Progress Report
Up to 2015

Enhancing Groundwater Recharge and Water Use Efficiency in SAT Region through Watershed Interventions – Parasai-Sindh Watershed, Jhansi

Submitted to

Coca–Cola India Foundation for Rural Water Infrastructure
Gurgaon 122 016, Haryana

ICRISAT Science with a human face
International Crops Research Institute for the Semi-Arid Tropics

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In partnership with ICAR

Table of Contents

Executive Summary

The Bundelkhand region of central India is the hotspot of water scarcity, land degradation and poor socio-economic status. The Parasai-Sindh watershed, comprising three villages and covering nearly 1,250 ha, was selected for developing a benchmark site in Jhansi district. From 2012 onwards, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) along with national partners National Research Centre for Agro-Forestry (NRCAF), district administration, government of Uttar Pradesh and local community started implementing watershed interventions in this area.

As an entry point, community mobilization and rapport building was achieved through formation of watershed committee under the regular support and guidance of NRCAF and ICRISAT. The required information and knowledge sharing was achieved through regular meetings (formal and informal). Regular interactions with the community contributed to strong trust with each other resulting in effective planning and implementation of watershed activities in the target villages.

Science-led interventions comprised soil and water conservation practices, productivity enhancement activities, crop diversification and intensification, integrated nutrient and pest management and other livelihood based activities. The village and the watershed committees identified potential locations where different soil and water conservation interventions such as check dams and gully control structures could be made. Series of check dams on the main river stream were constructed, which collectively developed 125,000 m^3 of storage capacity by the end of the June 2015 (9 check dams; 3 nala plugs, 1 haveli renovation, 1 community pond, 1 farm pond). It is estimated that these structures have harvested nearly 250,000 m^3 of surface runoff or more and has facilitated groundwater recharge. In Parasai-Sindh watershed, the groundwater table on an average increased by 2.5 m, varying from 2.0-4.0 m as per toposequence compared to non-interventions (or control watersheds) stage. This has increased cropping intensity by 30-50% especially during post monsoonal season.

Productivity of post-monsoonal crop especially wheat has doubled after the watershed interventions. Wheat yield before the watershed interventions was in the range of 1,500-1,800 Kg ha^{-1}. Before watershed intervention, despite the good establishment of crop, there was a high chance of crop failure or poor production, as depleted water resources by the end of Jan-Feb resulted in water shortage for supplemental irrigation at the flowering or milking stages of the crop development. After the implementation of the watershed program, farmers on an average started harvesting wheat yield ranging from 3,500-4,000 kg ha^{-1} which has made significant improvement in their income and livelihood. Further, farmers have shifted from low-water requiring crops to high-value crops. For example, there is huge shift in the cropping system, from chickpea to wheat during *Rabi* (postrainy) and vegetables in summer. Fodder availability has drastically increased and therefore milch animal population also increased by 30% within the first 3 years of the project period. Large scale surface and groundwater availability reduced the drudgery of men and women farmers in the villages. Easy access to drinking water for domestic animals has resulted in an average increase in milk yield per animal by one liter or more.

Moreover *in-situ* soil and water conservation practices have been promoted. Field bunds on farmers' fields and water outlet structure for safe disposal of excess runoff were also constructed. Agro-forestry is being strengthened by promoting tree plantation on farm bunds.

Improved varieties of chickpea and wheat were introduced and this has improved the crop yield in the villages by 30-50%. Moreover, improved groundnut varieties were introduced and evaluated through farmer's participatory field trials. In addition, various income-generating activities such as vermicompost, nursery plantation and "*dona-pattal"* making were promoted. Steps to enhance farmer's capacity through training program, exposure visits and field days were also undertaken.

To analyze the impacts of the planned interventions on water resource availability, crop productivity, water use efficiency and various ecosystem services, special attention was given to monitoring crop and biophysical indicators. First, a baseline information, comprising soils, topography, land use, crop yield details and socio-economic status of the households at the beginning of the project, was collected. State-of-the-art instruments were installed at different locations in watershed to monitor various hydrological components such as rainfall, groundwater level and surface runoff. In addition, water levels in 300 open wells were monitored manually on a monthly basis from June 2012. Crop yields and irrigation inputs were measured in selected fields for analyzing yield potential and water use efficiency. It is estimated that watershed interventions enhanced the average annual family income from 50,000 INR (830 USD) to 125,000 INR (2080 USD) in a short span of 3 to 4 years.

Background and Objectives

Degradation of agro-ecosystems and declining sustainability are major concerns for agricultural development in many poor regions of India, where rural livelihoods depend directly on management of land and water resources (Reddy et al., 2007). Bundelkhand is situated in central part of the India covering part of Uttar Pradesh and Madhya Pradesh. Bundelkhand is a hotspot of water scarcity, land degradation and poor socio-economic status. The region has experienced severe drought situation between 2004 and 2007. More than 80 % of the open wells dried out soon after the monsoon period due to deficit rainfall and poor groundwater recharge. In the absence of drinking water and livelihood opportunities, a large portion of the rural community migrated to nearby cities. Water for agriculture as well as domestic water sectors were adversely affected. Urban and rural communities largely depended on outside water source and private suppliers such as tankers for domestic supply, especially during summers. Cattles were abandoned due to water shortage and less fodder availability. In such conditions, the watershed development program was an effective intervention to enhance groundwater recharge and reduce water stress situation. The Coca-Cola India Foundation for Rural Water Infrastructure and ICRISAT led consortium, along with the National Research Centre for Agro-forestry (NRCAF), farmers and the Government of Uttar Pradesh, identified a micro-watershed, Parasai-Sindh in Babina block of Jhansi district, as a pilot site for improving water use efficiency, groundwater recharge and strengthening ecosystem services through community watershed management program. This watershed covers 1,250 ha and comprises of 3 villages named Parasai, Chhatpur and Bachauni (located at 25^0 23 ' 56 " to 25^0 27 ' 9.34 " N and 78^0 19 '45.71 " to 78^0 22 ' 42.57" E. - See Figure 1). The watershed development program in these selected villages started from 2011 onwards.

The specific project objectives were:

- To enhance water availability in target villages through rainwater harvesting and recharging of wells

- To enhance water use efficiency and agricultural productivity through improved management of land and water resources
- To establish a site for learning within five years of project inception
- To transform entire village from degraded stage to productive stage showing the example of science led consortium approach.

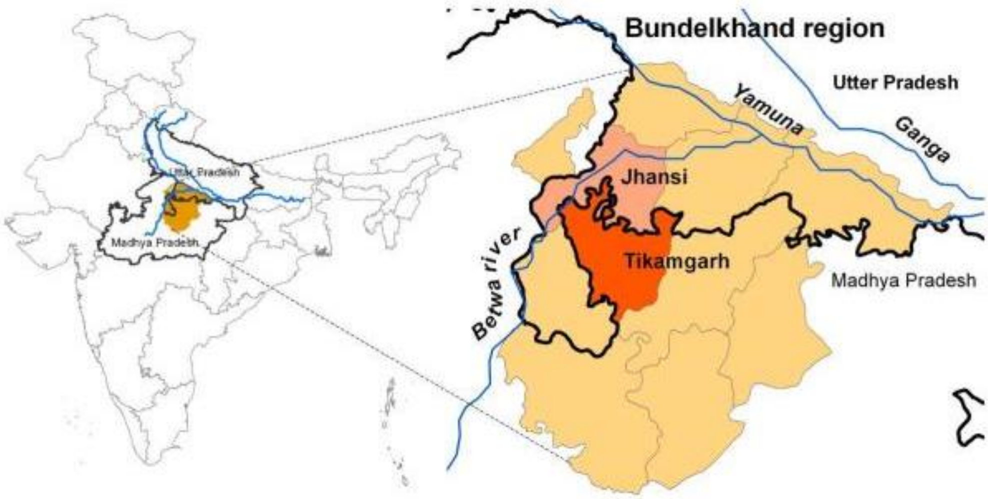
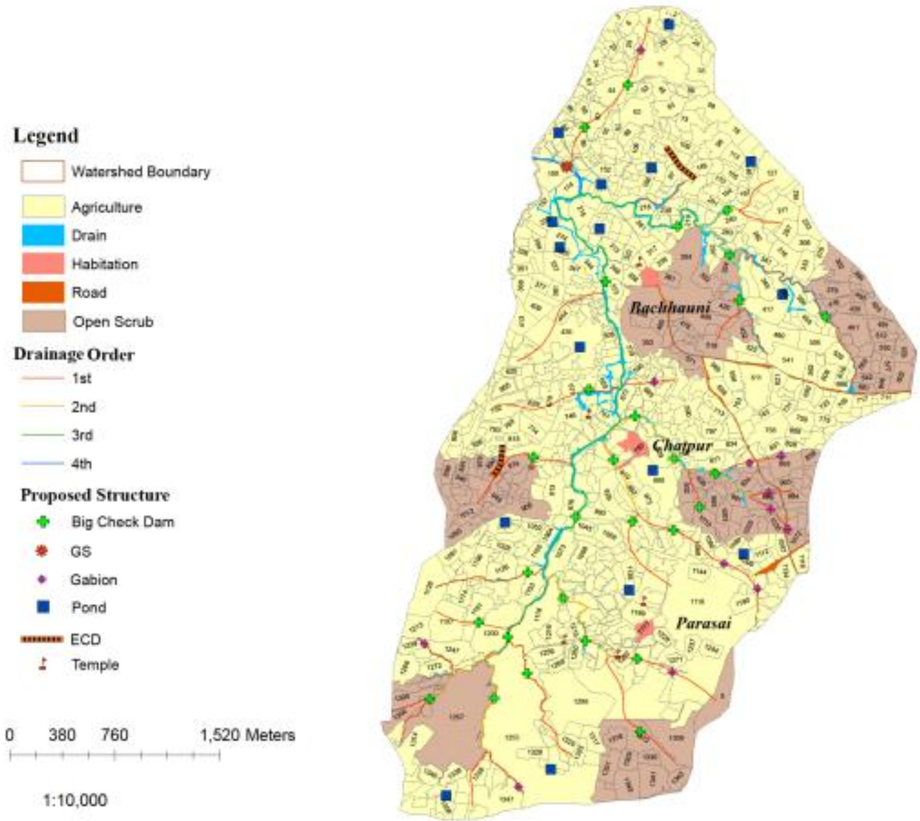


Figure 1. Location of Parasi-Sindh watershed, Jhansi district



Work Progress Since 2011

Watershed Delineation

Topographic data of the study region downloaded from the ASTER remote sensing data (via public domain), was of 30 m spatial resolution. This data was processed in the Geographic Information Systems (GIS) environment for delineating the stream network and watershed boundary. Topography of the watershed is relatively flat with 0.5 to 1.0 % of average land slope (Figure 2).

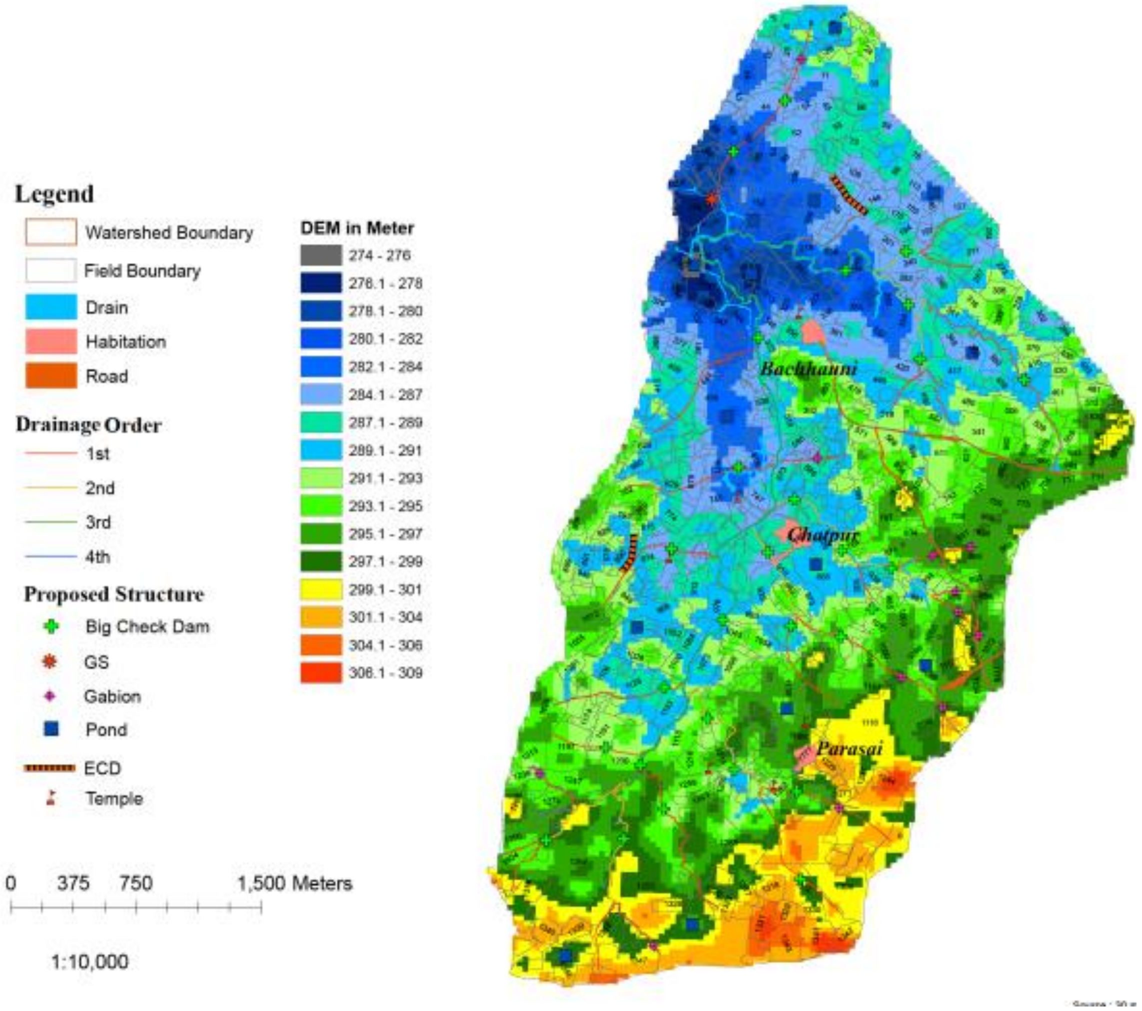


Figure 2. Topography of the watershed, stream network and watershed boundary of the Parasai-Sindh watershed

Land Use Classification

Land use is one of the important indicators which needed to be mapped before the initiation of watershed development. Agricultural land, waste land, residential area, roads and drainage network of the Parasai-Sindh watershed was identified with the help of remote sensing data base, Google Earth and ground survey, for all three villages in the pilot watershed (Figure 3).

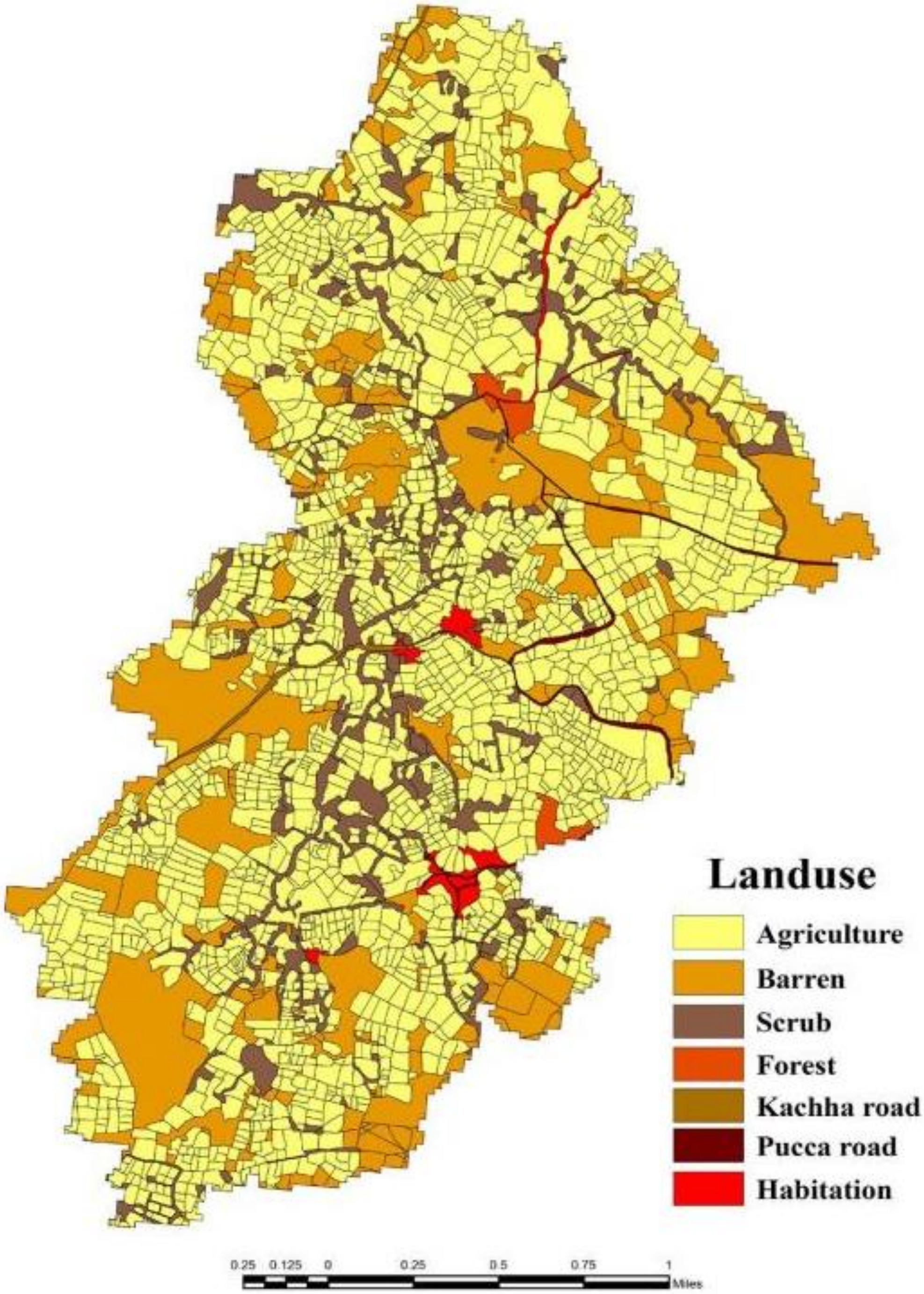


Figure 3. Land use-land classification of Parasai-Sindh watershed

Baseline survey was conducted in all three villages to understand the biophysical, social and economic condition of the selected watershed. Table 1 and Table 2 summarizes the biophysical and land use details of the pilot villages. This watershed is dominated by agricultural land, covering nearly 63% of the total geographical area. Thirty-two percent is covered by barren and scrub land, mainly used for grazing purpose. Groundnut, blackgram, sesame are dominant rainy season (*Kharif*) crops. Wheat and chickpea are mainly grown in the postrainy (*Rabi*) season. Average productivity (kg ha^{-1}) in the project villages for these crops were: wheat-2000 kg ha^{-1} barley-3,425 kg ha^{-1}, blackgram-350 kg ha^{-1}, greengram-398 kg ha^{-1}, chickpea-1,340 kg ha^{-1}, mustard 715 kg ha^{-1}, sesame-315 kg ha^{-1} and groundnut-775 kg ha^{-1}. Crops and their average productivity in project villages are given in (Table 3).

There are 388 open wells in the watershed which are the primary source of domestic and agricultural water. Tube wells in this region do not work due to hard rock aquifer and poor specific yield. Soils of the watershed are reddish to brownish red in color (Alfisols and Entisols) and characterized by shallow (10-50 cm), coarse gravel and light textured, with poor water holding capacity.

Table 1. General characteristics of Parasai-Sindh watershed	
Watershed location and topographic parameters	
Location	25^0 24' to 25^0 27' N Latitude, 78^0 20' to 78^0 22' E longitude
Area	1,250 ha
Altitude	270 to 315 m above MSL
Relief (m)	45
Length (m)	6,263
Width (m)	3,994
Perimeter (km)	27.83
Drainage density (km/km^2)	2.11
Land use classes (ha)	
Agricultural land	786 (63.1 %)
Barren land	323 (25.9 %)
Forest	6 (0.5 %)
Drain and Scrub land	111 (8.9 %)
Road (kachha and pucca)	11 (0.9 %)
Habitation	9 (0.7 %)

Table 2. Major crops cultivated during *Rabi, Kharif* and common property lands	
Season	**Cropping system**
Rabi crops	Wheat, gram, pea, etc.
Kharif crops	Groundnut, blackgram, sesame, etc.
Source of irrigation	388 open shallow dug wells existing in unconfined aquifer
Vegetation resource Live fence	Neem along road side, scattered desi *ber* (*Zizyphus mauritiana*) on field bunds , *Butea* along the drains Few farmers have *L. camera* along roadside as live fence

Table 3. Crops and their productivity kg/ha in project villages				
	Villages			
Crops	**Bachauni**	**Chhatpur**	**Parasai**	**Average**
Groundnut	750	750	840	770
Blackgram	250	250	600	350
Greengram	350	250	600	400
Sesame	250	250	510	310
Wheat	2000	2000	2000	2000
Chickpea	-	-	1340	1340
Mustard	690	730	720	710
Barley	-	-	3420	3420

Socio-economic Characterization

Socio-economic data such as crop yield and production, income source, livestock, literacy parameters are recorded. The total population of three villages in watershed is 1,918 persons: 1,068 male and 850 female (Table 4). Big farmers in the villages generate 80% of their income from agriculture and 20% from milk production. Percentage of income for the small and marginal farmers from agriculture and sale of milk is in almost equal proportions. Daily wage activities are also a source of income for the small and marginal group. Literacy status in the villages is poor, with an average of about 41.5% male and 12.4% female being literate. However, the literacy among children, both for male and female child, is more than 60%.

Table 4. Demographic details of the project villages

Village	No of households	Adult Male	Adult Female	Adult total	Male Child	Female child	Child total
Bachhauni	61	214	200	414	187	110	297
Chhatpur	86	217	187	404	167	108	275
Parasai	63	157	131	288	126	114	240
Grand Total	**210**	**588**	**518**	**1106**	**480**	**332**	**812**

Quality of Groundwater

Water in the open wells of the project villages is safe for drinking (ISO: 10500 safety requirements for drinking water). Table 5 presents the water analysis results, of the water samples from open wells used for drinking purpose in the project villages. However, human health survey conducted during 2013, showed large scale intestinal worm infection. This indicates the need for awareness building on safe use of water and food, and maintain hygiene.

Table 5. Groundwater quality for drinking purpose in project villages

SN	Parameter (mg/L)	Chhatpur	Parasai	Threshold
1	pH	7.45	7.51	6.5 to 8.5
2	EC (dS/m)	0.46	0.48	-
3	Total Dissolved Solids	307	320	Maximum 500
4	Alkalinity to Phenolphthalein as $CaCO_3$	Nil	Nil	-
5	Alkalinity to methyl orange as $CaCo_3$	225	220	-
6	Total Hardness as $CaCo_3$	184	203	Maximum 300
7	Chloride as Cl	7	14	Maximum 250
8	Sulphate as SO_4	2	2	Maximum 150
9	Nitrate as NO_3	38	47	Maximum 45
10	Fluoride as F	0.7	1.5	0.6 to 1.2
11	Calcium as Ca	62	61	Maximum 75
12	Magnesium as Mg	7	12	Maximum 30
13	Potassium as K	1	1	-
14	Sodium as Na	11	19	-
15	Iron as Fe	0	0.1	Maximum 0.3
16	Cadmium as Cd	Nil	Nil	Maximum 1
17	Cobalt as Co	Nil	Nil	Maximum 0.05
18	Copper as Cu	Nil	Nil	Maximum 2.0
19	Lead as Pb	Nil	Nil	Maximum 0.5
20	Manganese as Mn	Nil	Nil	Maximum 0.1

The water quality parameters for irrigation are as follows:

(i) pH- normal range----6.5- 8.5

Abnormal range; needs careful evaluation; indicates corrosion and encrustation problems; could be a breeding ground for disease causing bacteria/ mosquitoes

(ii) Residual sodium carbonate m el /l

Safe < 1.25
Moderately safe 1.25- 2.5
Unsafe >2.5

(iii) Sodium adsorption ratio

Safe <10
Moderately safe 10-18
Moderately unsafe 18-26
Unsafe >26

(**iv) Boron content**

Low hazard < 1.0 ppm
Medium hazard 1.0-2.0 ppm
High hazard 2.0- 4.0 ppm
Very high hazard > 4.0 ppm

Table 6 provides results of analysis of water quality in villages' open wells. The analysis show that the water quality of the open wells is safe for irrigation purpose also.

Table 6. Water quality of Irrigation well in project villages

	Sample No.	Chhatpur	Parasai
1	pH	7.45	7.51
2	Electrical conductivity dS/m	460	480
3	Carbonate m.e/l	NIL	NIL
4	Bicarbonate m.e/l	3.60	4.60
5	Chloride m.e/l	0.2	0.2
6	Nitrate	0.62	0.72
7	Sulphate m.e/l	0.05	0.04
8	Boron me/l	nil	nil
9	Calcium me/l	3.0	3.0
10	Magnesium m.e/l	0.63	0.96
11	Sodium m.e/l	0.57	0.82
12	Potassium m.e/l	0.02	0.03
13	Residual sodium carbonate m.e/l	0.3	0.8
14	Sodium Adsorption Ratio	0.43	0.58
15	Sodium%	14	17

Agroclimatic Characterization

The project location consisting of three villages falls in agro-climatic zone of central plateau hill region representing a transitional zone of tropical sub-humid to semi-arid and comes under hot moist semi-arid ecological sub-region. The agroclimate of the project location is characterized by dry and hot summer, warm and moist rainy season and cool winter with occasional rain showers. Mean annual temperature ranges from 24 to 25°C. The mean summer (April-May-June) temperature is 34°C which may rise to a maximum of 46 to 49°C during May and June. The mean winter temperature (December-January-February) is 16°C which may drop to 3-5°C in December and January. The diurnal variation in temperature is quite high. The mean annual relative humidity varies between 40 to 60%. The early rise in temperature during March-April, accompanied with westerly winds, reduces the humidity and causes desiccation of the *Rabi* crops, resulting in poor grain development. Rainfed agro-ecosystem occupies the major cropped areas of the Bundelkhand region. Although agriculture is the mainstay of the people, only 20% of the net sown area is irrigated by open wells as lifesaving irrigation.

The annual rainfall in the Bundelkhand region varies from 600 to 1,300 mm, with an average of 850 mm, about 90% of which is received during the southwest monsoons. The major part of the rainfall is received during the months of July and August. The length of the growing season in Bundelkhand ranges between 90 to 150 days depending upon rainfall and temperature regimes.

Formation of Watershed Committee

In 2011, an ICRISAT–led consortium along with NRCAF Jhansi, farmers and district administration selected the Parasai-Sindh watershed for enhancing water resources availability and to optimize agricultural productivity. The villagers and watershed committee members were involved from the project inception stage.

Watershed committees of Chhatpur and Parasai villages were formed (Figure 4; Table 7) to implement the watershed work. As the farmers are the primary stakeholders and beneficiaries, the involvement of the community was important for the successful execution of project activity/interventions and to ensure long term sustainability of the project. Women and SC/ST candidate and members from Gram Panchayat were also involved in the formation of watershed committee, as per common guidelines.

Figure 4. Formation of Watershed Committee

Table 7. Watershed committee members in Parasai-Sindh watershed						
	Chhatpur Sub-Watershed Committee			**Parasai Sub-Watershed Committee**		
SN	**Name**	**Designation**	**Gender/ Category**	**Name**	**Designation**	**Gender/ Category**
1	Badam Singh	President	M (OBC)	Kalyan Singh	President	M (OBC)
2	Balaram Yadav	Secretary	M (OBC)	Chandrabhan Yadav	Secretary	M (OBC)
3	Jadgish	Member	M (OBC)	Deepak Yadav	Member	M (OBC)
4	Karan Singh Pal	Member	M (OBC)	Uttam Ahirwar	Member	M (SC)
5	Ram Milan Yadav	Member	M (OBC)	Thakurdas	Member	M (OBC)
6	Pramod Yadav	Member	M (OBC)	Ghanshayam Kushwaha	Member	M (OBC)
7	Lala Ram Pal	Member	M (OBC)	Roshan Ahirwar	Member	M (SC)
8	Ram Charan Prajapati	Member	M (OBC)	Mattulal Prajapati	Member	M (OBC)
9	Babulal Yadav	Member	M (OBC)	Vishvanath Yadav	Member	M (OBC)
10	Anguri Yadav	Member	F (OBC)	Shivcharan Ahirwar	Member	M (SC)
11	Kali charan Prajapati	Member	M (OBC)			
12	Balveer Yadav	Member	M (OBC)			
13	Gulab Pal	Member	M (OBC)			
14	Komal Pal	Member	M (OBC)			

The committee was constituted in an open meeting and the objectives were briefed clearly. The committee members and villagers were involved at each and every stage of the project planning and execution of the proposed interventions. For example, site selection for construction of water harvesting structures, deciding on the types of structure, material procurement, record keeping, bills verification, payment delivery, etc., were handled by the watershed committee under the guidance of the consortium team. Transparency at every step established a good rapport and resulted in large, active participation of the village community in the watershed management and development.

With the technical backstopping of NRCAF and ICRISAT staff, potential locations for soil and water conservation structures were identified by the watershed committee and villagers themselves. Similarly, decisions on procurement of quality seeds, planting materials and other inputs were taken by the committee in open meetings. Right approach and knowledge based entry point enabled the village community to take up the responsibility, bring transparency and accelerate the execution process.

Formation of Environmental Clubs

Environmental clubs were formed in the watershed. These clubs involved women and children participants and aimed to create awareness about conservation and better utilization of natural resources such as water, air and groundwater resources. Consortium team interacted with children and women groups (Figure 5) and shared their knowledge on soil and water conservation. There were discussions around issues related to drinking water quality and causes of water pollution. Formation of these environmental clubs acted as an entry point activity during the project initiation. Consortium team gathered at the center of the village and interacted with the children through various activities such as team building exercises (conducting games, quizzes etc.,) and books on environmental issues were given away as prizes to the winners.

Taking the above activity further, 15 children were chosen to become members of the eco-club, based on their knowledge and participation. These children belong to diverse socio-economic background, attend different schools and are in the age group of 10-14 years. The project team motivated them to circulate books, share the knowledge and meet regularly at given venue and fixed dates. Formation of eco-clubs facilitated consortium team to interact with farmers and women groups and also with the village administration.

> Akash aged 10, from Chhatpur village was a Class 4 dropout who ploughed his deceased father's field. He was amongst the first group of farmers who was taken on an 'exposure visit' to Garhkundar watershed. He was also amongst the first farmers in the village who did grafting in the ber (*Zizyphus mauritiana)* bushes. He also felt the need to join school and continue his studies.

Eco-club members sent a formal letter to the watershed committee requesting for plants which they could plant in their backyards. The survival rate of these fruit plants planted by the children was much more than those by grownups. Members and non-members made miniature watershed models with sand and tried to understand the watershed intervention being undertaken in their villages. There was tremendous response from the girls as well who took active part in all activities. Children were given chalk and colors to write wrote slogans on sanitation and water conservation in their villages.

During a visit to Chhatpur village it was learnt that this village was not covered totally under the Integrated Child Development Services (ICDS) scheme which provides young children with food and nourishment, and is sponsored by the central government. The project took cognizance of this and sent a request to the authorities to pursue the matter. Since March 1, 2013 an ICDS center has been newly opened in the village benefiting 50 infants aged 7 months to 3 years, 68 children between the age group of 3 to 6, 11 pregnant women and 15 mothers feeding their infants and 3 young girls.

Figure 5. Members of environmental club (women and children) interacting with ICRISAT scientist in Parasai-Sindh watershed

Water Resources Development

Rainwater Harvesting

Open wells are the only source of water for domestic and agriculture use in the selected villages. Groundwater recharge in Bundelkhand areas is generally poor due to hard rock geology and poor specific yield. The situation becomes more critical during the summer months and dry years. Constructing low-cost water harvesting structures is one of the important interventions for groundwater recharge. These structures harvest substantial amount of surface runoff, allow them to percolate into aquifer and facilitate groundwater recharge.

A number of locations for harvesting surface runoff were identified with the help of the watershed committee and village members. A list of water harvesting structures constructed during 2011 and 2015, along with their storage capacities, is shown in Table 8. Nearly 125,000 m^3 storage capacity was developed in watershed by constructing various water harvesting structures (Figures 6, 7 & 8). Water balance described that such water harvesting structures can harvest surface runoff by a factor of two to three times of the developed storage capacity in a normal year (with average rainfall of 800 mm). Moreover, water table monitoring along with state-of art runoff monitoring system described that these structures harvested nearly 250,000 m^3 of surface runoff between June and Oct, resulting in high groundwater table. Water table in Parasai-Sindh watershed increased by 2.5 meter on average, compared to pre-implementing watershed activities. Increase in water table is found as high as 4.0 meter near stream location and 2 meter at upstream areas.

Figure 6. Check dams constructed at different locations in the watershed for rainwater harvesting during monsoon period

Figure 7. Water harvested by the check dam at Chhatpur village during Kharif 2012

Figure 8. Water harvested in different structures during Kharif 2013-14

Table 8. Details of water harvesting structures and storage capacity developed in Parasai-Sindh watershed (by end of June 2015)		
Structure	**Number**	**Storage capacity (m³)**
(9 Checkdams; 3 nala plugs, 1 haveli renovation, 1 community pond, 1 farm pond)	15	125,000
Field drain	1	-
Total storage capacity (m³)		**125,000**

Agroforestry Interventions

Through agroforestry interventions in the watershed, 15,983 seedlings of different tree species were planted in the farmer's fields (Figure 9). Brief account of seedlings of different species planted in watershed is given in Table 9a, 9b and 9c.

Figure 9. Teak and other trees were planted along the field bunds under the agro-forestry interventions in Parasai-sindh watershed during June-July 2012

Table 9a. Details of seedlings planted in watershed during 2011				
Village	**Parasai**	**Chhatpur**	**Bachhauni**	**Total**
Guava	70	172	8	250
Papaya	100	0	0	100
Teak	400	960	140	1500
Lemon	210	0	40	250
Mango	37	103	0	140
Bamboo	54	341	5	400
Jackfruit	81	120	24	225
Pomegranate	5	54	2	61
Karonda	12	13	0	25
Aonla	6	144	0	150
Total	**975**	**1907**	**219**	**3101**

Table 9b. Details of seedlings planted in watershed during 2013				
Village Name	**Parasai**	**Chhatpur**	**Bachhuni**	**Total**
No of beneficiaries	29	19	9	57
Teak	2450	2750	1250	6450
Lemon	529	130	145	804
Jack-Fruit	215	109	36	360
Bamboo	519	110	44	673
Anola	237	208	51	496
Karonda	149	92	36	277
Jamun	10	37	23	70
Mango	118	52	23	193
Shisham	98	43	17	158
Eucalyptus	74	42	18	134
Guava – Kalmi	185	121	33	339
Total seedlings	**4584**	**3694**	**1676**	**9954**

Table 9c. Details of seedlings planted in watershed during 2014				
	Parasai	**Chhatpur**	**Bachhuni**	Total
No. of Beneficiaries	29	55	8	92
Lemon	90	475	18	583
Jack-Fruit	6	21	4	31
Bamboo	37	27	16	80
Aonla	89	100	6	195
Karonda	24	63	7	94
Jamun	19	11	0	30
Mango	30	14	8	52
Shisham	9	8	4	21
Guava (grafted)	160	477	21	658
Anar	45	43	6	94

Teak	20	1070	0	1090
Total seedlings	**529**	**2309**	**90**	**2928**

Table 10. *Lac* production in watershed

Village	Farmer name	No. of trees inoculated	Young trees /saplings	Brood *Lac* inoculated (kg)	Stick *Lac* harvested
Chhatpur	Sh. Gulab	20	6	16	40.3
Chhatpur	Sh. Balbir	11	-	6	12.5
Chhatpur	Sh. Balaram	1	40	10	18.2
Parasai	Sh. Rajbir	7	16	5	9.7
Parasai	Sh. Jagdish	1	1	1.4	2.5
Parasai	Sh. Shiv Dayal	2	3	1.2	2.0
Parasai	Sh. Kalyan Singh	1	-	1	2.0
Parasai	Sh. Manoj Yadav	8	-	5	7.0
Total		**51**	**74**	**48.1**	**94.2**

Survival of different species varied from 66 to 95 % by end of November 2014. Apart from this, more than 300 desi *ber* were budded with improved varieties and survival was about 65 % by December 2014. Farmers of the watershed were exposed to *Lac* demonstration site at the NRCAF campus. They were briefed about its advantages, benefits, and management and cultivation practices. Many farmers showed willingness to adopt the technology. The survey and marking of trees were done during the month of January. Both young (4-6 years) and mature trees (10-16 years) were selected. Trees were pruned at the end of January (Figure 10). Brood *Lac* was procured from the Indian Institute of Natural Resins and Gums (Jharkhand, India). In total, eight farmers were selected for *Kharif* crop and 4 for *Baisakhi* crop. Brood *Lac* inoculated during June. The production statistics of *Kharif* crop is given in Table 10.

Figure 10. Tree of desi ber (traditionally grown) budded with improved variety

Productivity Enhancement Interventions

The yield gap analysis undertaken by ICRISAT revealed that large yield gap exists for all the major rainfed crops grown in the semi-arid tropics. Further, there is a potential of increasing the productivity by two to three folds using available technologies in the farmers' fields (Wani et al., 2009; 2012). Soils in the rainfed areas are not only water scarce but also deficient in essential nutrients, as 50-90% of the farmers' fields are found deficient in sulphur, zinc and boron (Table 11).

Table 11. Soil fertility status in selected villages

	EC (ds/m)	Exch-K (mg/kg)	Ols-P (mg/kg)	Org-C (%)	Avail-Zn (mg/kg)	Avail B (mg/kg)	Avail-S (mg/kg)
AVG*	0.16	83	11.12	0.51	0.75	0.23	5.47
STD	0.10	60	6.96	0.19	0.39	0.11	3.00
Max	0.54	335	36.00	1.10	2.50	0.64	19.95
Min	0.04	25	1.20	0.22	0.22	0.10	1.85

* Total 80 soil samples were collected from top 0-15 cm depth

In this context, farmers' participatory trials were conducted during *Kharif* 2011 to demonstrate the impact of micro nutrients (Zinc and Boron) application, on groundnut yield. Farmers contributed 50% of fertilizer cost [Agribor (B) and Zinc Sulphate ($ZnSO_4$)] and local groundnut variety was grown at nine watershed locations. It was observed that application of B and Zn increased groundnut yield by 15-20 % (Figure 11) over control plots (Table 12).

Figure 11. Farmers doing crop cutting exercise in demonstration field and estimating groundnut and wheat yield

Table 12. Impact of balanced micronutrient application on groundnut during *Kharif* – 2011.	
Treatment	**Pod yield (kg/ha)**
Groundnut + RDF* + Agribor + Zink Sulphate	1825 (21%)*
Groundnut + RDF	1510

* RDF: Recommended Dose of Fertilizers; Groundnut variety: local; * figures in parenthesis are % increase over control.

During *Rabi* 2011, improved varieties of chickpea (*Vaibhav*), lentil (DPL62) and mustard (*Pusa Bold*) were introduced (Figure 12) in 14 farmers' participatory locations (Table 13). Yields of the improved crop varieties increased by 18 to 33 % over local crop varieties.

Table 13. Performance of participatory trials at Parasai-Sindh watershed during *Rabi*

Crop	Variety	Number of participatory trials	Average grain yield (kg/ha)	per cent yield increase
Chick pea	Vaibhav	5	1870	33
	Desi	-	1402	-
Lentil	DPL62	6	1130	18
	Desi	-	960	-
Mustard	Pusa Bold	3	1470	25
	Desi	-	1180	-

Figure 12. Farmers participatory field trials on chick pea crop comparing different crop varieties

Participatory Varietal Evaluation of Groundnut in Farmer's Field

Farmers' participatory varietals evaluation trials of groundnut were laid out in Parasai and Chhatpur villages during Kharif, 2012 (Figure 13). Seven varieties *viz*., ICGS 5, ICGV 350, ICGV 86015, ICGV 8784, ICGV 91114, ICGV 9346, and TAG 24 as well as two local varieties *viz*, *Shivpuri* and *Kaushal* were evaluated for enhancing crop yield (Table 14). Pod weight was found highest (95g/100 pods) in ICGV 86015, ICGV 91114 and *Shivpuri*. Lowest pod weight was observed in ICGV 8784 (75g/100 pods). Weight of kernels varied from 0.55 to 0.7 g/pod. Pod yield of different varieties was recorded as 1.2 to 1.9 t ha^{-1}. ICGV 9114 produced highest pod yield (1.9 t ha^{-1}) followed by ICGV 9346 (1.6 t ha^{-1}), whereas variety *Kaushal* (1.2 t ha^{-1}), ICGS 5 (1.3 t ha^{-1}) and TAG 24 (1.4 t ha^{-1}) produced relatively lower pod yield. However, the biomass potential was found highest in *Shivpuri* (4.3 t ha^{-1}) followed by ICGV 8784 (3.9 t ha^{-1}) and ICGV 86015 (3.6 t ha^{-1}).

Table 14. Participatory varietals evaluation of groundnut at farmer's field (*Kharif*-2012)								
S. No.	**Variety**	**Pod weight (g/ 100 pod)**	***Kernels/ pod**	**Kernels wt. (g/pod)**	**100 kernal weight (g)**	**Pod yield (t ha^{-1})**	**Kernel Yield (t ha^{-1})**	**Plant dry matter yield (t ha^{-1})**
1	ICGS 5	85	1.61	0.55	35	1.264	0.591	2.311
2	ICGV 350	85	1.75	0.6	35	1.433	0.731	2.683
3	ICGV 86015	95	1.77	0.7	40	1.317	0.876	3.656
4	ICGV 8784	75	1.72	0.55	30	1.511	0.623	3.839
5	ICGV 91114	95	2.00	0.6	30	1.878	1.07	2.994
6	ICGV 9346	85	1.66	0.55	40	1.617	0.756	2.272
7	SHIVPURI	95	1.70	0.65	40	1.411	0.871	4.311
8	KAUSHAL	85	1.74	0.6	40	1.227	0.626	3.328
9	TAG 24	85	1.84	0.55	35	1.367	0.639	2.417

*Average of 100

Figure 13. Farmers' participatory demonstration field of groundnut crop

Productivity Enhancement in Groundnut Crop

Groundnut yields and other agronomic parameters were analyzed among farmers' participatory experimental fields and compared with traditional variety (*Jhumku*). Improved groundnut variety (TAG 24) was observed to have the highest pods (19.2 pods/plant). Correspondingly, this variety had highest kernel yield (1.68 t ha^{-1}) and pod yield (2.42 t ha^{-1}) as shown in Figure 14. Data showed that introducing improved groundnut variety enhanced crop yield by 30-50% compared to local variety.

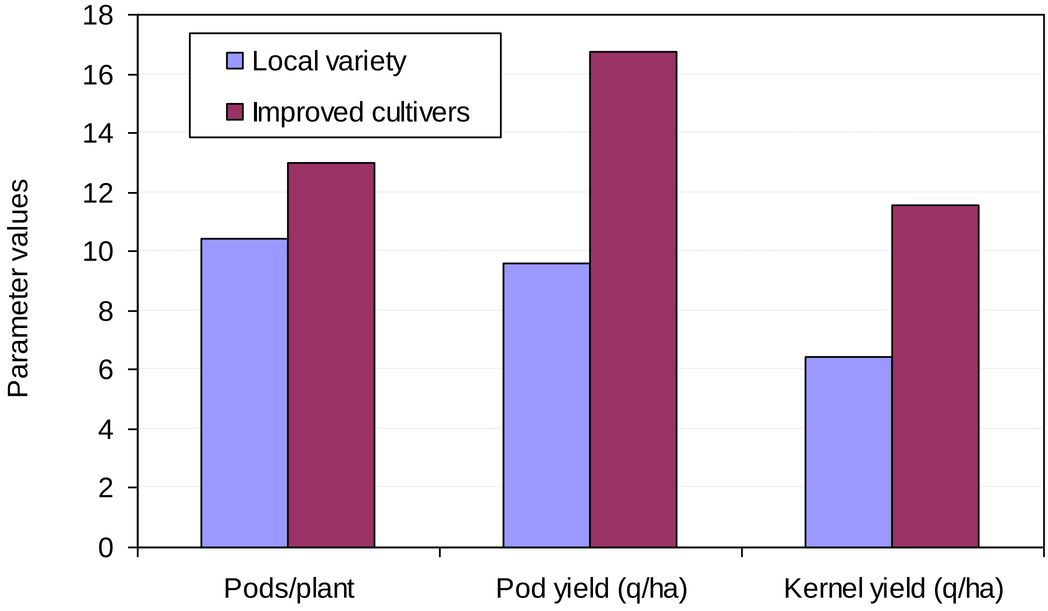


Figure 14. A comparison of groundnut productivity among improved cultivars and local variety in Parasai- Sindh watershed

Productivity Enhancement in Wheat crop

Farmers' participatory demonstrations were also conducted for wheat crop during *Rabi* 2012. During R*abi* 2012-13, crop demonstrations in 30 wheat fields (HI-1418, HI-1479, HI-1531, HI-1544) and 15 chickpea fields (JG-11 and JG-130) were designed. Farmers recognized the clear difference in crop growth and anticipated a 10-15% higher yield while harvesting the crops.

Participatory Varietal Evaluation in Year 2013-14

Farmers' participatory field trails on different crops were conducted during K*harif* 2013-14. Fifteen field trails and two demonstrations with soybean (var. PUSA-9712) and groundnut (ICGV-9346 and *Jhumku*) crops were carried out in *Kharif* 2013-14, showing the effect of improved seeds on crop yields, compared to local variety. Moreover, 80 demonstrations in groundnut and soybean fields were designed to show the impact of applying agribor on crop yield in nutrient deficit fields.

Wheat yield obtained by HI-1544, HI-1531, HI-1479 and HI-1418 were found relatively higher than Lok-1. HI-1544 recorded highest grain yield of 3.59 t ha^{-1} compared to 2.25 t ha^{-1} by Lok-1 . Chickpea yield for JG-11 recorded grain yield 2.65 t ha^{-1} compared to 1.24 t ha^{-1} by local cultivars. Due to heavy rainfall in *Kharif 2013,* no effect of agribore observed in groundnut and soybean fields on harvested yield. Groundnut (ICGV-9346) produced pod yield 1.90 t ha^{-1} (with agribore) compared to 1.48 t ha^{-1} by local cultivar (*Jhumku)* with application of agribore. Soybean (PUSA-9712) yield was s 0.72 t ha^{-1}(with agribore), and 0.65 t ha^{-1} (without agribore) during *Kharif* 2013. Unexpected rainfall during pod formation reduced total yield in *Kharif* 2013 in watershed (Table 15).

Table 15. Grain yield and pod yield of different participatory demonstrations (*rabi*-2012-13 and *kharif* 2013)		
***kharif*-2013**	**Crop variety**	**yield (t ha^{-1})**
		Av. Pod Yield (t ha^{-1})
Groundnut	ICGV-9346 with agribore	1.90
	ICGV-9346 with no agribore	1.84
	Jhumku (Local) with agribore	1.48
	Jhumku with no agribore	1.42
Soybean		**Av. Seed yield (t ha^{-1})**
	PUSA-9712 with agribore	0.72
	PUSA-9712 with no agribore	0.65

Moreover total number of 76 participatory demonstrations (14-Parasai; 44-Chhatpur; 18-Bachhauni) during 2013-14 (*rabi* season) were laid out at farmers' fields with improved varieties. About 28% increase was observed in barley (RD-2552), while 17% increase was observed in mustard (*Maya*) over local varieties (Table 15b).

Participatory crop demonstrations in 2014-15

Total of 65 participatory demonstrations 28-Parasai; 33-Chhatpur; 04-Bachhauni) were laid out at farmer's fields during 2014-15 (*kharif* and *rabi*). About 18% higher yield was observed in case of greengram as compared to local varieties. The detail about the number of demonstrations in each villages and the crop varieties is presented in Table 15b.

Table 15b. Participatory demonstrations at Parasai-Sindh watershed during Rabi 2013 and year 2014-15								
			Demonstration				Improved	Local
Year	**Crop**	**Varieties introduced**	**Parasai**	**Chhat pur**	**Bachh auni**	**Total no. of trials**	**Av. yield kg ha^{-1}**	**Av. Yield kg ha^{-1}**
2013-14	Barley	RD-2552	9	20		29	2395	1473
	Mustard	Maya	4	8	6	18	1194	1019
	Chickpea	JG130				20	1398	823
2014-15	Pigeonpea	ICPL-85063 (Lakshmi), ICPL-88039	3	3		6	762	628
	Green gram*	Samrat					146	131
	Barley	RD-2552	11	7	-	18		
	Chickpea	JG-130	-	6	2	8	1211	821
	Mustard	NRC HB-101, NRC HB-506, NRC DR-02	2	8	-	10	1184	923
	Wheat	HI1532; HI1544; HI1418; HI1479	8	12	8	28	4423	3450

* Due to long dry spell, crop yield drastically reduced

Weeds study during *Rabi* 2012-13 and *Kharif* 2013

Weed density and biomass studies (at harvest stage) were carried out in different participatory demonstration trials (Table 16). Dominating weeds, *Ageratum conyzoides, Anagallis arvensis, Chenopodium album, Cynodon dactylon* and *Lathyrus aphaca,* are generally found in wheat and chickpea. Average weed density was observed to be 2.2 m^{-2} (wheat) and 2.4 m^{-2} (chickpea) with an average biomass accumulation of 2.8 g m^{-2} (wheat) and 3.1 g m^{-2}(chickpea). Weeds *Ageratum conyzoides, Alternanthera sessilis, Celosia argentea, Chrysopogon fulvus, Commelina benghalensis* and *Cyperus rotundus* were the dominating weeds in *Kharif*. The number of weeds recorded in different crops were : 7.7 m^{-2} in groundnut (*Jhumku*), 11 m^{-2} in groundnut (ICGV-9346), 6.2 m^{-2} in soybean (PUSA-9712), 13.5 m^{-2} in greengram, 12.9 m^{-2} in sesame and 6.4 m^{-2} in blackgram.

Table 16. Weed density (No. m^{-2}) and biomass (dry weight in g m^{-2}) of weeds at harvest stage during *Rabi* 2012-13

Weed species	**Wheat**		**Chickpea**	
	Density	**Biomass**	**Density**	**Biomass**
Ageratum conyzoides	2.3	4.5	3.6	5.1
Anagallis arvensis	0.1	0.1	-	-
Chenopodium album	9.8	12.0	11.8	12.0
Cynodon dactylon	4.4	2.7	-	-
Lathyrus aphaca	0.7	1.1	0.7	0.6
Lathyrus sativus	0.9	0.9	-	-
Parthenium hysterophorus	-	-	0.7	0.9
Rumex dentatus		--	0.2	1.2
Sonchus oleraceus	1.6	4.7	1.3	2.7
Spergula arvensis	1.2	0.5	2.7	2.6
Solanum xanthocarpum	0.4	0.8	-	-
Vicia sativa	-	-	0.2	1.2
Unidentified broad leaved	0.3	0.4	0.2	1.7
Average	**2.2**	**2.8**	**2.4**	**3.1**

***Parthanium* Awareness Week**

Parthenium hysterophorus L. (Asteraceae) commonly known as carrot weed or congress grass is a native of central and southern America and a major weed of both agricultural and urban situations throughout India. The weed was spotted for the first time in India in 1955 and has now invaded about 35 million ha across the country. *Parthenium* is an annual herb in which flowering occurs in about a month after germination. A single plant can produce 5,000-25,000 seeds and can produce up to 100,000 seeds in its lifecycle. Its seeds do not have a dormancy period and are capable of germinating any time as per moisture availability. The highest germination rate are at temperature ranging from 12 to 27°C. It is a neo-tropical weed which also constitutes a serious health hazard due to its allergic properties. The pollen grains, air borne pieces of dried plant materials and roots of *Parthenium* can cause allergy-type responses like hay fever, photo dermatitis, asthma, skin rashes, etc. Infestation by *Parthenium* degrades natural ecosystems. It can be controlled by adopting mechanical measures (uprooting during monsoon season before flowering), sowing of *Cassia tora* seeds in the heavily infested areas, application of glyphosate (1-1.5%) before flowering. One of the best methods to eradicate this weed is through the release of bioagent Mexican beetle "*Zygogramma bicolorata*" during monsoon season.

The "*Parthenium* awareness week" were organized during 16-22 August, 2013 (Figure 15). Fifty boxes of bioagent Mexican beetle "*Zygogramma bicolorata*" were procured from the Directorate of Weed Science Research (DWSR), Jabalpur, to improve the crop yields by controlling *Parthenium* weeds. Each box contained about 400-500 beetles. During the *Parthenium* awareness week, lectures, demonstrations, meetings were organized to spread the awareness among farming community on weed management (Figure 15). On this occasion Dr. Sushil Kumar, Principal Scientist, DWSR, Jabalpur, and an expert of *Parthenium* management was the key resource person. He explained about *Parthenium*, its biology and control and also the work being carried out by DWSR, Jabalpur in its management. In his address he explained in detail about the biological control of *Parthenium* using the Mexican beetle. Thereafter, a practical demonstration was given on how to release the Mexican beetle on *Parthenium*.

Figure 15. Scientists from NRCAF, Jhansi and DWSR, Jabalpur speaking on Parthenium and its management during Parthenium awareness week

Developing Forage resource

Napier bajra hybrid and guinea grass are the important pasture species suitable for higher forage production. These have profuse tillering and regeneration capacity, high leaf-stem ratio and provide highly nutritious fodder to the livestock. About 90,000 rooted slips of napier bajra hybrid and *guinea* grass were transplanted in an area of about 2 ha (on bunds, near check dams) during monsoon (Figure 16). Two cuts, at an interval of 60 days, were obtained from the established areas. On an average Napier bajra hybrid and guinea grass recorded 4.57

and 3.35 (dry matter yield) DMY t ha^{-1}, respectively.

Similarly about 37,000 rooted slips of Napier bajra hybrid, guinea grass and TSH were transplanted on bunds, near checkdams and around ponds during 2014. Due to deficit rainfall, only a single cut could be obtained from the pasture established areas. On an average, biomass yield of 2.87 DMY t ha^{-1} could be obtained from the mixed pasture.

Figure 16. Napier slips planted at bunds near stream network

Income-generating Activities

Most families in the watershed have landholdings and cattle and women work alongside their husbands in fields. Yet, due to *pardah* system, it was difficult to communicate with them at the beginning of the project. The project team took help of a youngster from within the village to communicate with the women members. Young girls in the villages have taken the responsibility to form women self-help groups (SHGs) so that they can avail the benefits of government schemes. One such women SHG group was formed and promoted on generating vermicompost and nursery plantation in the project village.

Support for Training and Employment Program (STEP), a Government of India scheme, is to be converged with this watershed program. Meetings and discussions with the women groups have revealed that most of them are interested to take up vegetable cultivation as they are already growing them and sell their produce in the village. They offered valuable suggestions for incorporating input supply center and provisions for seed and pesticide to be incorporated in the project plan.

Income generating activity for land less (Self Help Groups)

One day training program on *dona* (platter) making was organized on 30 August 2014 at Bachchauni village in Jhansi district in which tribal farmers participated. Six SHGs were formed namely Shrihit swayam sahayata samooh, Parasai, Jai mata di swayam sahayata samooh, Bachhauni (Tribal), Jai Pathan Baba swayam sahayata samooh, Bachhauni, Jai khati baba swayam sahayata samooh, Chhatpur, Shri ganeshay namah swayam sahayata samooh, Bachhauni (Tribal) and Shri Radhe-Radhe swayam sahayata samooh, Bachhauni to undertake the activity under income generation (Figure 17 and 18).

Figure 17: Inauguration of Dona making machine at Bachhauni

Figure 18. Meeting of Self Help Group (SHG) members discussing various activities

Capacity Building

Promoting agro forestry interventions and budding of *Zizyphus mauritiana* (ber)

Farmers of the project villages were motivated to adopt agroforestry practices in their fields. Training programs on *Zizyphus* (b*er*) budding were conducted at the watershed villages and farmers identified for *Zizyphus* budding. It was planned with the technical help of NRCAF scientist.

Training on Vermicomposting Generation

Soil test results showed deficiency of micro-nutrients and poor organic matter. Use of un-decomposed manure may cause several pest problems and lead to poor crop productivity. Training on preparation of vermicompost from locally available materials (crop straw, biomass and cow dung) was conducted (Figure 19). In 2012, farmers constructed 12 pits at different locations (Figure 20) in watershed and produced nearly 40-50 tons of vermicompost.

Figure 19. Training organized for making vermicomposting at Parasai-Sindh watershed

Figure 20. Vermicomposting pits constructed by farmers in Parasai-Sindh watershed

A farm innovation day was organized at village Chhatpur (Parasai-Sindh watershed) in November 2013. Farmers were made aware and motivated about the role of agroforestry in the rural livelihood. A three-day training cum exposure visit program on vermicomposting was organized during 12-14 March, 2013 at village Ganeshgarh in Jhansi district. Farmers from Parasai-Sindh watershed villages i.e. Parasai, Chhatpur and Bachhauni participated in it. Six Self Help Groups (SHGs) were formed namely Shrihit Swayam Sahayata Samooh, Parasai, Jai Mata Di Swayam Sahayata Samooh, Bachhauni (Tribal), Jai Pathan Baba Swayam Sahayata Samooh, Bachhauni, Jai Khati Baba Swayam Sahayata Samooh, Chhatpur, Shri Ganeshay Namah Swayam Sahayata Samooh, Bachhauni (Tribal) and Shri Radhe-Radhe Swayam Sahayata Samooh, Bachhauni.

Land form Treatment by Tropicultor

Tropicultor is a multipurpose animal-drawn tool developed at ICRISAT to carry out all agricultural operations such as land preparation, seed sowing, fertilizer application and inter-cultivation operations. Tropicultor with accessories were made available to the committees in respective three villages (Figure 21). Farmers were involved in field demonstration trials with improved technologies including tropicultor use, maintaining suitable plant to plant spacing and optimum plant population.

Figure 21. The use of tropicultor in making broad bed and furrow (BBF) is demonstrated to farmers in model watershed

Fodder Management and *Lac* Cultivation

One day training on fodder management and *lac* cultivation is organized at NRCAF. Preservation of green fodder by silage making and procedure of *lac* cultivation was described to farmers (Figure 22).

Figure 22. Farmers practicing Lac cultivation at Parasai-Sindh watershed

Exposure Visits

A one-day exposure visit-cum-training program was organized for villagers from project villages, at Gadkundar watershed and Domagaur-Pahuj, to enhance their capacity. More than 50 farmers participated in this program. Farmers observed various interventions including soil and water conservation measures, rainwater harvesting structures, well recharging, improved crop varieties and cropping systems, crop diversification with high-value crops, productivity enhancement, livestock-based improvement, livelihood initiatives, and interacted with the local community. The visiting farmers were impressed with the salient impacts that resulted due to the implementation of this model and appreciated the success due to collective action.

They expressed that the visit provided an excellent learning opportunity. In 2012, farmers from Parasai-Sindh watershed also visited Indian Agricultural Research Institute (IARI), New Delhi for gaining more exposure on new and innovative technology. (Figure 23).

***Figure 23*. Farmers from Parasai-Sindh watershed visited to IARI, New Delhi for getting exposure on new and innovative technology**

Field Day

A field day was organized by the consortium team in the watershed to disseminate knowledge and create awareness about project activities and demonstrations in Nov 2012 (Figure 24). Farmers from all three project villages, including women members, participated in program. The community was reminded about the objectives of the project to increase surface as well as groundwater resources in the villages and its efficient utilization for increasing agricultural productivity and rural livelihoods.

***Figure 24*. Field day organized in Parasai-Sindh watershed in Nov 2012**

Farmers were informed about the soil fertility status and advised to adopt balanced nutrient application including the application of deficient boron, zinc and sulfur, in addition to the Nitrogen, Phosphorous and Potash (NPK) fertilizers. The farmers participated in experimental trials and narrated their experiences with project technological interventions of improved cultivars and balanced nutrition, including deficient secondary and micronutrients. The interactive session was followed by field visit to show the other farmers the effects of improved varieties and balanced nutrition in groundnut crop. As a result of the interactive session and a field visit, the farmers realized the importance of balanced nutrient application and got motivated to use the technology in their fields to improve crop productivity.

International Women Day at ICRISAT

Five tribal women participated in the International Women Day at ICRISAT, Hyderabad during year 2014. They also interacted with the SHGs of Adarsha watershed, Kothapally and were exposed to the best agricultural practices at the institute.

Human Health Camp

A human health camp was organized in Parasai-Sindh watershed during November 2013. Five medical practitioners (1 pediatrician, 2 gynecologists, 1 pathologist, 1 surgeon) from an eminent medical college in New Delhi visited the watershed. Nearly 400 village members benefited from this camp; nearly 10000 worth of medicines were distributed along with consultancy. Large number of children were found malnourished, women were diagnosed anemic, and a large number of villagers complained about worm infection and skin problem.

Figure 25. Villagers consulted medical doctors about their health issues in Parasai- Sindh watershed during Nov 2013

Monitoring and Evaluation

Weather monitoring at watershed

Automatic weather stations have been installed at three different locations for monitoring rainfall (monthly data shown in Figure 26) and temperature in the watershed. The instrument records daily scale weather information which is used for water balance and impact analysis.

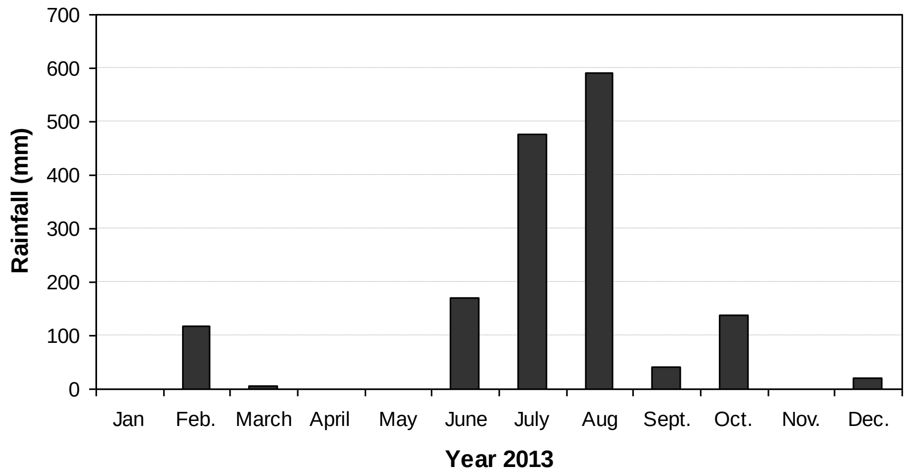


Figure 26. Rainfall recorded at Parasai-Sindh watershed in year 2013

Groundwater Monitoring

Groundwater table in all open wells (388 wells) have been monitored since May 2012 on a monthly basis (Figure 27). Depth of the wells in the watershed range between 3 and 18 m with an average of 9.7 m. Water table monitoring during the last 2 years showed that groundwater table in watershed increased by 2.5 m on an average after the interventions. Increase in water table ranged from 1 m to 5 m as per toposequence. Data showed that about 50% of the dug wells were drying up during summer months, before watershed interventions. These wells were rejuvenated and water found available throughout the year (Figure 27) after watershed interventions.

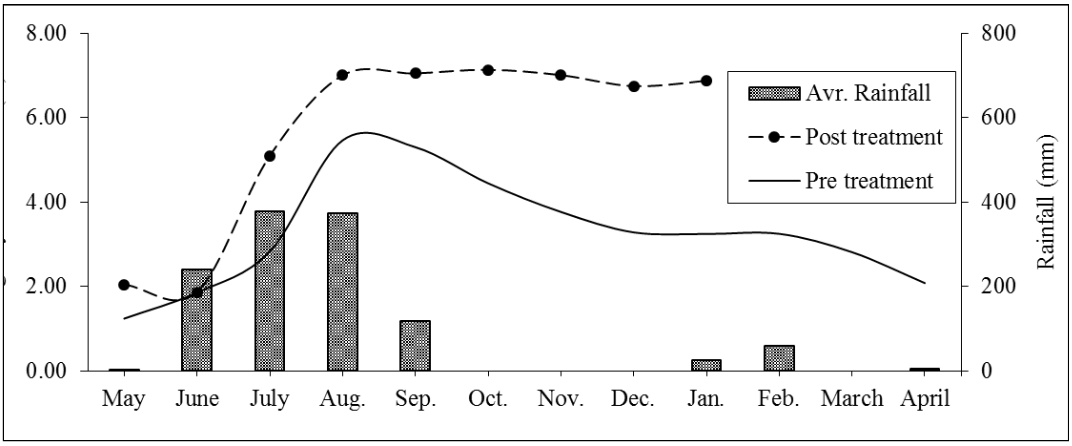


Figure 27. Fluctuation of hydraulic head with relation to rainfall in pre and post watershed interventions at Parasai-Sindh watershed

Hydrological Monitoring

Automatic runoff monitoring systems were installed at different checkdam locations, for continuous monitoring of surface runoff and for analyzing impact of various agricultural water management interventions on watershed hydrology.

Figure 28. Runoff monitoring system installed at different checkdam locations (logger installed in locked room at left corner of the picture).

Impact of watershed intervention on water resources availability and income

Number of water harvesting interventions and productivity enhancement activities, implemented in the last two years, have made significant impact on the water availability, income and livelihood of the farmers. Water, which was one of the limiting factor and a scarce commodity, has been enhanced significantly. Both surface and groundwater are found in surplus now, even at the end of the summer period (May 2014). Our hydrological monitoring showed that nearly 250,000 m^3 of water was harvested in storage structures which enhanced groundwater level by 2 to 5 m, with an average of 2.5 m compared to baseline status (before interventions). Cropping intensity increased by 30%. For example, post-intervention, for the first time in the recent past, farmers were able to cultivate nearly 100 acres waste/barren land, due to availability of surplus water in their wells. This resulted in extra income (nearly 20,000 INR/acre). Increased water yield in open wells facilitates farmers to irrigate their land within 1-2 days, compared to struggling for the entire season with low yielding water wells before the interventions. This has significantly reduced the drudgery among men and women farmers. Moreover, surface water which is now available throughout the year in surface ponds and checkdam for animals to drink from, has promoted livestock activities and animal (buffalo) population has increased from 900 to 1,200 during the project period. **Figure 29** shows the impact of various watershed interventions on water resource availability.

Availability of surplus surface and groundwater during May 2014 has drawn the attention of the local governing bodies and bureaucrats. More so, when compared to other areas in the same district suffered from water scarcity situations during summer months. The district magistrate (DM) along with the line department officials visited the Parasai-Sindh watershed and understood the importance of water harvesting and its impact on water resources availability, cropping intensity and livelihood (Figure 30). They appreciated the work done by ICRISAT and its partners in Parasai-Sindh watershed. The DM further emphasized that farmers using water saving technologies (such as drip irrigation) will contribute to further saving water. He has shown interest to scale-up the same technologies in rest of Bundelkhand region.

BEFORE

Haveli (Traditional RWHS) outlet under construction

AFTER

Rainwater harvested under haveli. It supports drinking and irrigation to Parasai village

Constructed checkdam under project

Rainwater harvested by checkdam

Deepening in the upstream of RWHS constructed during 2012

Rainwater harvesting during 2012

RWH structure (checkdam) under construction during 2013

Harvested rainwater

Desi ber top worked with improved variety

Fruiting after one year

Agricultural lands only sown during kharif

First time cultivated during rabi-2013 (wheat) due to enhanced yield of open wells

Figure 29. Pictures showing impact of watershed interventions in terms of enhanced water resources (surface and groundwater), crop intensification, agro-forestry in Parasai-Sindh watershed, Jhansi

अमर उजाला

स्प्रिंकलर के जरिये सिंचाई करें किसान: डीएम

अमर उजाला ब्यूरो

सिंध जल समेट परियोजना का किया स्थलीय निरीक्षण

झांसी। बुधवार को जिलाधिकारी समीर वर्मा ने बबीना ब्लाक के ग्राम परासई में सिंध जल समेट परियोजना 2011 - 12 का स्थलीय निरीक्षण किया। इस दौरान उन्होंने कहा कि योजनाओं का क्रियान्वयन व निर्माण ऐसा हो, जिससे अधिक से अधिक कृषक लाभान्वित हों। क्षेत्र के जल स्तर पर सुधार हो व पर्याप्त उपलब्धता बनी रही, जिसका लाभ किसान खरीफ व रबी दोनों फसलों में ले सकें।

इस दौरान जिलाधिकारी ने कहा कि किसानों को स्प्रिंकलर के जरिये सिंचाई के लिए प्रेरित किया जाए, ताकि उन्हें कम पानी में अच्छी फसल प्राप्त हो। उन्होंने किसानों को मेड़ पर सागौन के पेड़ लगाने का भी सुझाव दिया। इस दौरान आयोजित चौपाल की अध्यक्षता करते हुए डीएम ने किसानों से सीधा संवाद स्थापित किया। उन्होंने जल समेट परियोजना से होने वाले फायदों के बारे में जाना।

कृषि वानिकी के इंजीनियर डा. रमेश सिंह ने परियोजना के संबंध में जानकारी देते हुए बताया कि ग्राम परासई में बहते नाले पर पांच चेकडेम बनाए गए हैं। सभी नाले सोलह मीटर लंबे हैं, जिससे जल भंडारण अधिक हो रहा है। साथ ही डिजायनिंग की वजह से लागत भी कम आई है। इसके अलावा ग्रामीणों को भी योजना में शामिल किया गया है। साइट सलेक्शन ग्रामीणों ने ही किया, ताकि लाभ अधिक हो। परियोजना से 399 परिवार लाभान्वित हो रहे हैं। क्षेत्र में 388 कुएं हैं, जिनमें पहले पानी नहीं रहता था, परंतु अब पर्याप्त पानी है। क्षेत्र में पैदावार बढ़ी है। पहले 18 - 19 क्विंटल प्रति हेक्टेअर पैदावार होती थी, जो अब बढ़कर 20 - 25 क्विंटल प्रति हेक्टेअर हो गई है। इस दौरान प्रोजेक्ट साइंटिस्ट डा. आर सी तिवारी ने भी जानकारियां दीं। इस मौके पर सीडीओ संजय कुमार, उप कृषि निदेशक डा. यू पी सिंह, उप निदेशक भूमि संरक्षक रामगंगा शंकरदीन, जिला कृषि अधिकारी डा. बी आर मौर्य आदि मौजूद रहे।

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कम लागत के चेकडैम के लिए मंथन

मुआयना

Figure 30. Higher level bureaucrats (district magistrate) and line department officials visited Parasai-Sindh watershed in May 2014; Large water availability (surface and groundwater) in middle of summer months clearly demonstrated importance of water harvesting interventions and productivity enhancement activates for addressing issues of water scarcity and land degradation in Bundelkhand region of central India

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