha), 0.6 ton/ha (from 1.2 to 1.8 ton/ha) for groundnut, and 0.25 ton/ha (from 0.75 to 1.0 ton/ha) for mustard.

Figure 9A: Study team with farmers at the constructed dug well site in Udaipura Village

Figure 9B: Study team with farmers at the newly-constructed dug well site in Mirchwara Village

Figure 9C: Study team with farmers at the constructed dug well site in Surikala Village

5.2 Repair work of Check dam in Burogaon Village

Repair of one Check dam in Burogaon Village has been undertaken by the Agency with the help of local farmers. It will help local farmers to irrigate a total area of 68 acres contributing to 14 farmers. One such check dam has been repaired this year in the Burogaon village (Figure 10).

Figure 10: One of the check dams repaired near Burogaon Village, visited by the study team.

5.3 River rejuvenation of Streams

Presently, the agency is paying a considerable attention to the revival of small streams, tributaries of rivers, and some big *nalas* as silting in such small streams is causing frequent submergence during heavy rainfall events. This financial year also, a total of 5 km stretch of streams is planned to be revived and out of that 1.815 KM of river has already been covered. An average depth of 2 m and width range of 6-8 m is maintained to keep the smooth flow during heavy downpour. The farmers in the surroundings villages benefitted from this river revival work.

Figure 11A: Revival of a stretch of a stream heading to Sanjam River.

Figure 11B: A small stretch of a stream near Mirchwara village starting near Utari Dam and heading toward Sajnam River is revived this financial year.

5.4 Check Dam Construction

The agency has undertaken construction of five check dam on the small tributaries of Sajnam river at different locations. This small and medium-sized check dams help the surrounding farmers to irrigate more of their land. They also help them to grow highly watered crops other than some rain-fed crops. A total of five check dams are built in four different villages. Three such check dam sites visited by our study team during the field visit are shown in Figure 13A, 13B & 13C. A total of sixteen farmers will be benefitted by the Check dam (Figure 13B) built in Udaipura village. It helps farmers on both banks of the stream, from Kaloni and Udaipura with a total irrigation potential of 107 acres.

Figure 12A: A newly-constructed check dam with fish cultivation facility at the downstream of Utari Dam near Semra Bhagnagar village

Figure 12B: Study team with the villagers at the check dam site near Udaipura Village

Figure 12C: Study team visited newly constructed check dam site at a tributary of Sajnam at Semra Bhagnagar village, Lalitpur.

5.5 Overall Target for the CSR Interventions and the Achievements for 2023-24

The water resources development and water supply interventions planned by LPGCL for the year 2023-24 and the physical target achievements made till the end of June 2024 are given in Table 1.

Table 1: Target and Achievement under the CSR Activities for Water Resources Development and water supply Source: LPGCL, Lalitpur (September 13, 2024)

S.N.	Projects/Activities	Unit	2023-24	Physical Target	Physical achievement
I	**Water Resources Development:**				
1	Rejuvenation of Streams	Length (km)	5	5	1.815
2	Check dam construction	Nos.	5	5	5
3	Repair of Check dam Buragaon	Nos.	1	1	1
4	Repair of check dam in 4 villages		4	4	Site selection
5	Construction of Recharge Structures	Nos.	30	30	0
6	Well recharging through rainwater	Nos.	150	150	19
7	Soak pits (for drain/wastewater household level percolation chamber)	Nos.	451	451	0
8	Installation of Bori Bandh (A low-cost seasonal water harvesting structure)	Nos.	75	75	Planned for Oct-Nov. 2023
9	Drinking water supply 4 villages	Nos.	1	1	0
10	Group Diesel Engine with Pipes	Nos.	10	10	Nov Dec Activity
11	Construction of Group well	Nos.	12	12	19
12	Group Lift Irrigation Scheme	Nos.	2	2	0
13	Kachnoda Dam (Maintenance)	Months	12	12	5

6 Effectiveness of the Water Harvesting and Water Resources Development Interventions in the Area

6.1 Overall suitability of the interventions

The area receives very high mean annual rainfall (around 1060mm) and has a sloping terrain, with a good drainage density. Geologically, the terrain is granitic with a good weathered layer of alluvium on top. The high rainfall, the rocky outcrops and the less permeable black soils generate good runoff. The moderate slopes keep the velocity of flow and peak discharges high. The thickness of the alluvium (with silt, sand and gravel) varies from locality to locality. The weather changes drastically soon after the monsoon, with temperature dipping below 5 degrees centigrade. During summer (from March to May) it goes up to 43 degrees centigrade. The soils of the locality have low infiltration rates (in the range of 4-40mm/hour). The average water table fluctuates between 5 to 8 metres below ground level.

The area has fertile soils and the overall availability of cultivable land is good, and the unmet demand for irrigation is also considerably high. All these factors provide favourable conditions for water resources development for expanding irrigation facilities and to meet other water needs of the communities. The strategy followed by LPGCL to focus on development of surface water and groundwater resources is quite appropriate and is also in line with the developmental approach followed by the government for the region. The suitability of the strategy is evident from the presence of large impoundments of water in the reservoirs built in the villages even during the month of November and significant expansion in area irrigated in the villages from surface water systems created by LPGCL, as reported by the communities as well as the agency officials.

The surface water that otherwise runs off the area captured and stored in local reservoirs becomes a source of continuous recharge to the phreatic aquifer which has low thickness and in which water doesn't remain, owing to high lateral, flows--in the northern direction (see the groundwater contour map in Figure 8), during the lean season when the water table lowers. This helps the farmer access water at shallow depths. The many surface reservoirs (tanks and ponds) created through small dams also provide direct access of water to the village communities for irrigation, washing and bathing. The support for construction of wells provides poor farmers access to the augmented recharge and natural recharge to groundwater. However, caution needs to be exercised while planning well construction in future to address the concerns of unsustainable groundwater use. The Company's new focus on horticultural crops and drip irrigation is quite timely and would not only help save water, but would also increase the farm income, with 'more crop and cash per drop of the additional water resources created' (refer to Kumar et al., 2008a). These interventions being carried out by the agency together constitute a good example of integrated water resources development and management in this drought-prone region. It might be appropriate for the agency to offer new community wells to only those farmers who are willing to adopt micro irrigation and crops amenable to it in part of their cropped area.

6.2 Impact of the Structures on Groundwater Regime

If the local water resource development and water harvesting interventions taken up by the agency are effective, it would be reflected in the groundwater conditions of the area, along with positive change in water availability for irrigation and other uses locally (refer to Kumar et al., 2008b). We have already seen how the various interventions (river rejuvenation, tank rehabilitation and construction of check dams and dug wells) have improved the supply of water for irrigation. The best way to analyze the impact on groundwater is to examine the depth to groundwater levels. The groundwater level trend in the Bar block and within the LTPP campus was analyzed to determine the impact of water harvesting and water augmentation interventions undertaken by the LPGCL on groundwater recharge.

In the last 20 years (2000-2019), the depth to groundwater level in the Bar block during the pre-monsoon period fluctuated between a lowest of 5.35 m in 2013 and a highest of 10.34m (in 2008) with a mean value of 6.7m. During the post monsoon period, the depth to water levels fluctuated between 2.1m (in 2000) and 8.2 m (in 2011), with a mean value of 3.4m. Though the groundwater trend during both pre and post-monsoon shows high inter-annual variability, groundwater level has improved continuously post 2016 when the LPGCL started their interventions (Figure 13 and 14). While the groundwater has risen by 0.3 m per annum during pre-monsoon period, it has risen by 0.4 m per annum during post-monsoon after 2016.

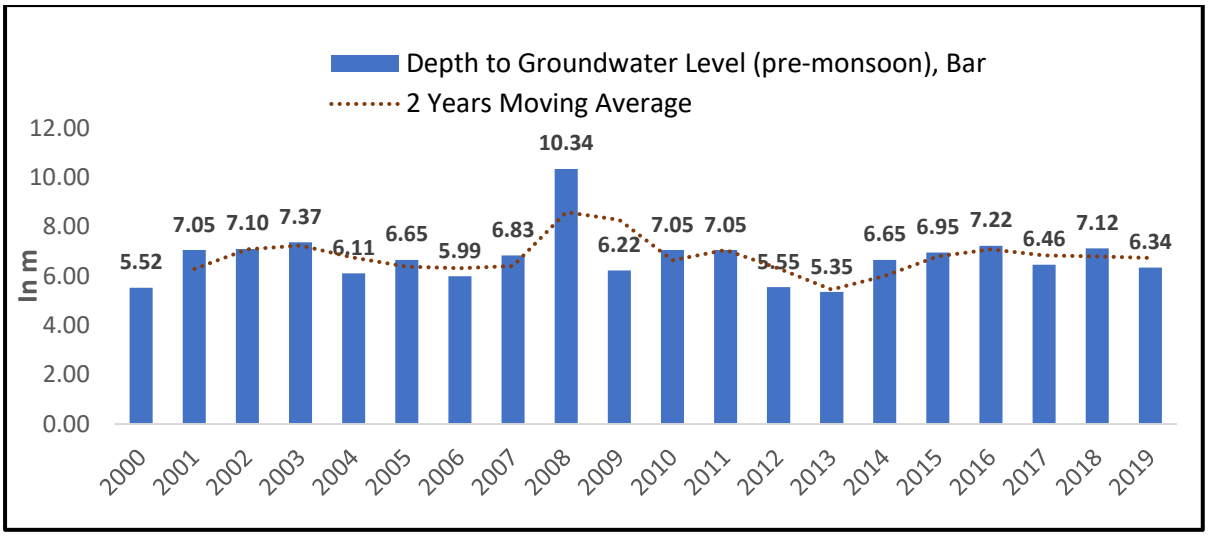


Figure 13: Pre-monsoon depth to groundwater level trend in Bar Block for 2000-2019
(Source: Based on analysis of CGWB data)

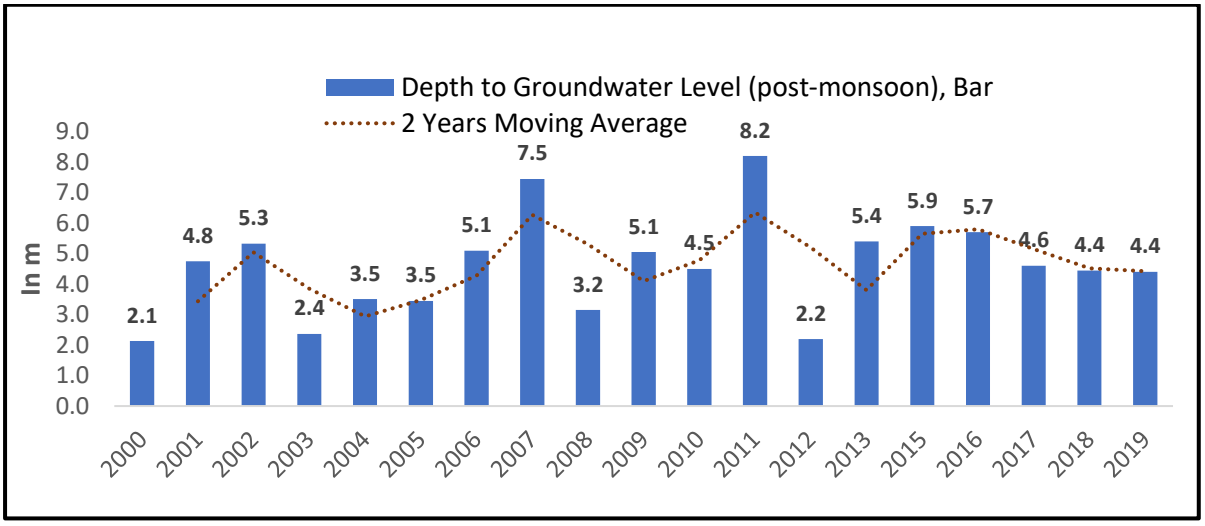


Figure 14: Post-monsoon depth to groundwater level trend in Bar Block for 2000-2019
(Source: Based on analysis of CGWB data)

Analysis of groundwater fluctuation (difference between pre- and post-monsoon depth to groundwater level) trend between 2016 and 2019 indicates that it has increased by 1.5 m per annum. This means that the recharge to groundwater has increased. Since the average annual rainfall in all four years between 2016 and 2019 was below normal (annual average of 914 mm against a normal of 1062 mm), the improvement in groundwater recharge can be attributed to various water harvesting and water augmentation interventions undertaken by the LPGCL in the Bar block. Further, LPGCL is undertaking regular monitoring of groundwater levels within the campus of the LTPP. For this purpose, seven piezometers (PZ) have been installed and water levels are recorded after every 15 days (refer to Figure 15). This data is available from September 2016 onwards.

Figure 15: One of the piezometers in the campus of LTPP

The average pre-monsoon depth to groundwater level during the period 2017-2023 is about 2.90 m. The highest during this period was 3.23 m during 2018, and the lowest was 2.52 m in 2023. For most of the piezometers, depth to groundwater level during pre-monsoon shows an improving trend post-2017, a year after the interventions were started by the LPGCL (Figure 16). Overall, the groundwater level in pre-monsoon has risen by 0.08 m per annum during 2017-2023, as indicated in the nearly consistent reduction in depth to piezometric levels.

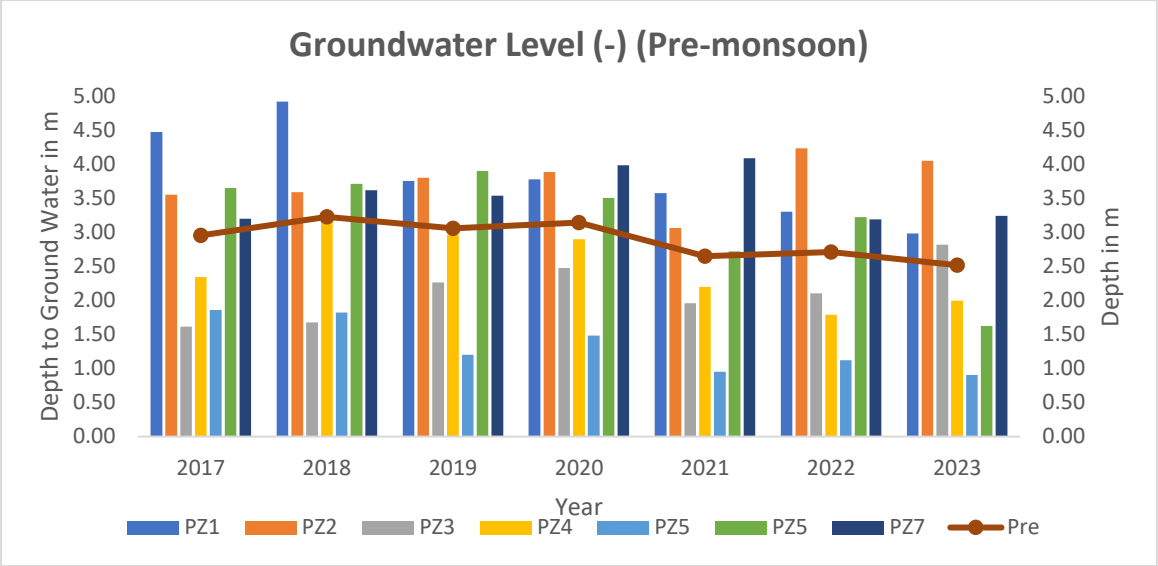


Figure 16: Pre-monsoon depth to groundwater level trend in the LTPP campus for 2017-2023
(Source: Based on analysis of data provided by LPGCL)

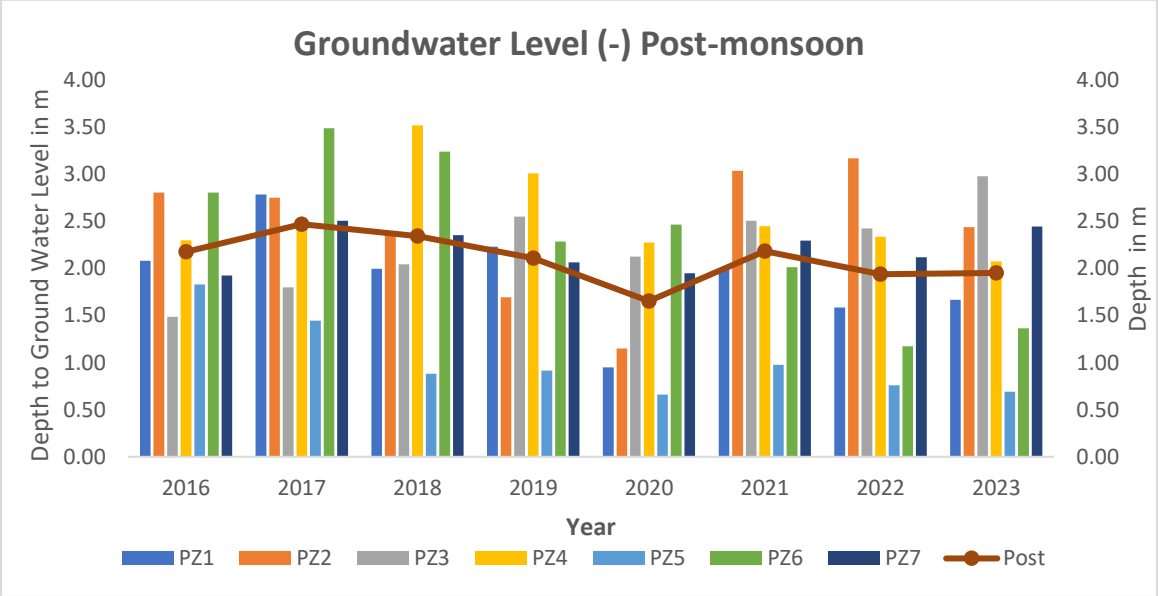


Figure 18: Post-monsoon depth to groundwater level trend in the LTPP campus for 2016-2023
(Source: Based on analysis of data provided by LPGCL)

Further, the average annual groundwater fluctuation for the period 2017-2023 was estimated to be 0.78 m. It declined from 0.76 m in 2017 to 0.66 m in 2023. Considering that groundwater levels have improved during both pre as well as post-monsoon between 2016 and 2023, the reduction in annual groundwater drop over this time period could be due to control on abstraction within the LTPP campus. Thus, there has been a significant positive impact on groundwater availability.

6 Suggestions to Enhance Effectiveness of the Interventions

LPGCL has planned, designed, and implemented most of the water harvesting and water augmentation using good technical inputs. However, there is a scope for enhancing the effectiveness of some existing interventions.

One suggestion is to improve the design and construction of the check dams. In one case, it was observed that the bund top level (BTL) of the check dam was almost at the same height as that of the embankments. This can cause flooding in the surrounding areas during the event of peak flows due to excessively high rainfall events. For such small dams, the embankments need to be stabilized. Nevertheless, the design and construction of these small dams in the future should consider peak floods that can occur in the catchment once in 50 years, and accordingly, the spillways need to be designed, based on extreme rainfall events, estimated from historical rainfall data, by applying techniques in stochastic hydrology. The purpose is that the spillway is able to evaluate the discharge during peak floods safely without causing overtopping the dam.

Presently, groundwater development in the area is low. However, after seeing the impact of well irrigation on crop productivity and income of farmers, numerous dug wells will be constructed in the area by farmers in the coming years. With this, groundwater abstraction will eventually increase, and the groundwater of the area can face problems of over-development in the years to come. If the well spacing is not proper, the zone of influence of one well can overlap with the nearby ones, leading to the phenomenon of 'well interference' (Foster, 2012). In such a situation, the productivity of wells will go down (Kumar et al., 2012). Therefore, attention should be paid to 'minimum spacing of wells' considering the aquifer characteristics. Further to ensure sustainable use of groundwater, large farmers need to be encouraged to grow crops that are amenable to drips and mulching. Presently, mostly maize, rice, and wheat are grown in the block. Farmers having large landholdings can grow oilseeds and horticulture crops (including fruits and vegetables) in addition to the food crops. This will ensure water saving at the farm scale and will also enhance the income of such farmers. LPGCL has already begun the work of introducing horticultural crops and drip irrigation in the area.

7 Conclusion

The water resources development and water management interventions undertaken by the LPGCL since 2016 in the surrounding areas and within the campus of the LTPP for augmenting local water resource availability had shown very encouraging results. These interventions have resulted in an increase in areas under irrigation, increase in cropping intensity, increased crop production, improved groundwater recharge and rise in groundwater levels. Further, the creation of small and medium-sized reservoirs through water resource development interventions have improved access to surface water for multiple needs (irrigation, domestic water supply, fisheries, and recreation) in the villages. Water availability in the reservoirs, especially during the lean season, also improves the overall environmental conditions in the villages during the lean season, when the region generally faces intense dryness due to high aridity. With expanded irrigation, the farm households in the project villages have been immensely benefited in terms of improved crop yield and increased farm income. The promotion of dug wells for irrigation for the poor small and marginal farmers, who were earlier purchasing irrigation water at a high rent, is a good strategy to increase their access to groundwater that is replenished through the local interventions, for livelihood generation. The current focus on introducing horticultural crops is a step in the right direction to ensure sustainable water use in agriculture in the area. The model adopted by the

agency constitutes a good example of integrated water resources development and management at the local level.

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A Study Report on Groundwater Quality and its Comparison with the Baseline Data for the Lalitpur Power Generation Company Limited, Lalitpur (U.P.)

Report Prepared for:

Lalitpur Power Generation Company Limited (LPGCL)

By:

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1 Background

Lalitpur Power Generation Company Limited (LPGCL), a subsidiary of Bajaj Group, is operating a 3x 660MW (1,980 MW) supercritical thermal power plant in Lalitpur district, Uttar Pradesh. To reduce its carbon footprint, the plant is equipped with modern technologies and advanced automatic monitoring and control with high-efficiency electrostatic precipitators. The first unit was commissioned in 2015, and the second and third ones in 2016.

The thermal power plant depends on public reservoirs in the district for meeting its water demands, viz., *Rajghat* and *Kachnoda*. An ash pond is constructed that acts as a landfill for the coal combustion products released from the plant, i.e., bottom ash and fly ash. In line with the statutory requirement, LPGCL has undertaken water harvesting and water pollution control interventions around its power plant to reduce the adverse impact on the local water environment. On a request from LPGCL, a study was undertaken by the Institute for Resource Analysis and Policy (IRAP) to assess the impact of water harvesting and water pollution control interventions on the quality of local groundwater resources and changes (if any) with respect to the baseline conditions. This report presents the findings of the study.

2 Objective of the Study

The main objectives of the study were to:

- Analyse the present (pre-monsoon of 2023) groundwater quality for the area surrounding the Lalitpur Thermal Power Plant.

- Compare the present groundwater quality with the baseline (pre-monsoon of 2010) conditions.

3 Approach and Data Sets Used

LPGCL has undertaken several interventions pertaining to water harvesting and groundwater recharge in their campus and the surrounding areas. Such interventions serve a dual purpose: first is the augmentation of surface water storage and groundwater recharge at the local scale; and second, is the improvement in water quality through dilution of minerals in the local water sources. Further, water pollution control interventions have been designed and implemented at ash pond of Lalitpur Thermal Power Plant (LTPP) to ensure that the leachate from the ash pond does not contaminate the nearby water resources, especially groundwater in the shallow aquifers.

The LPGCL is conducting a regular monitoring of ground water and analysis of samples collected from various groundwater sources in and around the LTPP through an independent testing laboratory duly approved by the Ministry of Environment, Forests & Climate Change (MoEFCC) and also accredited by NABL. The groundwater testing is performed by the agency lab covering physical, chemical, and bacteriological parameters following the Standard Indian testing methods. Testing is also done for heavy metals. Overall, testing is done for four groundwater sources (handpumps near ash pond in the LTPP, and villages *Semra*, *Udaipura*, and *Mirchwara*) covering 40 water quality parameters. One of the groundwater monitoring sources is within the campus of LTPP, its location is provided in Figure 1.

First of all, a macro analysis on groundwater quality in district Lalitpur and block Bar (where the LTPP is located) was performed. It covered analysis of electrical conductivity (EC), nitrate, fluoride, bacteriological contamination, pesticides, and heavy metals in shallow aquifers. The information needed for this analysis was accessed from a report of the Central Ground Water Board (CGWB, 2017). Thereafter, data on groundwater samples collected and tested during March 2021 (pre-monsoon) by LPGCL were analyzed.

Finally, the results of the present groundwater sample analysis were compared with the baseline data (pre-monsoon of 2010) provided by the LPGCL. For this, three groundwater sources (handpumps near ash pond in the LTPP, and villages *Udaipura* and *Mirchwara*) for which data on 31 water quality parameters was available for both present and baseline years were selected.

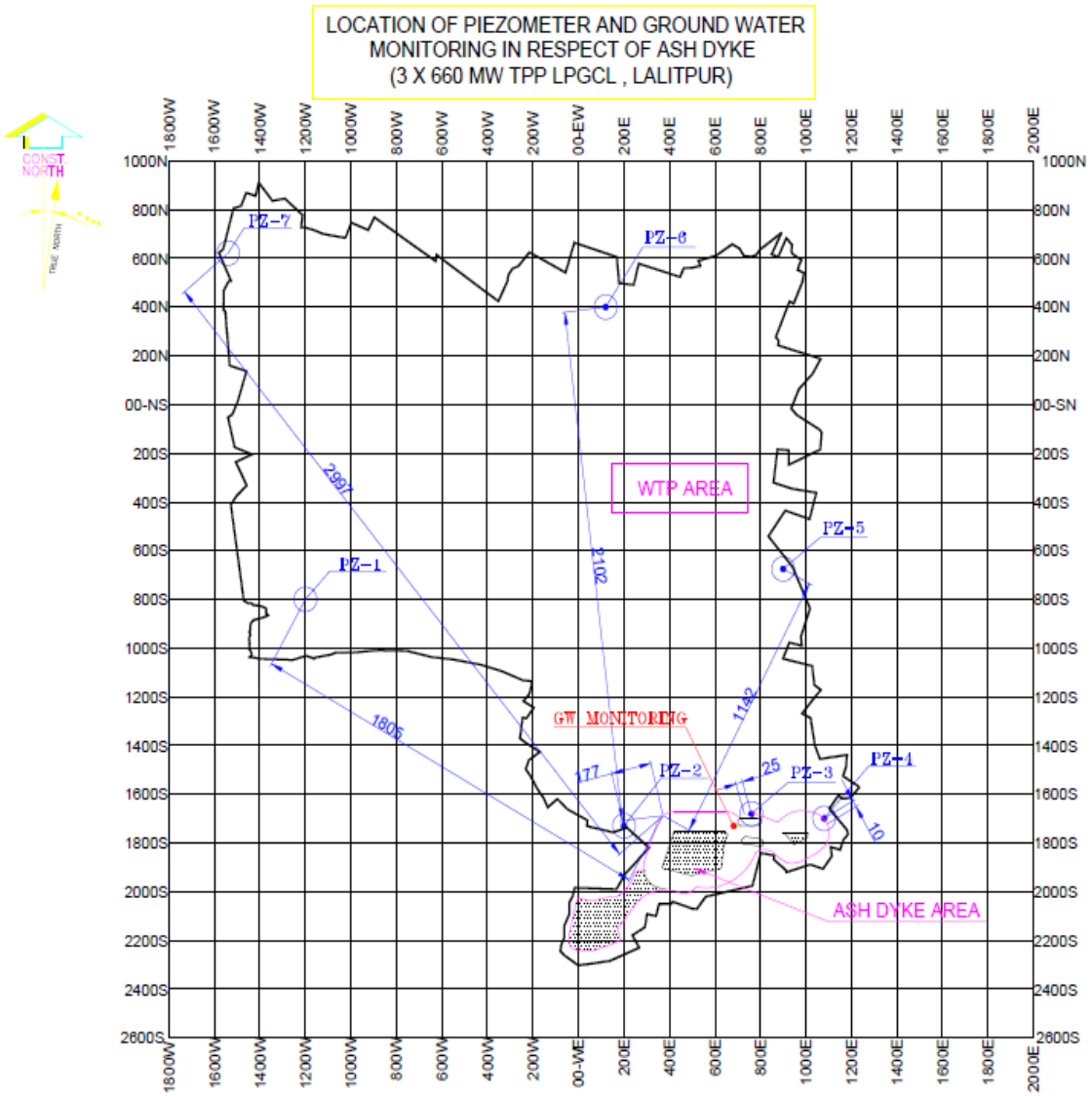

Figure 1: Location of groundwater monitoring source within the LTPP

(Source: Map provided by LPGCL)

4 Groundwater Quality in Lalitpur District of Uttar Pradesh

The analysis of the groundwater samples collected during 2017 by the Central Ground Water Board (CGWB) from the observation wells in Lalitpur district shows that the average electrical conductivity (EC) of groundwater is 1,014 µS cm-1, with a lowest of 199 µS cm-1 to a high of 3245 µS cm-1. Nevertheless, in most parts of the district, the EC value varies from 750 to 1500 µS cm-1 (refer to Figure 2). The average concentration of total dissolved solids (TDS) is 547.0 mg/l. About 97% of the analysed groundwater samples fall in the category of freshwater, and only 3% in the brackish water category. The high EC and TDS (up to 2392.8 mg/l for the latter) of groundwater in the latter category makes it unsuitable even for irrigation.

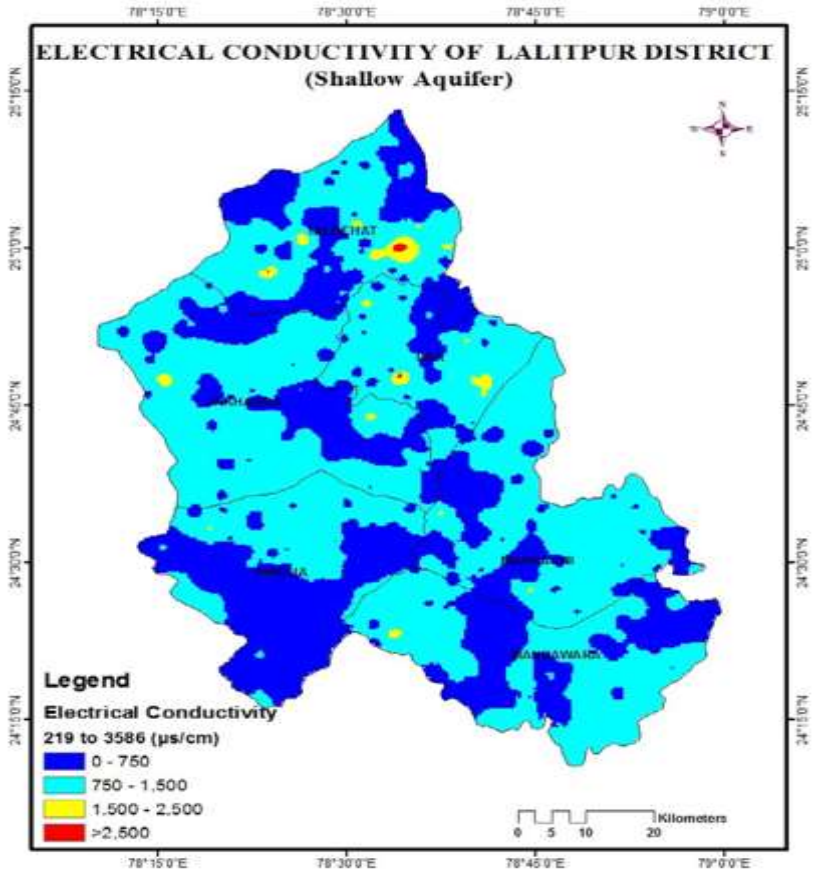

Figure 2: Distribution of EC values in shallow aquifers of district Lalitpur
(Source: CGWB, 2017)

The average concentration of nitrate is 54.4 mg/l, with higher values in the groundwater samples in the northern blocks of the district (refer to Figure 3). Even the average concentration of nitrate exceeds the maximum permissible limit for 100 ppm for drinking water use (as per IS 10500: 2012).

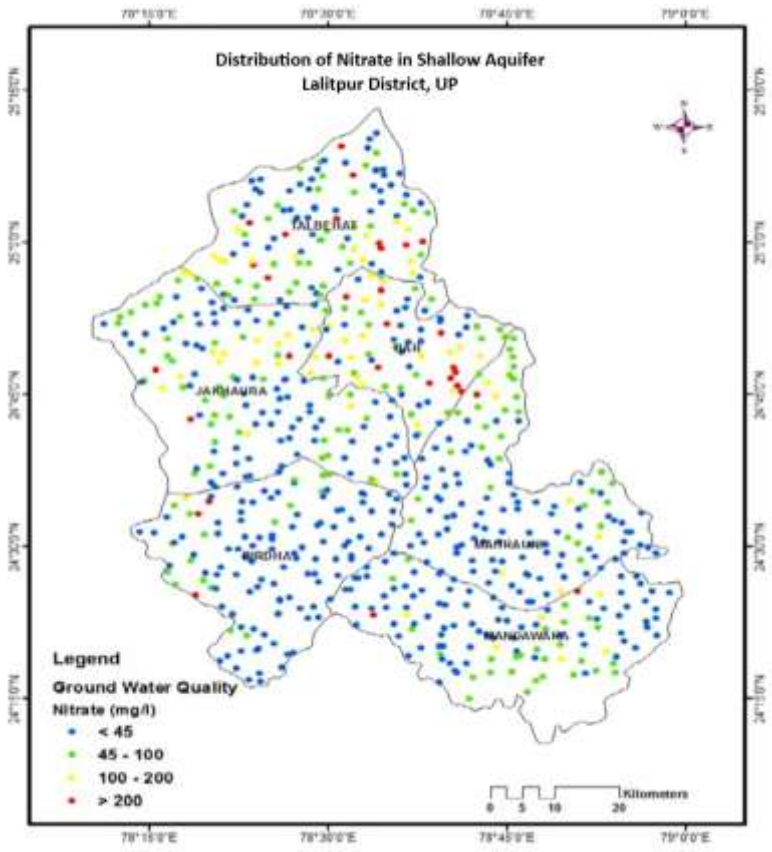

Figure 3: Distribution of Nitrate concentration in shallow aquifers of district Lalitpur
(CGWB, 2017)

Further, fluoride concentration exceeds the prescribed 1.5 mg/l drinking water maximum permissible limit (specification allowed as per IS 10500: 2012 in absence of alternate sources) in about 54.6% of the groundwater samples. Mahrauni, Talbehat, and Jakhaura are the worst affected blocks (refer to Figure 4).

A significant number of groundwater samples were found to be bacteriologically contaminated. Out of the 33 groundwater samples collected for bacteriological investigation, the total coliform was found in 51.5% whereas faecal coliform was found in 42.4% of the analysed groundwater samples. Inadequate maintenance of wells and unsanitary conditions existing around the wells were found to be the major reasons for the bacteriological contamination of groundwater.

However, pesticide presence was not detected in 66 groundwater samples collected for the purpose. Heavy metals too were detected in a very small fraction of the total 699 groundwater samples that were analysed. The concentration of Cadmium (Cd), Chromium (Cr), Nickel (Ni), and Lead (Pb) exceeded the maximum permissible limit for drinking water use (as per IS 10500: 2012) in only 1.9%, 0.3%, 0.3%, and 0.6% of analysed samples respectively. Further, the concentration of Arsenic (As) exceeds the maximum permissible in 1.1% of the samples.

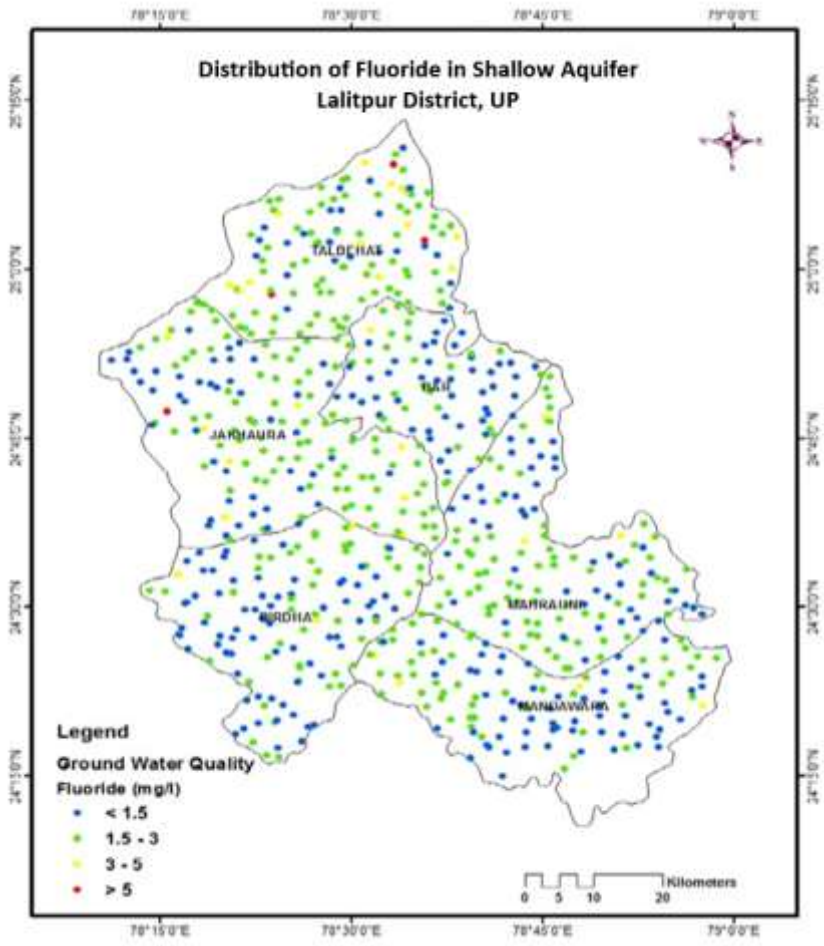

Figure 4: Distribution of Fluoride concentration in shallow aquifers of district Lalitpur
(Source: CGWB, 2017)

5 Comparison of the Present Status of Groundwater Quality baseline condition

The laboratory test results of the groundwater samples collected during June 2023 were analyzed for determining the concentration of 31 different water quality parameters from the handpumps near the LTPP ash pond, and the villages *Udaipura* and *Mirchwara*. The estimated values of concentration of these parameters are presented in Table 1. The baseline (March 2010) water quality status of the same three monitored groundwater sources vis-à-vis 31 different physical, chemical, and bacteriological parameters and toxic substances along with their maximum permissible limit for drinking water use (as per IS 10500: 2012) is also presented in Table 1.

It is observed that for all the parameters, groundwater quality has either remained more or less the same or has improved with respect to the baseline. The only two parameters whose values have increased marginally as compared to the baseline are iron and nitrate, whose concentrations were slightly above the baseline in one village (0.17 for current year as against 0.1 mg/litre for baseline in Udaipura for iron, and 4.98 as compared to 4.08 mg/litre for nitrate in the same village). Moreover, the values of all the physical, chemical, bacteriological parameters and toxic substances) remained within the permissible limits for drinking water supply for most cases except for total dissolved solids, total hardness, alkalinity and calcium in whose cases, the values marginally exceeded the permissible limits. Nevertheless, the values were far below the maximum permissible limits (of 600 mg/litre for both alkalinity and total hardness, 2000 mg/litre for TDS and 75 mg/litre for calcium).

The testing of the groundwater samples in district Lalitpur (outside the project area) by the CGWB (2017) observed that the total hardness in the groundwater samples was up to 1316.7 mg/l. Further, it was observed that the Ca-Mg-HCO_3 is the dominant hydro-geochemical facies (referring to the characteristics of the rock) in the groundwater. Yet the concentration of these chemical compounds in groundwater at the plant site and project area was far below these levels and within permissible limits. Further, the values of TDS, total alkalinity and total hardness for all the groundwater samples, which showed decline from the base line values in most cases, are almost came close to the permissible limit in all the three locations. It is also to be noted that the presence of toxic metals including those associated with fly ash in the analyzed groundwater samples is far below the permissible limits (such as As, Pb, Hg, and Cr) and the baseline data.

Table 1: Values of Water Quality Parameters obtained from Sample Tests (Base line, present, 2023)

Sr. No.	Parameters	Unit	Plant Site/ Near Ash Pond		Mirchwara village		Udaipura Village		Permissible Limit as per IS 10500: 2012
			Baseline	Present**	Baseline	Present**	Baseline	Present**	
A	Bacteriological								
1	E. Coli	MPN/ 100ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent
2	Total Coliforms	MPN/ 100ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent
B	Physical								
3	Colour	Hazen	<1.00	<1.00	<1.00	<5.0	<1.0	<5.0	15
4	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
5	Taste	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
6	Turbidity	(NTU)	1	<1.0	1	<1.0	<1.0	<1.0	5
7	pH	-	7.2	7.26	7.1	7.46	-	7.38	6.5-8.5
8	Total Dissolved Solid (TDS)	mg/l	632	591	688	510	502	630	500
C	Chemical								
9	Aluminium (as Al)	mg/l	<0.01	<0.01	<0.01	<0.03	<0.01	<0.03	0.2
10	Anionic Detergents (as MBAS)	mg/l	<0.01	<0.02	<0.01	<0.02	<0.1	<0.02	1
11	Boron (as B)	mg/l	0.05	<0.05	0.02	0.1	0.15	<0.5	1
12	Calcium (as Ca)	mg/l	117.21	78	100	81.2	90	70.1	75
13	Chloride (as Cl)	mg/l	136	40	87	38	69	65	200
14	Fluoride (as F)	mg/l	0.86	0.58	0.9	0.48	1	0.58	1

15	Free Residual Chlorine	mg/l	<0.1	<0.2	<0.2	<0.2	<0.3	<0.2	1
16	Iron (as Fe)	mg/l	0.3	0.14	0.3	0.2	0.1	0.17	0.3
17	Magnesium (as Mg)	mg/l	54.6	25	41.8	28	36	35	100
18	Manganese (as Mn)	mg/l	<0.01	<0.1	<0.01	<0.1	<0.01	<0.1	0.3
19	Nitrate (as NO3)	mg/l	23.7	4.81	38.6	4.2	4.08	4.98	45
20	Selenium (as Se)	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
21	Sulphate (as SO4)	mg/l	111	24.3	68	22.8	45	23.2	400
22	Total Alkalinity (as CaCO3)	mg/l	610	290	240	210	279	290	200
23	Total Hardness	mg/l	516	312	398	290	378	319	200
24	Zinc (as Zn)	mg/l	<0.1	0.101	<0.1	<0.05	<0.1	0.182	15
D	Toxic Substances								
25	Cadmium (as Cd)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003
26	Cyanide (as CN)	mg/l	<0.02	<0.01	<0.02	<0.05	<0.02	<0.01	0.05
27	Lead (as Pb)	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
28	Mercury (as Hg)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
29	Polynuclear Aromatic Hydrocarbons (PAH)	mg/l	Nil	<0.0001	Nil	<0.0001	Nil	<0.0001	0.0001
30	Total Arsenic (as As)	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05
31	Total Chromium (as Cr)	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05

(Source: Based on the LPGCL conducted laboratory test results and BIS 2012)

Notes:

'Baseline' refers to the pre-monsoon of the year 2010

** 'Present' refers to the pre-monsoon of the year 2023.

6 Conclusion

Overall, the analysis shows that the various interventions undertaken by LPGCL within the campus and surrounding areas of the Lalitpur Thermal Power Plant for augmenting water resources and controlling water pollution have helped ameliorate the groundwater contamination and maintain water quality parameters within permissible limits. The analysis of water samples undertaken as per the water quality testing protocols did not show the presence of any toxic substances associated with fly ash in the groundwater sources.

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