7 Improving Water Availability and Diversification of Cropping Systems in Pilot Villages of North and Southern India

Kaushal K. Garg,[1]* Ramesh Singh,[2] Suhas P. Wani,[1] O.P. Chaturvedi,[2] Inder Dev,[2] Mukund D. Patil,[1] R. Sudi[1] and Anand K. Singh[1,2]

[1]*International Crops Research Institute for the Semi-Arid Tropics, Patancheru, India;* [2]*Central Agroforestry Research Institute (ICAR), Jhansi, India*

Abstract

Bundelkhand region of Uttar Pradesh and southeastern region of Karnataka (e.g. Kolar) are hot spots of poverty located in the semi-arid tropics. These regions are vulnerable to climate change and experience water scarcity and land degradation. Despite having moderate to good rainfall (700–850 mm), freshwater availability in these areas are declining due to over-extraction, poor groundwater recharge and change in land use. With realization of the importance of watershed development programme, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) along with national partners (ICAR – Central Agroforestry Research Institute (CAFRI), Jhansi), NGO (MYRADA), district administration, state governments and local community started developing a model watershed with support of CSR funding of Coca-Cola India Foundation from 2011. The Parasai-Sindh watershed of 1250 ha with ICAR–CAFRI at Jhansi and Muduvatti watershed of 1340 ha with MYRADA in Kolar district were selected. From beginning of the project, science-led interventions comprising soil and water conservation practices, productivity enhancement, crop diversification and intensification through agroforestry interventions, integrated nutrient and pest management and other livelihood-based activities were implemented. This has resulted in improved groundwater table, crop intensification and increased rural income and livelihood. Low-cost rainwater harvesting structures at Parasai-Sindh watershed harvested minimum 250,000 m^3 of surface runoff annually and facilitated groundwater recharge, resulting in increased groundwater table by 2–5 m and increased cropping intensity and agricultural and livestock productivity by 30–50%. It is estimated that watershed interventions in pilot villages enhanced average annual family income from ₹50,000/year to ₹140,000/year in a short span of 3–4 years in Parasai-Sindh watershed. Similar results on increased groundwater table and crop intensification were observed in Muduvatti watershed in Kolar district.

7.1 Introduction

India has been recognized as a hot spot for poverty. In 2012, the Indian government stated that 22% of its population lived below its official poverty limit. In 2011, the World Bank, based on 2005 purchasing power parity initiative, the International Comparison Program, estimated that 23.6% of Indian population or about 276 million people lived on less than US$1.25 per day on

* Corresponding author: k.garg@cgiar.org

purchasing power parity. Agriculture is the largest sector, providing employment and a source of livelihood for more than 65% of the population in India. Out of a total of 141 million ha of agricultural land, 55% of total area is rainfed having current productivity level of 1–1.5 tons/ha. To achieve growth and sustainability, it is essential to enhance the agricultural productivity both in rainfed and irrigated areas. Current agricultural productivity has largely become either stagnant or is declining due to several reasons. Inappropriate use of natural resources resulted in increased water scarcity, land degradation and loss of various ecosystem services. Moreover, large uncertainty is arising on current and future water availability and other resource availability due to changing climatic situations. Extreme events like flash floods or longer dry spells, more frequent dry or wet years, change in crop water demand, and increasing temperature and pest/disease infestation (the clear evidence of climate change) are enhancing risk in agricultural system.

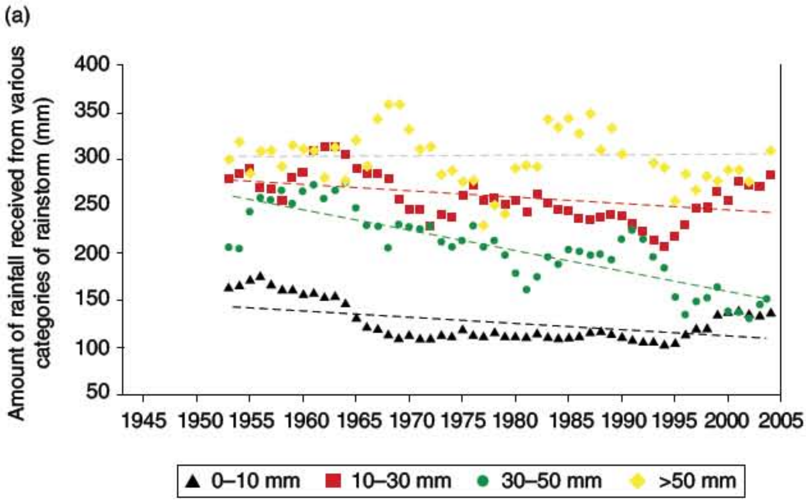
Despite a number of challenges, integrated watershed management approach has proved to be the suitable adaptation strategy to cope with the changing climatic situation and for achieving holistic development (Wani *et al.*, 2009; Garg *et al.*, 2011; Singh *et al.*, 2014). Integrated watershed development programmes reduce water-related risks by improving the green and blue water availability, reduce land degradation and strengthen various ecosystem services (such as reduced soil loss, increased base flow, carbon (C) sequestration, etc.). International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and Indian Council of Agricultural Research – Central Agroforestry Research Institute (ICAR–CAFRI), Jhansi, India has long research and development experience in areas of natural resource management and also in designing and developing watershed technologies. ICRISAT along with consortium partners has developed a number of watersheds across India and also outside the country (e.g. China, Vietnam and Thailand) in regions with variation in rainfall, soil types and agroecology. Technologies demonstrated in these watersheds have not only helped farmers and the farming community directly in terms of enhancing agricultural productivity, income and livelihood (e.g. Adarsha watershed, Kothapally in Medak, Telangana; and Garhkundar-Dabar watershed, Uttar Pradesh) but also influenced various stakeholders (development agencies, nongovernment organizations (NGOs), government and private agencies, policy makers, etc.) to scale-up and adopt further on a larger scale (Wani *et al.*, 2009).

The Coca-Cola India Foundation has requested ICRISAT to undertake watershed activities in Parasai-Sindh watershed (adjoining three villages in Jhansi district, Uttar Pradesh) and Muduvatti watershed of 1340 ha in Kolar district, Karnataka under the corporate social responsibility (CSR) initiative. The Coca-Cola India Foundation, a company registered under Section 25 of the Companies' Act 2013, is committed to sustainable development and inclusive growth by focusing on issues relating to water, the environment, healthy living and social advance so that it can contribute to a strong and resolute India enabling the common people to build a better life. In order to promote the Foundation's objectives, monetary grants and other assistance will be provided to NGOs, beneficiary organizations, cooperatives, philanthropies and such others who can be suitable partners in implementing projects for social welfare across the country. The Foundation seeks to ensure project execution, maintenance and sustainability through the active involvement and direct participation of the beneficiary community at the grassroots level. The overall project goal in both the selected watersheds was to build resilience of the rural community against climate change (e.g. drought, dry spells, etc.) by enhancing groundwater recharge and introducing various natural resource management (NRM) interventions.

7.2 Bundelkhand Region of Central India

Bundelkhand region of Central India is a hot spot of water scarcity, land degradation, poverty and poor socioeconomic status. Due to poor groundwater potential, high temperature, and low and erratic rainfall, agricultural productivity in this region is very poor (0.5–1.5 t/ha). Most of the areas are single cropped and completely under rainfed conditions (Tyagi, 1997). Rainfall is highly erratic, both in terms of total amount and its distribution over time. Long-term weather data monitored at Jhansi station (nearby site) show that annual average rainfall in study region is 877 mm (standard deviation, σ = 251 mm) with about 85% during June to September. On an average, 42 rainy days during the monsoon and 13 rainy days during non-monsoon were recorded. Long-term data analysis showed that annual average rainfall has decreased from 950 mm between 1944 and 1973 as compared to 847 mm between 1974 and 2004 (Fig. 7.1). This reduction was mainly due to decreased number of low (0–10 mm) and medium rainfall (30–50 mm) events (Fig. 7.1). Similarly, total number of rainy days in a year also decreased.

Dry spells longer than 5–7 days are very common and occur several times (5–6 times) per season, whereas 10–15 days or longer dry spells also may occur during the monsoon period. The climate of the region is tropical monsoonal preceded by hot summer (minimum air temperature ranges between 17 and 29°C and maximum air temperature between 31 and 47°C in May) and is followed by cool winter (minimum



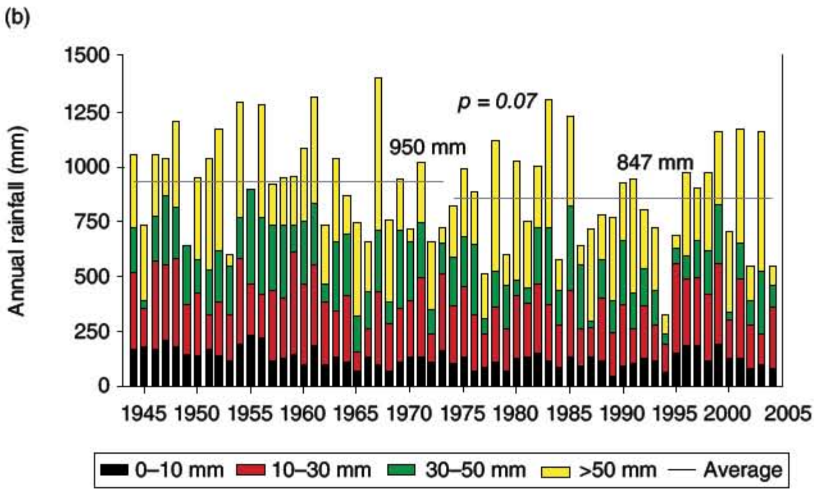


Fig. 7.1. Rainfall in Jhansi: (a) moving average (ten years) of rainfall received from various categories of rain events between 1944 and 2004; (b) comparison of annual rainfall between 1944–1973 and 1974–2004.

air temperature ranges between 2 and 19°C and maximum air temperature between 20 and 31°C in January). Soils in the region are reddish to brownish-red in colour (Alfisols and Entisols), coarse-gravelly and light-textured with poor water-holding capacity (80–100 mm/m). A large extent of the region is in degraded stage, and poor in organic matter and nutrient status. The geology of the targeted region is dominated by hard rocks of Archaen granite and gneiss and largely composed of crystalline igneous and metamorphic rocks (Tyagi, 1997), and aquifers are either unconfined or perched, having poor storage capacity (porosity of 0.01–0.05%). These aquifers were derived primarily from weathering and developed into two-layered system: (i) unconsolidated fractured layers derived through prolonged weathering of bedrocks within 10–15 m depending upon the topography, drainage and vegetation cover; and (ii) relatively impermeable basement starting from 15 to 20 m depth. In such hard rock aquifers with poor transmissibility, shallow dug wells of 5 to 15 m depth are the only primary source of water for domestic and agricultural use in this region (Singh *et al.*, 2014).

7.2.1 Pilot site: Parasai-Sindh watershed, Jhansi

Frequent droughts are common in Bundelkhand. More than 80% of open wells get dried out soon after monsoon period due to deficit rainfall and poor groundwater recharge. In the absence of drinking water availability and poor livelihood opportunity, a large number of the rural community usually migrate to nearby cities. Lack of availability of water has affected the agricultural sector.

The urban and rural communities largely depend on outside water source and private suppliers such as tankers for domestic use especially in summer. Cattle were abandoned due to shortage of water and less fodder availability. In such conditions, watershed development programme is considered to enhance groundwater recharge and reduce water scarcity with effective interventions. ICRISAT consortium, with ICAR–CAFRI, selected one of the mesoscale watersheds, Parasai-Sindh in Jhansi district to demonstrate the impact of watershed development interventions on groundwater recharge and strengthening ecosystem services. This watershed is located in Babina block of Jhansi district, Uttar Pradesh and covers 1250 ha of geographical area. It comprises three villages, namely Parasai, Chhatpur and Bachauni located between 25°23′56″ to 25°27′9″ N and 78°19′45″ to 78°22′42″ E (Fig. 7.2). The watershed development programme of CSR initiative in selected villages was started in 2011 with the objectives: (i) to enhance groundwater recharge and reduce water stress situation; (ii) to enhance agricultural productivity and water use efficiency; and (iii) to improve livelihoods of rural community.

7.2.2 Baseline characterization

A baseline survey was conducted in all the three villages for understanding biophysical, social and economic condition of selected villages at inception of the project in 2011 (Table 7.1). The total population of the three villages in the watershed is 2896 persons (1550 male and 1346 female). Large farmers in the villages generate 80% income from agriculture and 20% from milk production. The source of income for small and marginal farmers is from agriculture and by sale of milk almost in equal proportion. Activities on daily wages are also a source of income for small and marginal farmers. Literacy status in the villages is poor. On average about 56% of the population is literate. Topography of the selected watershed is relatively flat with an average slope of 1–2%. This watershed is mainly dominated by agricultural land covering nearly 63% of total geographical area and a large portion (32%) is covered by barren and scrubland which is used mainly for animal grazing. Groundnut, black gram and sesame are the dominating *kharif* (rainy season) crops and wheat and chickpea are grown mainly in *rabi* (post-rainy) season. Average productivity of these crops in the project villages was: wheat 1677 kg/ha, barley 1725 kg/ha, black gram 189 kg/ha, green gram 169 kg/ha, chickpea 430 kg/ha, mustard 907 kg/ha, sesame 315 kg/ha and groundnut 1111 kg/ha.

Soils of the watershed are dominated by Alfisols and Entisols which are shallow (10–50 cm), coarse-gravelly, light-textured with poor water-holding capacity (80–100 mm/m), and

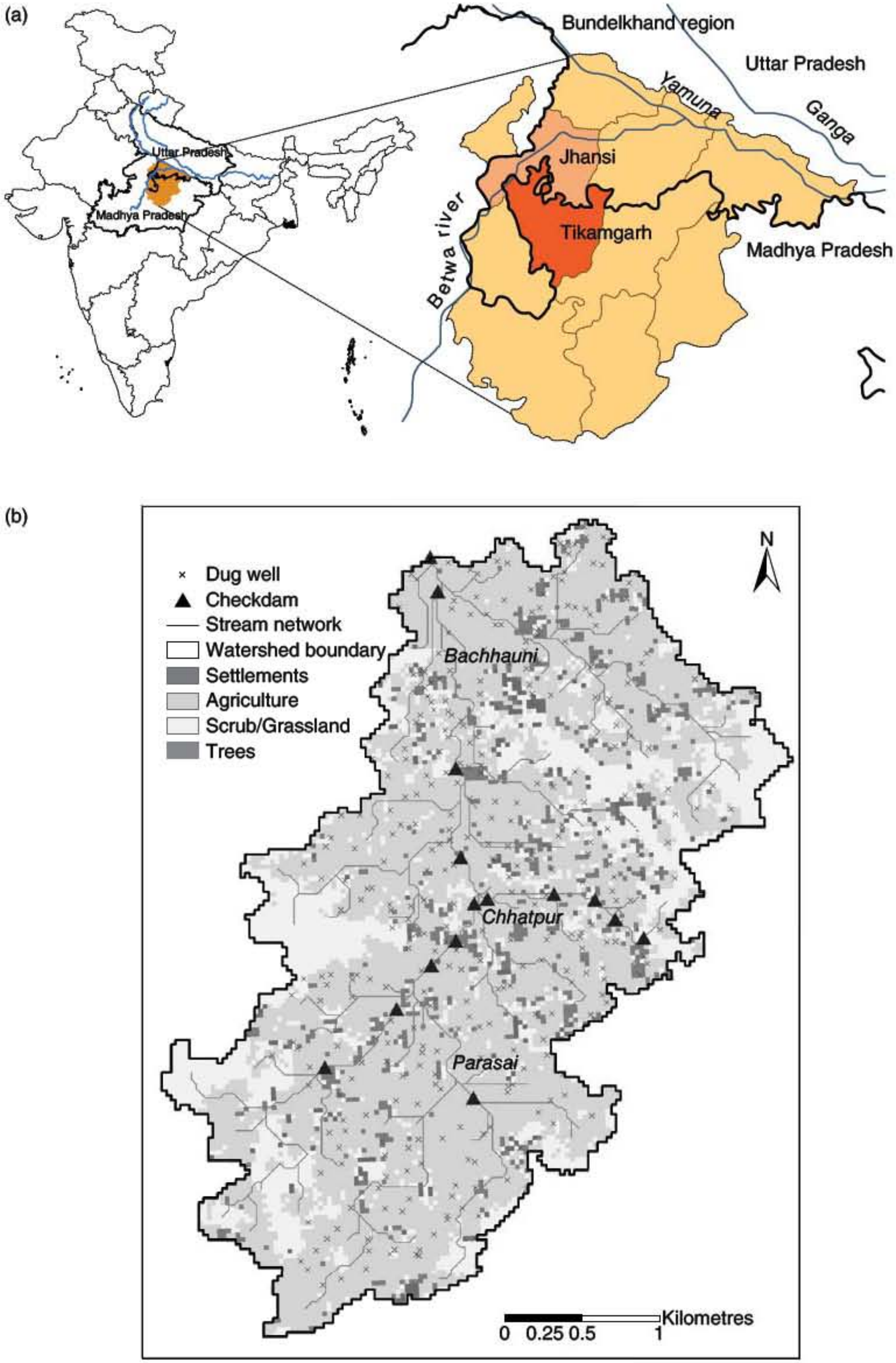


Fig. 7.2. (a) Location of Bundelkhand region; (b) major land use classes of Parasai-Sindh watershed.

Table 7.1. General characteristics and land use resources of Parasai-Sindh watershed.

Particulars	Data
Watershed characteristics	
Area (ha)	1250
Altitude (m above msl)	270 to 315
Relief (m)	45
Length (m)	6263
Width (m)	3994
Perimeter (km)	27.83
Drainage density (km/km^2)	2.11
Land use[a] (ha)	
Agricultural land	1105.5 (88.70)
Scrubland	66.00 (5.29)
Forest	5.60 (0.45)
Drain network	43.4 (3.60)
Road	14.30 (1.15)
Habitation	11.10 (0.89)
Resources	
Total population	2896
Population below 18 years age (%)	52
Literacy (%)	56
No. of households	417
No. of animals	2558
Average holding (ha/household)	3.12

[a]Figures in parentheses are percentage values.

low in nitrogen, phosphorus and organic carbon. There are 388 open wells (8–12 m deep) in the watershed and these are the primary source of water for domestic and agricultural use. Bore wells in this region do not work due to poor specific yields (<0.5% specific yield). Water in the open wells of the project villages was found safe for drinking. 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 hygiene.

7.3 Kolar District of Peninsular India

Kolar district in Karnataka lies between latitude 12°46′ to 13°58′ N and longitude 77°21′ to 78°35′ E. The district lies almost in the central part of peninsular India, which has immense bearing on its geo-climatic conditions. Kolar district falls in the eastern dry agroclimatic zone. It experiences a semi-arid climate, characterized by typical monsoon tropical weather with hot summer and mild winter. The year is normally divided into four seasons: dry season during January-February, pre-monsoon season during March-May, southwest monsoon season during June-September and post- or northeast monsoon season during October-December. There is a general south to north decreasing trend in annual rainfall. The southwest monsoon contributes around 55% of the annual rainfall while the northeast monsoon yields around 30%. The balance of around 15% results from the pre-monsoon. September and October are the wettest months with over 100 mm monthly rainfall. Thunderstorms are common during May. The post-monsoon season often gets copious rains due to passing depressions.

As per the classification of the National Bureau of Soil Survey and Land Use Planning, Kolar area falls in the hot moist semi-arid agro-ecological subregion with medium to deep red loamy soils. Available water capacity is low (80–100 mm/m) and the rainfed length of growing period is about 120–150 days. Summer showers are experienced in May. Though the southwest monsoon sets by the first week of June, rainfall more than the potential evapotranspiration (PET) is received only during middle of September to third week of October. This period has potential for harvesting and storage of runoff water for use by *rabi* crops. First week of August is usually dry, but may not adversely affect the crops. During the period from last week of August to the first week of September, average rainfall is comparatively low and the rainfall expected at 60% probability is almost zero. This period coincides with the flowering and late flowering phase of several crops, which are likely to experience severe moisture stress. Annual PET is 1638 mm and the annual average rainfall is 711 mm.

7.3.1 Pilot site: Muduvatti watershed, Kolar

Muduvatti watershed comprises eight villages (Muduvatti, Jangalahalli, Konepura, Papenahalli, Shettiganahalli, Shettikothanur, Dandiganahalli and Nernahally) of Kolar district, Karnataka (Fig. 7.3). The total area of the eight selected villages of the project is 1340 ha, with a population of 5556 that has an average family

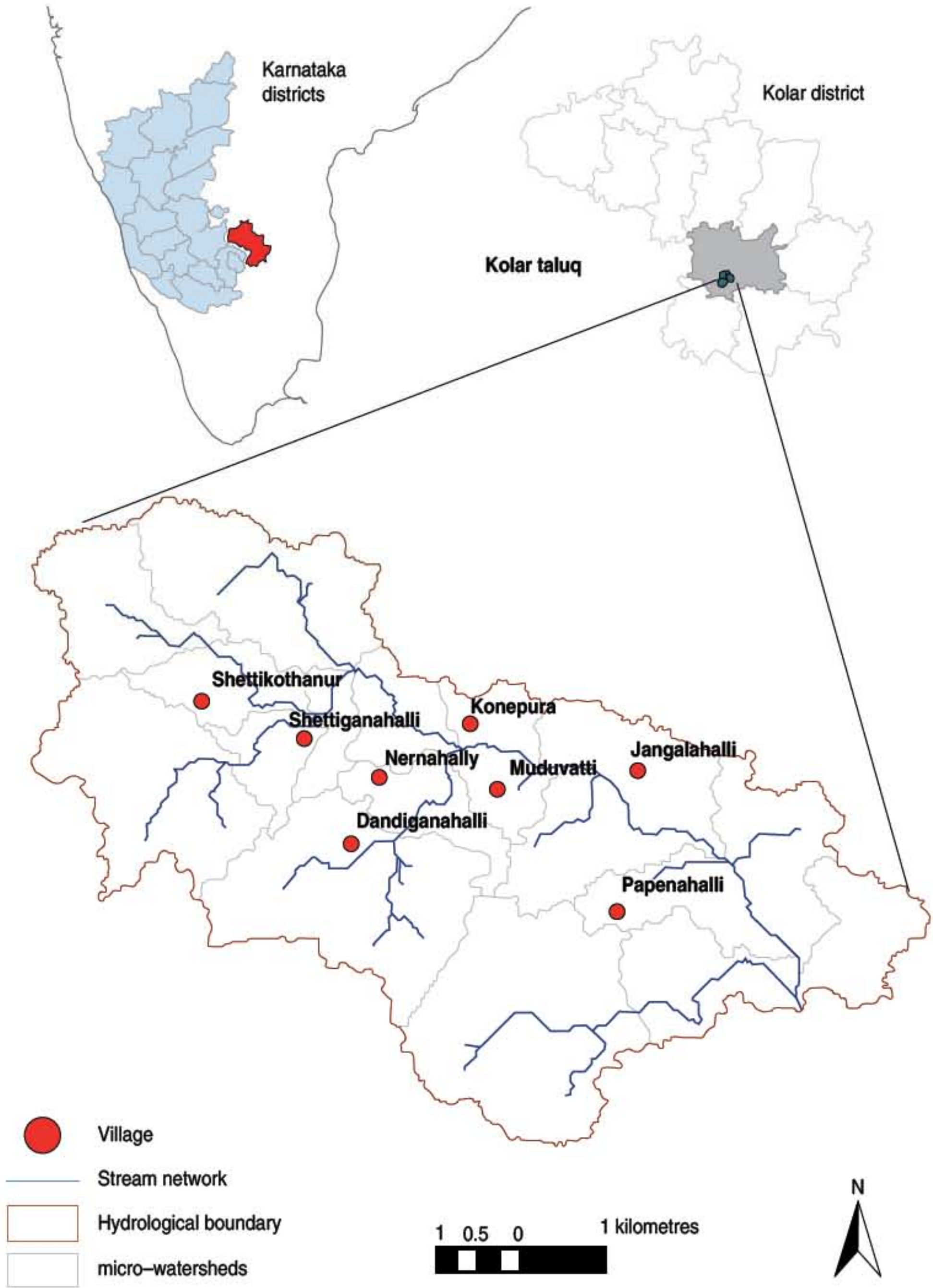


Fig. 7.3. Location of study villages, stream network and micro-watersheds of Muduvatti watershed.

size of 4.7 and population density of 4.01 persons per ha. These eight villages of Vakkaleri Hobli are in the vicinity of Kolar town about 6–16 km away.

7.3.2 Baseline characterization

Baseline of the selected villages is presented in Table 7.2. About 67% of households are in

Table 7.2. Baseline information of selected villages in Kolar watershed collected in 2013.

Particulars	Muduvatti	Jangalahalli	Konepura	Papenahalli	Shettiganahalli	Shettikothanur	Dandiganahalli	Nernahally
Population (2011)[a]								
Backward	704	78	33	NA	222	109	301	132
Others	1064	512	259	NA	695	874	110	209
Total	1768	590	292	NA	917	983	411	341
No. of households	368	98	45	17	116	210	82	72
Total geographical area (ha)	304	87	70	70	260	215	179	155
Common land (ha)	57	20.42	17.29	22.39	54.78	43.74	63.11	63.11
Agricultural land (ha)								
Irrigated	80.17	26.53	28.2	8.75	19.44	12.28	24.55	43.35
Unirrigated	90.36	15.45	12.26	8.3	152.4	138.41	53.17	14.07
Livestock (no.)								
Large ruminants	240	128	44	7	120	129	170	120
Small ruminants	800	610	140	0	470	320	700	420
Tubewells (no.)								
Total	206	66	81	1	91	97	95	75
Functioning	52	10	14	1	16	11	28	16
Defunct	154	56	67	0	75	86	67	59
Average depth of tubewells (ft)	1100	1000	1000	1100	1100	1100	1200	1000

[a]From: http://censusindia.gov.in. NA= Data not available in 2011 census.

small, 27% in medium, and 3% each in the large and landless category. The arable land in the watershed is about 55% of total geographical area. The common land which is about 25% is the source of grazing. Major land area is under rainfed agriculture, while with bore well as a main source vegetable cultivation is gaining importance. The present land use is 88% cultivated (46% rainfed, 31% under vegetable and irrigated annual crops) and 12% under other uses that includes habitat, forest, road and drains. The main agricultural crops grown are finger millet, paddy, pigeonpea, groundnut, castor, etc. The major horticultural crops grown in the villages are tomato, onion, cabbage, carrot, brinjal, beans, potato, green chilli, leafy vegetables, etc. The major fruits grown are mango, banana, guava, sapota and papaya. Tamarind, ginger, coriander are also grown. The main floriculture crops are marigold, *Crossandra* sp., jasmine and chrysanthemum. Mulberry is also quite a prominent crop grown for sericulture. Good animal population, particularly milch animals prevails in the villages.

7.4 NRM Interventions Implemented in Parasai-Sindh Watershed

7.4.1 Entry point activities

Formation of watershed committee

In 2011, an ICRISAT-led consortium along with ICAR–CAFRI, Jhansi, farmers and district administration selected Parasai-Sindh watershed for enhancing water resources availability and optimizing agricultural productivity. Villagers and watershed committee members were involved from the project inception stage. Watershed committee of pilot villages were formed to implement the watershed work. Farmers are the primary stakeholders and beneficiaries. Hence, involvement of community was important for successful execution of project activity/interventions and to ensure long-term sustainability of the project. Women, and Scheduled Caste/Scheduled Tribe candidates and members from panchayat were also involved in the formation of watershed committee, as per common guidelines. 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 project planning and execution of proposed interventions. For example, selection and construction of water harvesting sites and types of structure, procurement of the materials, record keeping, verification of bills and payment delivery, etc. were handled by the watershed committee under the guidance of the consortium team. Transparency at every step established good rapport and resulted in large and active participation of the village community in watershed management and development. With the technical backstopping of CAFRI and ICRISAT scientists, 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 pilot villages. 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. The consortium team interacted with children and women groups (Fig. 7.4) and shared their knowledge on soil and water conservation. There were discussions on poor quality of drinking water and causes for water pollution. Water-quality analysis showed that groundwater in Parasai and Chhatpur villages is safe for human and animal consumption as all the quality parameters are found in permissible limit (Table 7.3). Formation of these environmental clubs was the entry point activity during the project initiation. The consortium team gathered at the centre of the village and interacted with children through various activities such as team building exercises (conducting games, quizzes, etc.). Winners were awarded books on environmental issues.

Further, 15 children were chosen to become members of an eco-club based on their knowledge and participation. These children belonged

Fig. 7.4. Members of the environmental club (women and children) interacting with an ICRISAT scientist in Parasai-Sindh watershed.

Table 7.3. Groundwater quality for drinking purpose in project villages in 2011.[a]

Parameter	Chhatpur	Parasai	Threshold
pH	7.45	7.51	6.5 to 8.5
EC (dS/m)	0.46	0.48	–
Total dissolved solids (mg/l)	307	320	Maximum 500
Alkalinity to phenolphthalein as $CaCO_3$ (mg/l)	Nil	Nil	–
Alkalinity to methyl orange as $CaCO_3$ (mg/l)	225	220	–
Total hardness as $CaCO_3$ (mg/l)	184	203	Maximum 300
Chloride as Cl (mg/l)	7	14	Maximum 250
Sulphate as SO_4 (mg/l)	2	2	Maximum 150
Nitrate as NO_3 (mg/l)	38	47	Maximum 45
Fluoride as F (mg/l)	0.7	1.5	0.6 to 1.2
Calcium as Ca (mg/l)	62	61	Maximum 75
Magnesium as Mg (mg/l)	7	12	Maximum 30
Potassium as K (mg/l)	1	1	–
Sodium as Na (mg/l)	11	19	–
Iron as Fe (mg/l)	0	0.1	Maximum 0.3
Cadmium as Cd (mg/l)	Nil	Nil	Maximum 1
Cobalt as Co (mg/l)	Nil	Nil	Maximum 0.05
Copper as Cu (mg/l)	Nil	Nil	Maximum 2.0
Lead as Pb (mg/l)	Nil	Nil	Maximum 0.5
Manganese as Mn (mg/l)	Nil	Nil	Maximum 0.1

[a]Five water samples were collected in first year of the project.

to diverse socioeconomic background, attended different schools and were in the age group between 10 and 14 years. The project team motivated them to circulate books, share the knowledge and meet regularly at the given venue and date. Formation of eco-clubs facilitated the consortium team to interact with farmers and women groups and also with village administration. 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 planted by adults. Members and non-members made miniature models with sand and tried to understand the watershed intervention being undertaken in their villages. There was a tremendous response even among girls who took active part in all such activities. Children were given chalk to write slogans on sanitation and water conservation in their villages.

During a visit to Chhatpur it was discovered that this village was not totally covered 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 1 March 2013, an ICDS centre has been newly opened in the village benefiting 50 infants aged 7 months to 3 years, 68 children aged 3–6 years, 11 pregnant women and 15 nursing mothers and 3 young girls.

7.4.2 Rainwater harvesting

Groundwater recharge in Bundelkhand areas is generally poor due to hard rock geology and poor specific yield. The situation becomes critical during dry years and summer months. Construction of low-cost water-harvesting structures is one of the important interventions considered for groundwater recharge. These structures harvest a substantial amount of surface runoff, allow it to percolate into aquifer and facilitate groundwater recharge. A number of locations for harvesting surface runoff were identified by the watershed committee and village members. Nearly 115,000 m^3 of storage capacity was developed in watershed by constructing various water harvesting structures (Fig. 7.5). Water balance indicated 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 877 mm). Moreover, water table monitoring along with state-of-the-art runoff monitoring system showed that these structures harvested nearly 250,000 m^3 of surface runoff between June and October, resulting in high groundwater table. Water table in Parasai-Sindh watershed increased by 2.5 m on average, compared to that before implementation of watershed activities. Increase in water table was 5 m near stream location and 2 m at upstream areas.

7.4.3 Agroforestry interventions

Through agroforestry interventions in watershed a total of 22,210 (5380 fruit and 16,830 multipurpose trees) seedlings of different tree species were planted in farmers' fields, households and on bunds (Fig. 7.6). Effect of deep pitting and profile modification using black soil on survival and growth of teak was demonstrated. Teak plantation on field boundary has been adopted by more than 150 farmers. Survival of different tree species varied from 32% to 95% by the end of 2015. Apart from this, during 2012 to 2016, about 2100 *desi ber* (*Ziziphus mauritiana*) plants were budded with improved varieties with more than 80% survival. Sixty-seven households have guava, citrus and pomegranate in their homestead with survival more than 90%. Plantations in homesteads are meeting nutritional requirement of the households.

7.4.4 Productivity enhancement interventions

Yield gap analysis undertaken by ICRISAT revealed that large yield gap exists in the major rainfed crops grown in the semi-arid tropics. Further, there is a potential of increasing the productivity by two- to threefold using available technologies in farmers' fields (Wani *et al.*, 2009, 2012). Soils in rainfed areas have low moisture content and are deficient in essential nutrients. Soil analysis showed 65–80% of the farmers' fields were deficient in sulfur (S), zinc (Zn) and boron (B) (Table 7.4).

Fig. 7.5. Rainwater harvesting in watershed: (a, b) check-dams constructed at different locations; and (c, d) water harvested in check-dams during the rainy season 2013–14.

In this context, farmers' participatory trials were conducted in different years to demonstrate the impact of micronutrients (Zn and B) on groundnut yield. Farmers contributed 50% of fertilizer cost (agribor (B) and zinc sulphate ($ZnSO_4$)). Application of B and Zn increased groundnut yield by 15–20% (average yield 1825 kg/ha) over control plots (average yield 1510 kg/ha) in 2011. During *rabi* 2011, improved varieties of chickpea (Vaibhav), lentil (DPL 62) and mustard (Pusa Bold) were introduced in farmers' participatory trials at 14 locations. Crop yields of improved crop varieties increased by 18 to 33% over local crop varieties (Table 7.5).

In addition, groundnut yields and other agronomic parameters were evaluated in farmers' participatory trials and compared with traditional cultivar (*Jhumku*) (Fig.7.7). Improved groundnut variety (TAG 24) had highest number of pods (19.2 pods/plant). Correspondingly, this variety had highest kernel yield (1.68 t/ha) and pod yield (2.42 t/ha). Data showed that introducing improved variety of groundnut enhanced crop yield by 30–50% compared to the local cultivar.

Similarly, farmers' participatory demonstrations were conducted for wheat crop in different years. For example, crop demonstrations in 30 wheat fields (HI 1418, HI 1479, HI 1531 and HI 1544) and 15 chickpea fields (JG 11 and JG 130) were designed during *rabi* 2012–13. Farmers recognized a clear difference in crop growth and anticipated a 10–15% higher yield while crop harvesting. A total number of 76 participatory demonstrations (14 in Parasai, 44 in Chhatpur and 18 in Bachhauni) were laid out in farmers' fields with improved varieties during *rabi* in 2013–14. About 28% increase in yield was observed in barley cultivar RD 2552, while 17% increase was observed in mustard cultivar Maya over local varieties (Table 7.6).

Fig. 7.6. Agroforestry interventions in Parasai-Sindh watershed: (a–c) teak and other trees were planted along field bunds during June–July 2012; (d) tree of *desi ber* (traditionally grown) budded with improved variety.

Table 7.4. Soil fertility status in selected villages in Parasai Sindh watershed.[a]

Particulars	EC (ds/m)	Exchangeable K (mg/kg)	Olsen P (mg/kg)	Organic C (%)	Available Zn (mg/kg)	Available B (mg/kg)	Available S (mg/kg)
Average	0.16	83	11.12	0.51	0.75	0.23	5.47
SD	0.10	60	6.96	0.19	0.39	0.11	3.00
Maximum	0.54	335	36.00	1.10	2.50	0.64	19.95
Minimum	0.04	25	1.20	0.22	0.22	0.10	1.85

[a]A total of 80 soil samples were collected from the top 0–15 cm of soil.

7.4.5 Developing forage resource

Napier bajra hybrid (NBH) 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 137,000 rooted slips of NBH and guinea grass were transplanted in an area of about 3 ha (on bunds, near check-dams and around *haveli*) during 2013 and 2014. During the initial year of establishment of these grasses two cuts could be harvested with biomass potential of 4.0 tons dry matter per ha. During 2015 farmers of the area transplanted the rooted slips obtained from well-established tussocks of NBH, thereby increasing the area under these pasture grasses to about 7 ha. Biomass potential has gone up to 7.2 tons dry matter per ha, whereby farmers are able to harvest 8–10 cuts in a year (Fig. 7.8).

7.4.6 Income-generating activities

Most families in the watershed have landholdings and cattle. Women work alongside their husbands in fields. Yet due to *purdah*, it was often difficult to communicate with the women in the beginning of the project. The need for a female field worker was felt and the project team was helped by one of the youngsters within the village to communicate with the women members. Young girls have taken responsibility to form women self-help groups (SHGs) so that they can avail the benefits of government schemes.

Table 7.5. Performance of crop varieties in farmers' participatory trials in Parasai-Sindh watershed during *rabi* 2011.

Crop	Variety	Number of trials	Average grain yield (kg/ha)	Yield increase (%)
Chickpea	Vaibhav	5	1870	33
	Desi	–	1402	–
Lentil	DPL 62	6	1130	18
	Desi	–	960	–
Mustard	Pusa Bold	3	1470	25
	Desi	–	1180	–

Promoting agroforestry

Farmers of the villages Parasai, Chhatpur and Bachhauni were motivated to adopt agroforestry practices in their fields. Training programmes on *Z. mauritiana* (*desi ber*) budding were conducted for farmers and women SHGs in watershed villages.

Vermicomposting

Soil test results showed that soils in the watershed are deficient in micronutrients and poor in organic matter. Use of undecomposed 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 for farmers and women SHGs in watershed villages.

Introduction of dona-making machine

A one-day training programme on *dona* (platter) making was organized in August 2014 in Bachchauni village in Jhansi district in which tribal farmers from the village participated and six SHGs were formed.

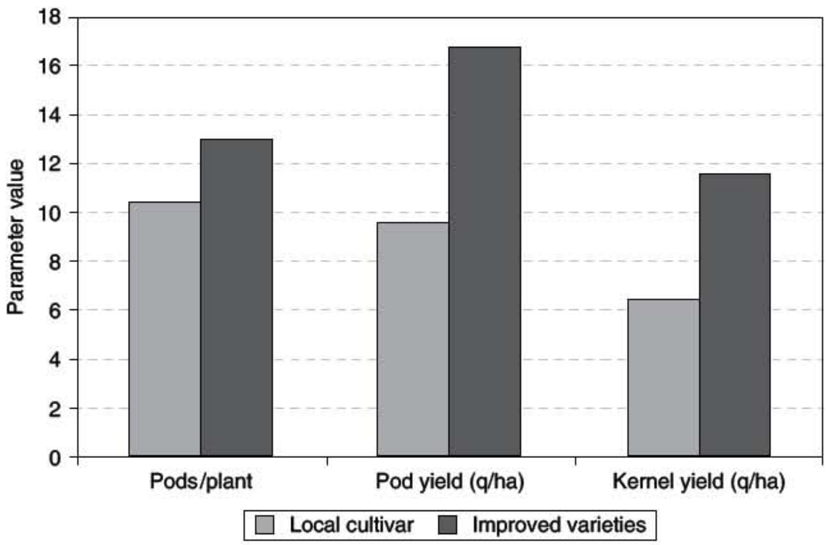


Fig. 7.7. Productivity of improved varieties and local cultivar of groundnut in Parasai-Sindh watershed.

Table 7.6. Participatory demonstrations at Parasai-Sindh watershed during *rabi* 2013–14 and 2014–15.

		No. of demonstration trials				Av. yield (kg/ha)	
Crop	Varieties introduced	Parasai	Chhatpur	Bachhauni	Total	Improved	Local
2013–14							
Barley	RD 2552	9	20	–	29	2400	1470
Mustard	Maya	4	8	6	18	1190	1020
Chickpea	JG 130	–	–	–	20	1400	820
2014–15							
Pigeonpea	ICPL 85063 (Lakshmi), ICPL 88039	3	3	–	6	760	630
Barley	RD 2552	11	7	–	18		
Chickpea	JG 130	–	6	2	8	1210	820
Mustard	NRC HB 101, NRC HB 506, NRC DR 02	2	8	–	10	1180	920
Wheat	HI 1532, HI 1544, HI 1418, HI 1479	8	12	8	28	4420	3450

Fig. 7.8. Napier bajra hybrid slips planted on bunds near stream network.

7.4.7 Capacity building

Exposure visits

A one-day exposure visit-cum-training programme was organized for villagers at Garhkundar-Dabar watershed and Domagaur-Pahuj to enhance their capacity. More than 50 farmers participated in this programme. 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 and 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 to gain more knowledge on new and innovative technology (Fig. 7.9).

Field day

Field days were organized by the consortium team in the watershed to disseminate knowledge and to bring awareness about project activities and demonstrations. Farmers from all the three villages, including women members, participated in the programme. The community was reminded about the objectives of the project to increase

Fig. 7.9. Capacity development programmes for Parasai-Sindh watershed farmers: (a) exposure visit to IARI, New Delhi; (b) field day in project village; (c, d) health camp during November 2013.

surface as well as groundwater resources in the villages and its efficient utilization for increasing agricultural productivity and rural livelihoods. Farmers were explained about the soil fertility status and advised to adopt balanced nutrient application, including the deficient B, Zn and S, in addition to only nitrogen, phosphorus and potassium (NPK) fertilizers. Farmers participated in experimental trials and narrated their experiences with project technological interventions of improved varieties 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 field visit, the farmers realized the importance of balanced nutrient application and became motivated to use the technology in their fields to improve crop productivity (Fig. 7.9).

International Women's Day at ICRISAT

Five tribal women participated in International Women's Day at ICRISAT, Hyderabad during 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 with the support of the project fund. Five medical practitioners (one pediatrician, two gynaecologists, one pathologist and one surgeon) from an eminent medical college in New Delhi visited the watershed. Nearly 400 village members benefited from this camp; about ₹10,000 worth of medicines were distributed along with consultancy. A large number of children were found to be malnourished, women were diagnosed as anaemic, and many villagers complained about intestinal worm infestation and skin problems (Fig. 7.9).

7.4.8 Impact of watershed intervention on water resources availability and income

A number of water harvesting interventions and productivity enhancement activities, implemented at Parasai-Sindh watershed have made a significant impact on water resources availability, and income and livelihood of the farmers. Water, which was one of the limiting factors and a scarce commodity, was enhanced significantly. Both surface and groundwater were found in surplus amount even at the end of the summer period. 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) (Fig. 7.10). The NRM interventions have significantly changed the cropping pattern both in *kharif* and *rabi* seasons (Fig. 7.11).

Groundnut is the predominant crop in *kharif* along with black gram and sesame whereas wheat, mustard, chickpea, lentil and barley are being cultivated in the *rabi* season. More than 100 ha cultivable fallow land was brought under groundnut cultivation in *kharif* with increased water availability in open wells during the project period. Significant change also has been found in *rabi* crops. With increased and assured water availability, farmers who were cultivating lentil, chickpea and mustard have replaced these crops with barley and wheat. Also nearly 300 ha additional area which was left fallow in *rabi* especially at upstream locations were brought under wheat cultivation. This has made a significant contribution towards enhancing farmers' income in the villages during three to four years of NRM interventions. Figure 7.12 shows the NDVI (normalized difference vegetation index) values in Parasai-Sindh watershed before (February 2011) and after (February 2014 and 2015) the interventions. This is clear evidence of how the upland areas which were fallow have now been brought under cultivation due to groundwater availability. High rainfall occurred in 2014 but rainfall in 2015 was deficit by 30% than normal. Despite low rainfall, farmers were able to cultivate *rabi* crop successfully in 2015.

With increased water availability, the cost of cultivation especially for wheat and barley has reduced. Before project interventions, farmers used to engage hired or family labour for more number of days for irrigation work due to poor availability of groundwater as water in open wells used to deplete completely within 2–3 hours of pumping. Increased water availability (2–5 m increased water table in open wells) after the project interventions has facilitated farmers to complete irrigation in few days as they can pump water for 8–10 hours per day and therefore enhance labour use efficiency. This has reduced the cost of production especially for barley and wheat by reducing labour engagement. In addition, by introducing improved cultivars and management practices, wheat yield increased from 1.7 t/ha to 2.7 t/ha (Fig. 7.13). This all together made a compounding effect in enhancing net profit from agricultural production (Table 7.7) significantly. Yield and household data collected from pilot villages clearly showed that agricultural sector alone contributed towards enhancing net income from ₹20.8 million/year to ₹58.4 million/year.

The NRM interventions further improved fodder and livestock productivity. The number of buffaloes in project villages increased from 950 to 1300 with increased milk productivity of 2–3 l/day/animal. Livestock income increased from ₹10.2 million/year to ₹21.2 million/year, i.e. additional gain of ₹11 million/year. Altogether, average household income in Parasai-Sindh watershed increased from ₹51,000 to ₹143,000 per household per year, clearly indicating that there exists a huge scope for enhancing farmers' income by more than double through implementation of various NRM interventions in the Bundelkhand region. In addition to agriculture and livestock sectors, project interventions also helped in enhancing other ecosystem services such as increased greenery, tree biomass and productivity and reduced soil erosion and carbon sequestration. Moreover, drudgery and migration levels have significantly reduced in pilot villages with increased domestic and agricultural water availability and livelihood opportunities.

Fig. 7.10. Watershed status (a–d) before interventions: (a, b) rainwater harvest locations; (c) *desi ber* budding for agroforestry; (d) noncultivable fallow area; and (e–h) after interventions: (e, f) harvested water in check-dams; (g) fruiting one year after budding; (h) wheat crop grown in fallow land due to enhanced availability of groundwater during 2013.

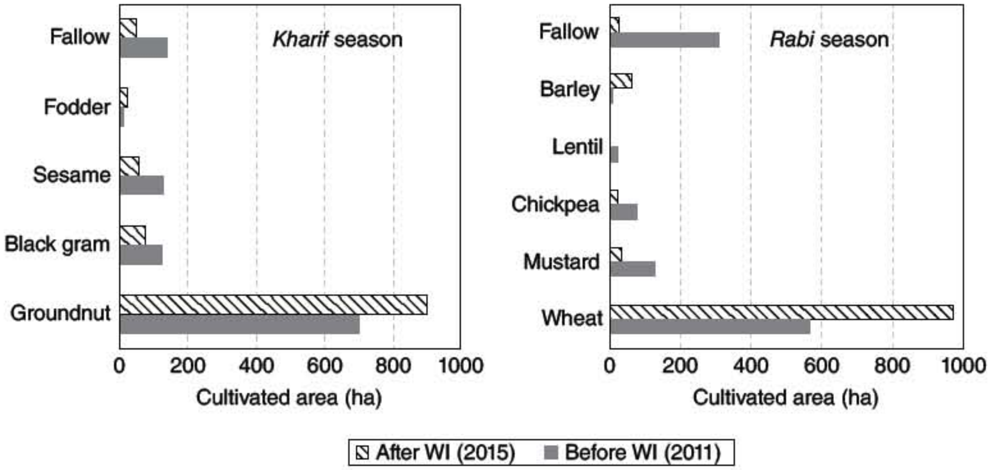


Fig. 7.11. Change in cropping pattern due to watershed interventions (WI) during *kharif* and *rabi* seasons.

7.5 NRM Interventions Implemented in Muduvatti Watershed

7.5.1 Entry point activity

Formation of watershed committee

Several village-level meetings were conducted with farmers and the watershed committee was formed with 15 members representing each village, women and small farmers. Along with watershed committee members, panchayat members and farmers participated in identification of constraints and preparation of work plan for the various possible watershed interventions to alleviate the constraints to enhance water resources and agricultural productivity while minimizing degradation of natural resources. Transparency at every step established good rapport and resulted in large and active participation of the village community in watershed management and development.

Soil fertility assessment

Soil health degradation is an important issue and studies show that most of the farmers are affected by it. As good soil health is a prerequisite to strengthen agri-based enterprises and this intervention fits well in the criteria of a good entry point activity, it may prove to be a very effective entry point intervention. Based on stratified soil sampling method (Sahrawat *et al.*, 2008), 70 soil samples were collected and analysed. Farmers' fields were found severely deficient in organic carbon (84%), S (73%) and B (61%) (Table 7.8). Soil fertility status was shared with farmers through village-level meeting during awareness-building programmes and by writing the information on walls of common buildings. Further, soil fertility information was used to provide village-wise and crop-wise fertilizer recommendation. Moreover, demonstrations were conducted in farmers' fields with these recommendations.

7.5.2 Rainwater harvesting

Rainwater harvesting is the most-needed activity in this watershed to improve water recharge as well as groundwater quality. Various soil conservation and groundwater recharge structures were constructed (Fig. 7.14) and these included farm ponds (28), field bunding (8800 m), gully plugs (75) and ponds for cattle (Table 7.9). As the watershed has low potential of runoff in waterways, major focus was on construction of farm ponds to harvest the runoff from individual fields of farmers. These farm ponds have been very beneficial in terms of storage of water after percolation. All the water-harvesting structures constructed increased the storage capacity by 13,500 m³ resulting in total 33,750 m³ rainwater harvested (assuming 2–3 times filling) in a season depending on the rainfall during the year. A success story is described in Box 7.1.

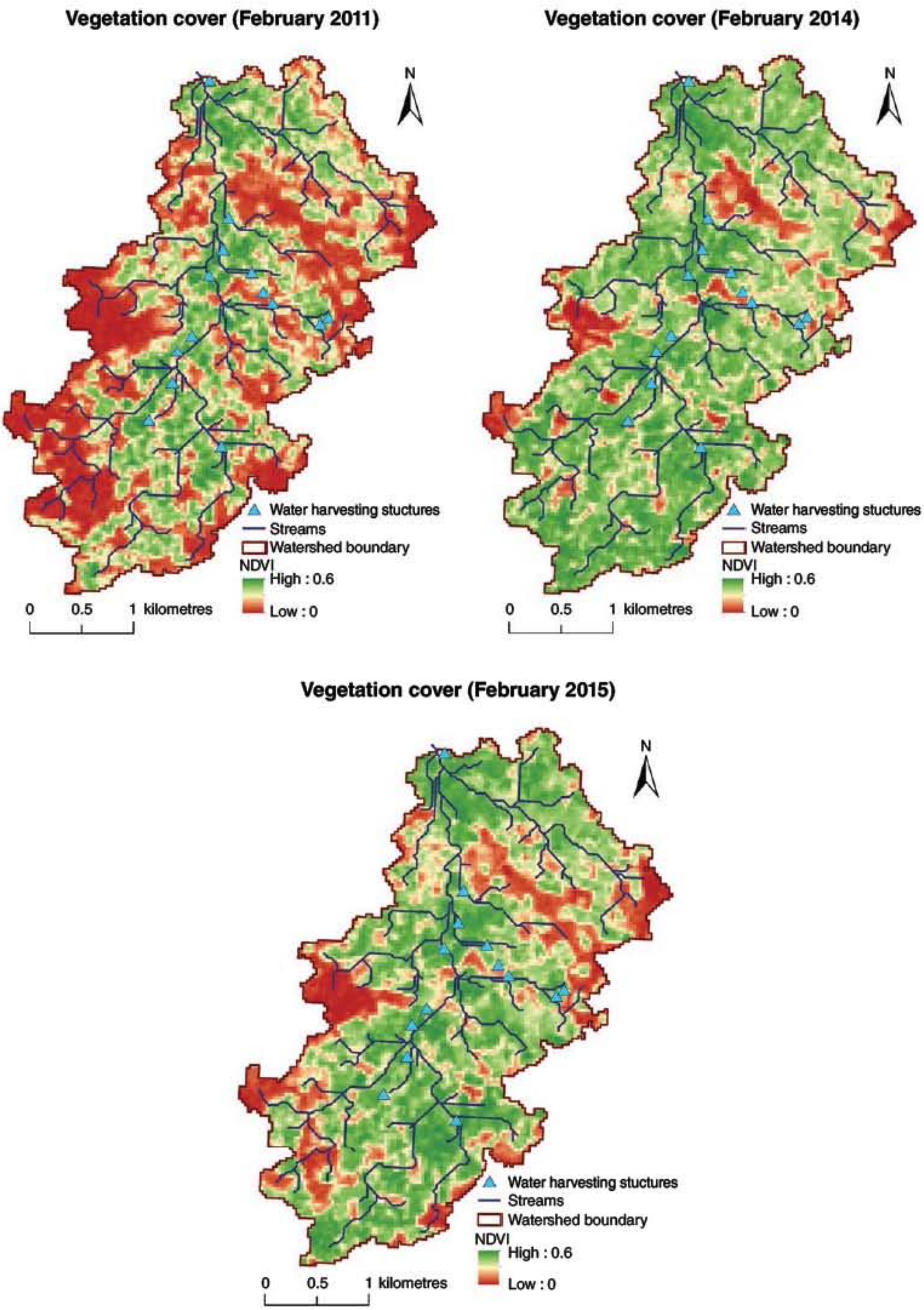


Fig. 7.12. Spatial maps of NDVI before NRM intervention (February 2011) and after intervention (February 2014 and February 2015) in Parasai-Sindh watershed. (Note: The dark red colour shows fallow area and green shows cropped area; triangles indicate various water-harvesting structures constructed across the stream network such as *haveli* renovation, check-dam and village pond.)

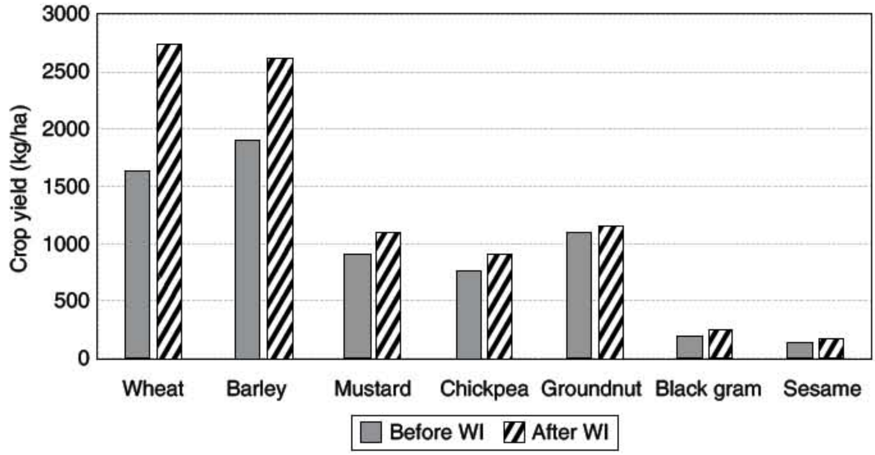


Fig. 7.13. Impact of watershed interventions (WI) on crop productivity.

Table 7.7. Impact of various natural resource management interventions on household (HH) income in project villages.

Details	Before interventions	After interventions	Difference
Kharif area under cultivation (ha)	968	1,057	89
Net income generated in *kharif* (₹ million)	13.8	20.3	6.5
Rabi area under cultivation (ha)	797	1,083	286
Net income generated in *rabi*[a] (₹ million)	–2.6	18.5	21.1
Total net income from agriculture (₹ million)	11.2	38.8	27.6
Buffalo population	950	1,300	350
Milk yield (l/day/animal)	6	8.5	2.5
Milk yield[b] (l/day)	2,850	5,525	2,675
Annual milk production cost (₹ million)	4.8	7.8	3
Annual income from livestock[c] (₹ million)	10.2	21.2	11
Total net income (₹ million/year)	21.4	60	38.6
Number of HHs	417	417	Nil
Average increase in income (₹/HH/year)	51,000	143,000	92,000

[a]Imputed cost of HH labour included.
[b]50% of the total buffaloes providing milk.
[c]150 days lactation period.

Table 7.8. Soil health status: percentage of farmer's fields deficient in nutrients in watershed villages.

	Percentage of farmers' fields deficient					
Village	Organic carbon	Phosphorus	Potassium	Sulfur	Zinc	Boron
Jangalahalli	75	0	0	75	0	38
Dandiganahalli	88	0	13	88	0	88
Konepura	100	0	13	100	0	88
Muduvatti	67	0	0	0	0	0
Nernahally	86	0	0	71	0	71
Papenahalli	80	0	0	20	0	20
Shettiganahalli	81	6	6	69	0	63
Shettikothanur	87	7	33	87	0	67

Fig. 7.14. Soil and water conservation structures established in project villages: (a) farm pond at Konepura; (b) trench bund at Dandiganahalli.

Table 7.9. Rainwater harvesting structures created in project villages.

	No. of structures				
Rainwater-harvesting structures	2013–14	2014–15	2015–16	Total	No. of beneficiaries
Farm pond	6	15	7	28	28
Cattle pond	1	1	–	2	65
Check-dam	–	–	4	4	40
Vermicomposting unit	–	3	26	29	29
Silage	–	–	4	4	4
Rooftop rainwater harvesting	–	–	3	3	3
Animal drinking water tank	–	–	7	7	350
Gully plugs	–	64	11	75	–
Bunding[a]	–	1800	7000	8800	–

[a]Bunding in m.

7.5.3 Productivity enhancement interventions

Field trials were conducted to demonstrate the impact of application of micronutrients (Zn and B) on groundnut and finger millet. Crop cutting experiments were conducted for estimating crop yield in improved and farmer-managed field practices. Farmers contributed 50% of fertilizer cost (agribor (B) and zinc sulphate ($ZnSO_4$)). Application of B and Zn increased crop yields by 23–26% over control plots (Table 7.10). Apart from field crops, bund plantation was done in the watershed with 3812 horticultural plants covering 15 ha benefiting 68 farmers and forestry species of about 4000 plants of silver oak, *Gliricidia* and neem covering 20 ha benefiting 30 farmers.

7.5.4 Livestock-related activities

Watershed villages had good number of milch animals so the watershed committee had suggested to provide assistance on livestock management for improving the milk yield. In this context, key initiatives started under the project were structures for drinking water storage, animal health camps, demonstrations of silage preparation, fodder production, etc. Forage production in the watershed improved through introduction of fodder purpose trees such as *Melia dubia* and silage for storing the fodder (see Box 7.2 for a success story). The Department of Animal Husbandry, Government of Karnataka has extended help through existing schemes for implementing these activities in the watershed villages.

Box 7.1. Watershed project helps farmer diversify activities and gain increased rewards.

In Jangalahalli village, progressive farmer Srinivas B, aged 40, proves the benefits of the watershed project through diversification in his farm. The farmer, who owns 2.4 ha of land in the village at present, is growing maize and napier grass in 0.6 ha, marigold in 0.2 ha and mango (Alphonso and Mallika varieties) in 1.6 ha. After the initiation of the project, the farmer decided to construct a farm pond through the project and the benefits have been extremely positive. After the farm pond construction, water availability improved drastically in comparison to other farmers' fields and Srinivas decided to grow fodder crops, such as maize and napier grass. He has also put a tarpaulin sheet as an impermeable lining in the farm pond to help retain more water.

Maize fodder and napier grass have increased the milk yield per cow by 3–4 l/day and from 5 milch animals the farmer could get about 100 litres per day, which resulted in net additional income of up to ₹27,600 per month. With 200 mango trees in 1.6 ha, the farmer now harvests about 2 tons per year, with net income of ₹43,000 per year.

Table 7.10. Impact of balanced micronutrient application with improved variety on groundnut and finger millet during *kharif*.

Variety	Treatment[a]	Yield[b] (kg/ha)	Year
Groundnut	Improved practice: ICGV 91114	1780 (14)	2012
	(RDF + agribor + zinc sulphate)	2450 (26)	2013
	Local variety: Farmers' practice (RDF)	1560	2012
		1950	2013
Finger millet	Improved practice: GPU 28 (with two irrigations)	2650 (17)	2012
	(RDF + agribor + zinc sulphate)	2860 (23)	2013
		740 (26)	2015
	Local variety: Farmers' practice (RDF)	2260	2012
		2320	2013
		580	2015

[a]RDF = Recommended dose of fertilizers.
[b]Figures in parentheses are percentage values of increase over control.

Box 7.2. Use of micronutrients and reduction of inorganic fertilizers helps farmer Muniswamy reap large rewards.

Muniswamy, a panchayat member and his wife, the watershed committee treasurer, have played pivotal roles in making the project a success. The couple, who own 2 ha of land in Konepura village, mainly practise dryland farming on their land and were dependent on finger millet for their income. After the project team visited their fields, they decided to apply micronutrients and used the recommended amounts of 12 kg zinc sulphate, 4 kg borax and 100 kg gypsum per hectare. The results have been phenomenal: the dependence on inorganic fertilizers such as diammonium phosphate has been reduced to 18 kg per ha from 100 kg per ha and urea to 36 kg per ha from 100 kg per ha.

The yield of finger millet increased by 1230 kg/ha and the farmer harvested 2470 kg/ha and sold at ₹21 per kg. Having had severe labour shortage, the farmer decided to share the labour in the field and thus expenditure on harvesting has reduced, spending only ₹24,700 per ha as overall expenditure. The net income generated for 2.02 ha is ₹65,000 for finger millet alone and earlier it used to be only ₹20,000–25,000 for 2 ha.

The project has also enabled the farmer to try methods such as mango–finger millet intercrop and with the increased income the farmer has diversified his goat-rearing business and also his small dairy unit. By selling the lambs, he earns almost ₹100,000 additional income per year and also after planting 50 *Melia dubia* saplings as a part of the project, milk yields have increased to 8 litres per day per cow after feeding the leaves as compared to 6 litres per day per cow before feeding *M. dubia* leaves. The monthly expenditure on the dairy unit is ₹15,000 and the net income generated from 4 HF crossbred cows is approximately ₹8000 to ₹10,000 per month.

7.5.5 Waste management: recycling, recovery and reuse

Composting the crop residue and animal waste

Along with multinutrient deficiencies, low levels of soil organic carbon due to soil mismanagement and misuse are the major stumbling blocks for realization of productivity potential. Soil organic carbon plays a major role in soil health improvement through influencing soil chemical, physical and biological properties. So practices that add organic matter into soil need to be promoted. Considering the availability of large quantities of on-farm wastes, there are opportunities to promote composting for soil health improvement and also cost-cutting of chemical fertilizers. Traditional composting (farmers' practices of heaping straw and dung) is very time-consuming and relatively less effective. In such a case, using half-decomposed compost/manure/plant residue creates many plant nutrient and pest-related problems rather than benefits. Vermicomposting (using earthworms) and aerobic composting (using microbial consortia culture) are tested technologies to effectively recycle on-farm wastes to produce quality compost for use in crop production. Vermicomposting has been done with 19 farmers with vermi-bed size of 3 m × 1 m × 1 m, which can prepare 10–12 tons of manure in 8–10 weeks.

Wastewater treatment and safe reuse of treated wastewater for improving water productivity

The rationale behind developing a decentralized wastewater treatment (DWAT) system is water scarcity, direct use of wastewater in agriculture is not good for farmers and consumers, disposal of untreated wastewater pollutes the environment, and all localities do not have sewage treatment plants. Wastewater treatment should be linked with integrated watershed development programme at field and community scale (500–1000 ha) (Wani *et al.*, 2015). A combination of wastewater treatment and integrated water resources management is helpful not only in enhancing crop production and income of smallholders but also in improving the water quality of groundwater wells and downstream water bodies and better soil quality through carbon sequestration. Phytoremediation technology in the form of constructed wetlands was adopted to treat the wastewater. The treatment capacity of the established constructed wetland is approximately 5 m^3 per day (Fig. 7.15).

Fig. 7.15. Constructed wetland in Dandiganahalli for treating domestic wastewater.

7.5.6 Income-generating activities

Several SHG activities have been adopted to improve the livelihoods with convergence and linkage of banks to SHG members for financial support. The watershed project coordinated to train 13 SHG members on tailoring by Community Management Resource Centre of MYRADA and linked SHGs to banks for financial support to buy sewing machines to improve their livelihood. One such woman, Ms Pavitra, was linked to National Bank for Agriculture and Rural Development (NABARD) through the project and procured a loan to buy one sewing machine. She also obtained free training on tailoring for 3 months. During marriages and festivals, she gets many orders and her income has increased by ₹4000 per month due to stitching alone. Similarly, the watershed project has facilitated farmers (11 groups consisting of 15 members in each group) to avail themselves of a loan from NABARD for the purchase of milch animals. To encourage women farmers to improve home nutrition and additional income, 300 fruit plants were distributed on the occasion of the International Women's Day celebration.

7.5.7 Capacity building

Awareness among the village/farming community regarding the solutions to achieve food and water as well as environmental security was very poor. For example, majority of smallholders are following the traditional agricultural practices that are not sustainable to cope with climate change and increasing food demand. The awareness-building programmes such as farmers' field day, environment day in schools, exposure visits to progressive farming communities or research institutes, etc. were conducted to bring new knowledge to the community and to create supportive environment for introduction of new interventions (Table 7.11).

Farmer-to-farmer video dissemination

In addition to conventional methods of information dissemination a farmer-to-farmer dissemination route was explored through a farmer-centric video documentation (Fig. 7.16) in collaboration with Digital Green (http://www.digitalgreen.org) (Patil *et al.*, 2016). The processed videos were used for screening during the village-level meeting. The battery-operated portable projectors (PICO projector) along with necessary accessories were provided to NGO staff. The project team screened the video to a small gathering (20–30 farmers) in villages. At the end of the video, the farmer facilitator collected feedback from farmers regarding previous videos. The feedback system also captures the adaptation rate of screened technologies. Thirteen videos were produced by ICRISAT staff and were screened in target villages, which benefited 400 farmers.

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Table 7.11. Capacity development programmes conducted in watershed villages.

Description	No. of programmes	No. of beneficiaries
Farmers' training	11	366
International Women's Day	2	350
World Environment Day	2	210
Video production and dissemination	13	401
National Women's Day at ICRISAT	1	13
Training to SHGs	29	486
Visit to Kamasamudra watershed (milk federation)	5	42
Visit to ICRISAT	1	14

Fig. 7.16. Project staff recording a video in a farmer's field.

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