4 CSR and Climate-resilient Agriculture – A JSW Case Study

Kiran J. Petare,* A.V.R. Kesava Rao, Mukund D. Patil, Suhas P. Wani, R. Sudi and K. Srinivas

International Crops Research Institute for the Semi-Arid Tropics, Patancheru, India

Abstract

The semi-arid tropics being dominant region is primarily agrarian with rainfed traditional agricultural production systems. Jawhar is a tribal block in Maharashtra, India characterized by high rainfall, water scarcity, degraded soils and low crop productivity. ICRISAT in collaboration with JSW has initiated agricultural interventions with watershed approach. Over a two-year period, the project has demonstrated various activities to build the resilience against climate change to cope with varying climatic risks and to improve livelihoods. Conservation of available resources through various measures was carried out with active community participation. Agriculture is the main source of livelihood of the community. Soil health management, rainwater harvesting, soil conservation, promotion of improved cultivars, introduction of new crops (crop diversification), income-generating activities and promotion of agronomic practices were the major interventions carried out in the project villages. These have taken farmers towards the path of building resilience to cope with climatic risks.

4.1 High-rainfall Zone – Jawhar, Maharashtra

4.1.1 Challenges and opportunities

The semi-arid region is primarily agrarian with rainfed traditional agricultural production systems being dominant. In the semi-arid tropics (SAT) soil degradation along with water scarcity are the main causes for low crop yields; and inefficient utilization of existing water resources results in low water use efficiency. An integrated watershed management approach proved to be the suitable strategy for achieving holistic development in these regions through collective action (Wani *et al*., 2003a). The very purpose of the watershed development programme is to reduce water-related risks in rainfed agriculture by improving the local soil–water balance by implementing both *in-situ* and *ex-situ* interventions. Since water and soil are important components of agricultural development, proper management of these resources is crucial to build the resilience of these systems to cope with varying climatic risks and to improve livelihoods. Rainfed soils are multinutrient deficient and need proper nutrient management strategies to bridge the existing gap between farmers' current yields and achievable potential yields (Sahrawat *et al*., 2010).

* Corresponding author: k.petare@cgiar.org

Jawhar is situated in the Konkan region of India. The rainfall in the region is seasonal and generally comes as torrential downpour resulting in large runoff and causing severe soil erosion; its distribution is quite erratic. Even though annual average rainfall in the region is 2729 mm, most rural people face water scarcity and drinking water shortage in summer. The hilly terrain and subsurface basalt rock limit the subsurface water percolation, causing heavy surface runoff during a monsoon, leading to soil erosion and land degradation. About 92% of the population in Jawhar taluk, Maharashtra is indigenous (tribal). Landholding of farmers is low and most of the farmers are small and marginal. Malnutrition is a major issue in the taluk; 52.44% of children are underweight. Crop productivity levels are very low due to adoption of traditional practices. Agriculture is rainfed and is the main source of livelihood. Migration is predominant in the taluk after harvesting the *kharif* (rainy season) crops. The main issue for farmers is the scarcity of water in summer and due to undulated landscape, it is not possible to cultivate a second crop after rainy season. This situation in the region provides a unique opportunity to assess and address livelihood issues in the region by tapping the potential of rainfed agriculture through knowledge-based management of natural resources for increasing productivity.

4.1.2 Climatic situation

Palghar district was formed on 1 August 2014 (earlier it was part of Thane district, Maharashtra). Palghar district comprises eight taluks, viz. Dahanu, Jawhar, Palghar, Mokhada, Talasari, Vada, Vasai and Vikramgad. As per the agroecological classification, Palghar district falls under 'Central and South Sahyadris, hot moist subhumid to humid transitional Ecological Sub Region'. Palghar district has mostly deep, loamy to clayey red and lateritic soils with low to medium (200 mm) available water capacity. The length of the rainfed crop-growing period varies between 210 and 270 days. There is variation in the rainfed crop-growing period across the taluks due to the change in rainfall distribution and topography. Average annual rainfall for Jawhar taluk is about 2729 mm, and normal monthly rainfall ranges from 3 mm in May to 1042 mm in July; rainfall is nil during December to April.

The normal date of onset of the southwest monsoon over Jawhar taluk is around 10 June and the monsoon withdraws by the last week of September. Monthly rainfall distribution in Jawhar taluk indicates that July is the rainiest month of the year. Rainfall activity generally ceases by the end of October.

Weekly rainfall data of Jawhar taluk was collected by the Government of Maharashtra for 19 years (1998–2016) (http://maharain.gov.in) and the average weekly rainfall was computed. Two contrasting years were identified as a wet year (2011) and a dry year (1999) and the distribution of weekly rainfall during the major crop-growing period (10 June to 28 October) for these two years and for the 19-year average is shown in Fig. 4.1. Average total rainfall during the season is about 2699 mm; in the wet year (2011), the total seasonal rainfall was about 3932 mm which was 46% above the average while in the dry year (1999), the total seasonal rainfall was about 1565 mm, which was 42% below the average. In the wet year, three peaks with a rainfall of more than 500 mm per week were observed, and the total rainfall for these three peaks is about 1740 mm; even during the dry year, two peaks with rainfall of 230 mm and 300 mm per week were seen. This highlights the need for proper runoff water management to save crops from inundation and storage of excess water for use during the following non-rainy season.

4.1.3 Rainfed crop-growing period

The length of the rainfed crop-growing period is the period of the year in which crops could be grown successfully as both rainfall and moisture stored in the soil will meet the moisture demands of crops. Knowledge on crop-growing period and its variability helps in choosing the right crops and varieties for higher productivity as well as identifying the optimum sowing time. The beginning and end and length of the rainfed crop-growing period at Jawhar taluk were identified (Fig. 4.2). Crop-growing period can begin as early as 3 June, but could be delayed as late as

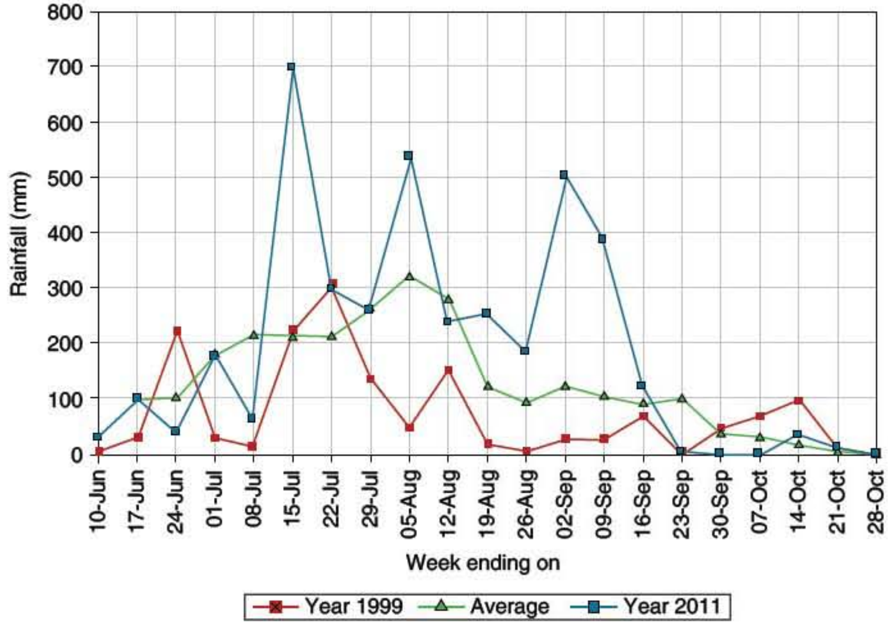

Fig. 4.1. Rainfall in contrasting years in Jawhar taluk, Maharashtra.

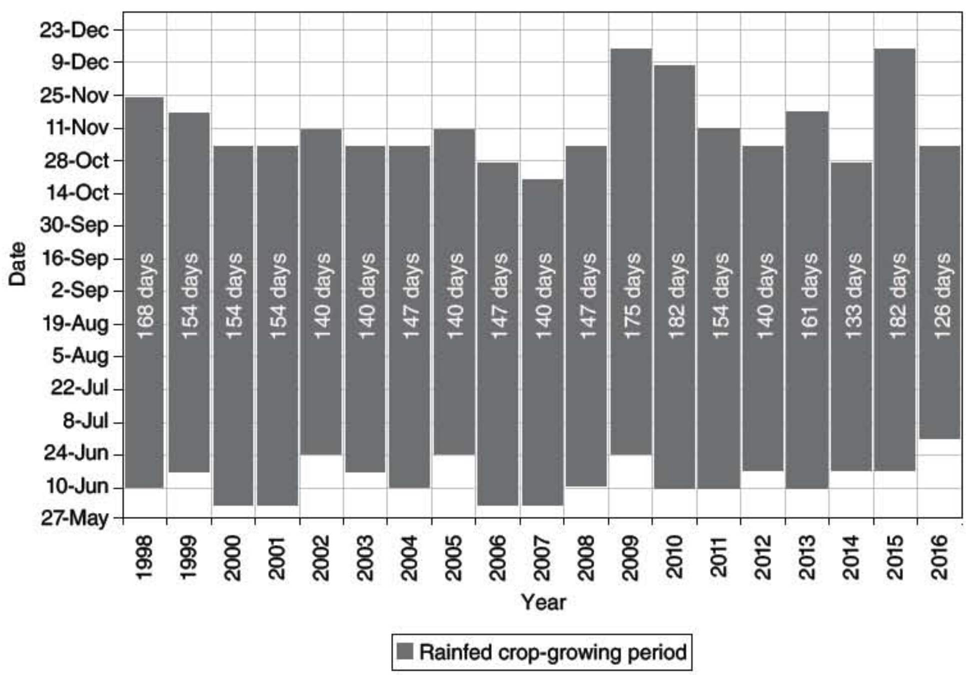

Fig. 4.2. Variation in the rainfed crop-growing period in Jawhar taluk, Maharashtra.

1 July; a difference of about 28 days. On average, the growing period begins by mid-June and ends by mid-November, so the length of the growing period is about 150–155 days.

Crop-growing period can end as early as 21 October and could extend up to 16 December; a difference of about 55 days. Thus, the beginning is more assured compared to the end of the growing period; there is a risk of end-of-season drought that can be managed by storing the excess water during the peak rainfall periods and with proper water management.

4.1.4 Projected climate change

Global atmospheric concentration of carbon dioxide has increased from a pre-industrial level of 280 ppm to 400 ppm in 2015. Various studies show that climate change in India is real and it is one of the major challenges faced by Indian agriculture. Climatic change in terms of water resource availability, changes in the length of crop-growing period and droughts is likely to aggravate the existing crop production risks. Both the strategic (longer-term) and tactical (seasonal) approaches are needed to manage climatic variability for sustainable crop production and rural incomes through efficient management of natural resources.

A study carried out by International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India revealed a net reduction in the dry subhumid area (10.7 million ha) in the country, of which about 5.1 million ha (47%) became drier and about 5.6 million ha (53%) became wetter, comparing the periods 1971–90 and 1991–2004 (Kesava Rao *et al.*, 2013). Results for Madhya Pradesh have shown the largest increase in semi-arid area (about 3.82 million ha) followed by Bihar (2.66 million ha) and Uttar Pradesh (1.57 million ha).

Relatively little changes occurred in Andhra Pradesh; semi-arid areas decreased by 0.24 million ha, which became both drier (0.13 million ha under arid type) and wetter (0.11 million ha under dry subhumid type). Results indicated that dryness and wetness are increasing in different parts of the country in place of moderate climates that existed earlier in these regions.

Projections of future climate are based on the output of atmosphere/ocean general circulation models and are used to simulate conditions in the future based on projected levels of greenhouse gases. There are several models available with different spatial resolutions. Majority of projections of future climate come from Global Circulation Models, which vary in the way they model the climate system, and so produce different projections about what will occur in the future. In the present study, Beijing Climate Center Climate System Model version 1.1 (BCC_CSM1.1) for the Coupled Model Intercomparison Project phase 5 (CMIP5) was considered. Monthly temperature and rainfall projections for the year 2030 for RCP 8.5 (Representative Concentration Pathways) were collected for the area representing Jawhar taluk, Palghar district and are shown in Figs 4.3 and 4.4.

Studies indicate that in addition to air temperature, rainfall amount and intensity are likely to change in future. These will impact the amount of water that can be stored as soil moisture and lost as runoff, thereby changing the water availability to crops at critical stages. Reduction in yields as a result of climate change is predicted to be more pronounced for rainfed crops as opposed to irrigated crops because of no coping mechanism for rainfall variability. Thus, rainfed agricultural crop production would become more challenging under future climatic conditions.

Projected changes in maximum and minimum temperatures and rainfall for Jawhar taluk show that there is great month-to-month variation. In the Jawhar taluk, the annual maximum temperature is expected to be higher by about 0.8°C and annual minimum temperature is likely to be highest by about 1.0°C. Maximum temperatures in July may increase by 1.2°C, while minimum temperatures during winter (November to February) are likely to increase by 1.2 to 1.5°C. A rise in temperature above a threshold level will cause a reduction in agricultural yields, but a change in the minimum temperature is even more crucial. Though the lands are mostly kept fallow in winter in this area, encouraging crop cultivation in winter is a way to enhance incomes of farmers. Higher minimum temperatures in winter are likely to hasten maturity and reduce crop yields in future and introduction of heat-tolerant varieties is likely to bring resilience.

Jawhar taluk is projected to have a positive change in annual rainfall of about 358 mm, mostly due to increase in rainfall during July and

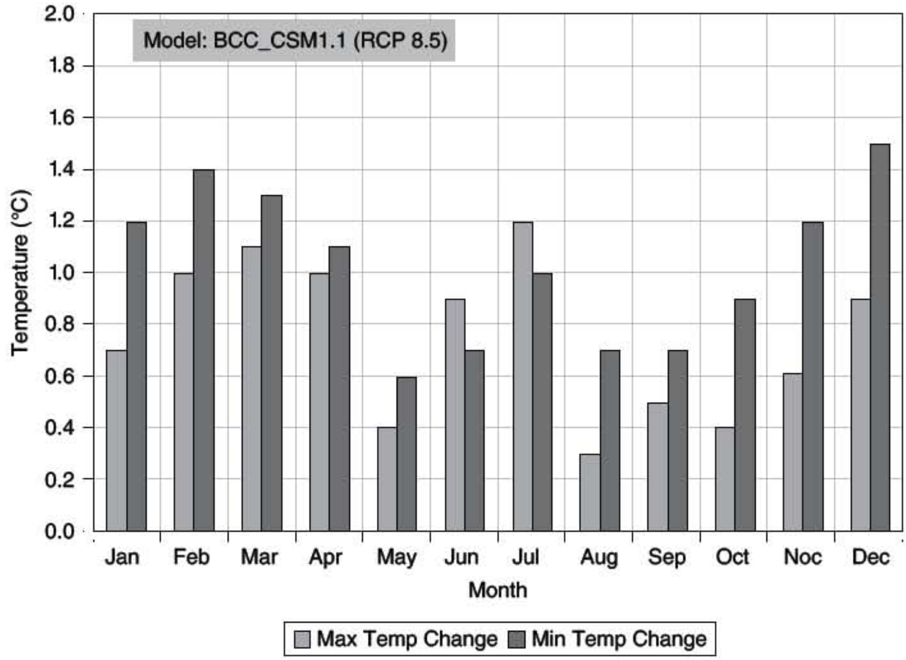

Fig. 4.3. Projected changes in temperature in Jawhar taluk, Maharashtra.

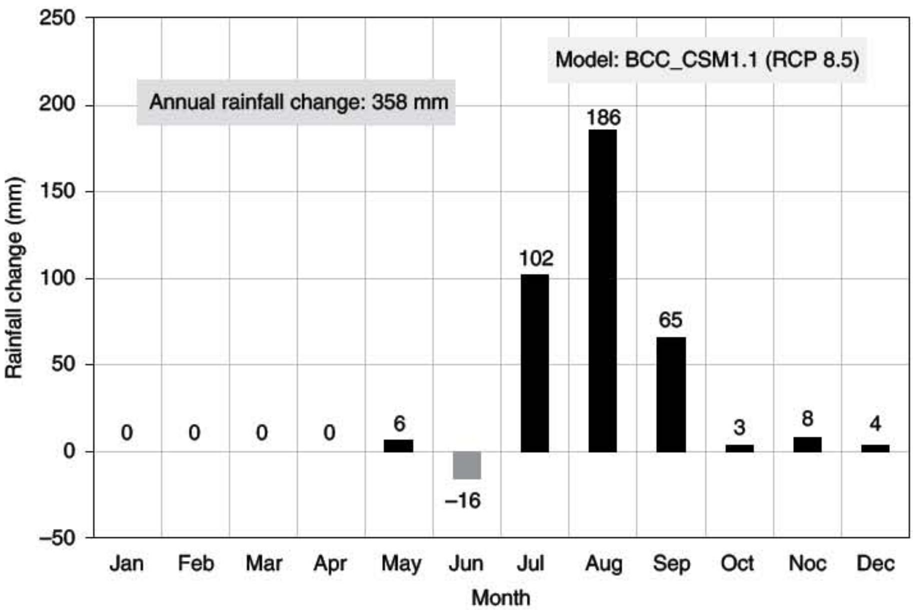

Fig. 4.4. Five projected changes in rainfall in Jawhar taluk, Maharashtra.

August. This is a positive indication for Jawhar taluk, as more water will be available for water harvesting and storing during these months. However, as June is likely to receive slightly lower rainfall and June is crucial for sowing and transplanting operations, more focus is needed for addressing the lower rainfall and variability in the sowing rains. Except for June, all other months are likely to have no change or higher rainfall compared to the present conditions (Kesava Rao *et al.*, 2013).

4.1.5 Corporate social responsibility opportunity

The JSW Foundation works consciously to support and empower communities by reducing social and economic inequalities by providing better opportunities through health, education, skill development and employment. It also works to tackle the issue of malnutrition, facilitate to make learning more effective and meaningful, empower the youth through employable skill programmes, ensure water security through long-term watershed development programmes and provide access to sanitation facilities in rural areas to make them open-defecation-free.

The JSW Foundation works with Government of Maharashtra to reduce malnutrition in Jawhar taluk, Palghar district. The interventions are mainly planned targeting the 0–6 age group children, pregnant women and lactating mothers. The focus of interventions are mainly on the dietary supplement provision to the targeted population. However, to eradicate malnutrion from Jawhar block, a long-term solution is required. Agriculture being the mainstay of the rural community in the region, agriculture-based interventions need to be planned. At a pilot scale, six villages, namely Ghivanda, Kogda, Jamsar, Dabheri, Sakharshet and Chambharshet were identified for malnutrition reduction through climate-resilient agriculture interventions (Fig. 4.5). The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India initiated the preliminary work with participatory rural analysis to get an overall understanding of ground situation in consultation with the local community. Discussions were focused mainly on needs assessment and interventions.

4.1.6 Pre-project scenario – constraints

Jawhar is a tribal block in Maharashtra state characterized by high rainfall, water scarcity, degraded soils and low crop productivity. About 84% of the households are engaged in agriculture, which covers 64% of the geographical area (Table 4.1). Agriculture landholding is also fragmented, with 24% of the households with less than 1 ha and 37% of the households less than 3 ha.

The major crops in this region are paddy, finger millet, pigeonpea, black gram, groundnut, sesame and proso millet. The productivity levels of paddy and finger millet are low. Most of the area is under rainfed agriculture with sole cropping system. Few farmers also cultivate vegetables with irrigation. There are some plantation gardens with mango, sapota and coconut.

The economic condition of farmers in this region is poor. Agriculture is the main source of livelihood; however, agricultural produce is mainly used for household purposes. There are a few progressive farmers cultivating marketable vegetables and flowers.

Farmers' perception about fertilizer application is that their fields at the foothills get nutrients from runoff water as it flows through decomposed material in the forest area. Some farmers use organic manure in the form of farmyard manure, and chemical fertilizers such as urea and diammonium phosphate are also used. Except for rice, farmers do not use improved cultivars of crops. Farmers believe that the local traditional varieties are more suitable to their region than the improved cultivars. Improper use of chemical fertilizers and other inputs have increased the cost of cultivation, which results in poor economic returns.

Few farmers grow mango, cashew, sapota and guava; but their productivity is lower. Banana cultivation is picking up. Progressive farmers cultivating flowers and vegetables are getting more benefits through available resources. Even though farmers get profit, they cannot cultivate their farms in *rabi* (the post-rainy season) because of open grazing of cattle and crop damage. Due to low population density, farmers do not get enough labour during peak season, whereas during *rabi* season some people migrate to other places in search of employment.

Farmers are not aware of good agricultural practices. For example, farmers do not use fertilizer as per the soil and crop requirements. As a result, soils may be deficient in major and micronutrients. Soil fertility assessment needs to be carried out as a priority. Due to poor land management practices and high rainfall, agricultural

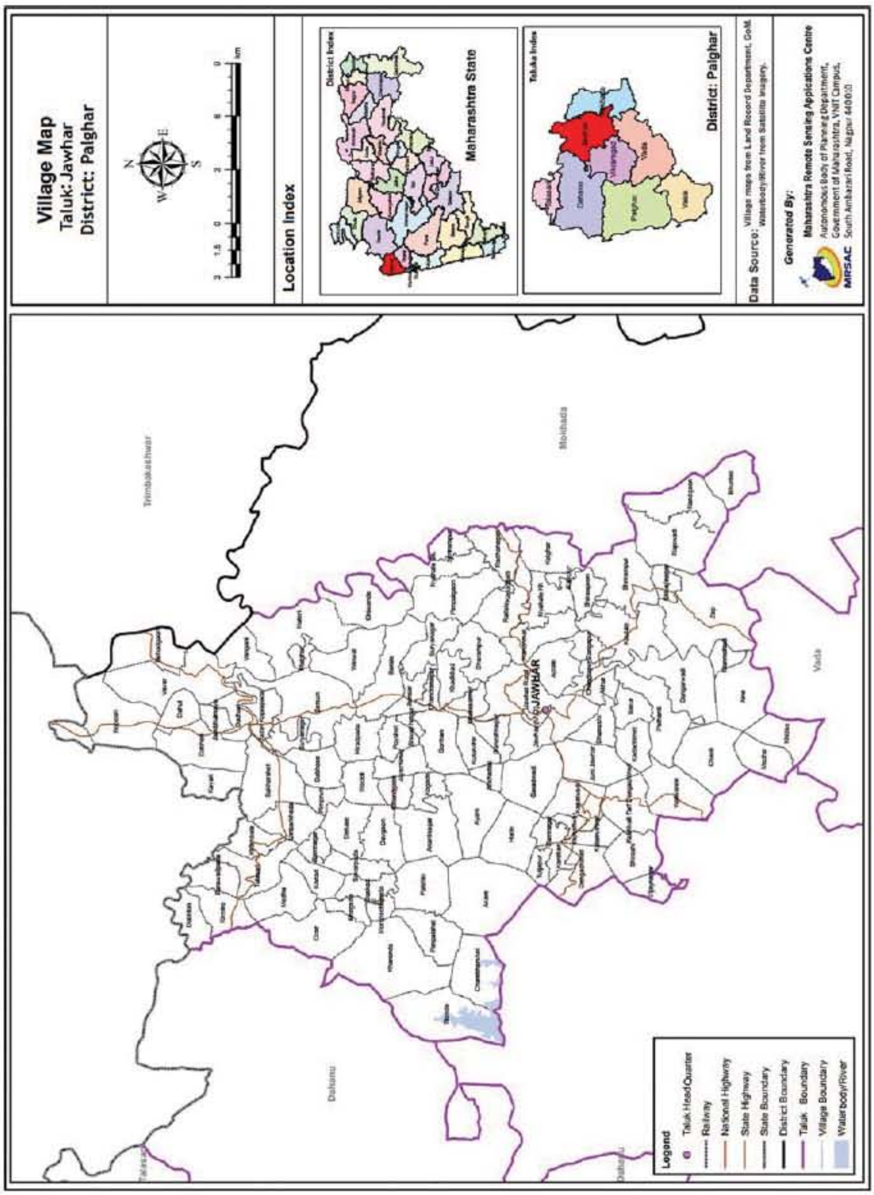

Fig. 4.5. Study sites in Jawhar taluk, Palghar district, Maharashtra. From: Maharashtra Remote Sensing Application Centre, Nagpur.

Table 4.1. Brief demographic information about the pilot villages.

Village	Households (no.)	Population (no.)		Land area (ha)
		Male	Female	
Ghivanda	323	805	844	808.52
Kogda	124	310	303	1405.07
Jamsar	305	730	731	941.12
Dabheri	321	938	882	875.15
Sakharshet	373	926	926	932.12
Chambharshet	288	829	845	807.95

land in these villages is degraded. Soil depths are shallow and low in organic carbon. Water-holding capacity is low to medium. Most of the farmers do not have an irrigation facility. Although the state government is providing 50% subsidy on irrigation pumps, farmers cannot afford to buy the pumps as farm holding size is very low.

4.1.7 Strategy and approach

Farm and land-based systems are complex with a multitude of problems. It requires a holistic approach that considers social, economic, political and institutional factors to achieve specific objectives. In this project, a holistic strategy has been adopted that considers all farm and land-based activities to take care of the multisectoral needs of farmers. The schemes and programmes initiated by central and state government have also been linked up to tap the resources for the welfare of the farming community. To gain community confidence on project interventions as a strategy, knowledge-based entry-point activity has been carried out in all the project villages; this has helped to promote confidence among the community members and generate awareness among the masses.

To achieve the overall goal of this initiative, emphasis was laid on increasing agricultural productivity and improving livelihoods on a sustainable basis by enhancing the impact of integrated watershed management programmes through capacity-building initiatives using site of learning in high rainfall agroecoregions. The project adopted consortium approach to bring together the expertise of different areas to expand effectiveness of various project interventions. In this project, the ICRISAT-led consortium has helped address complex issues effectively addressed by the joint efforts of key partners, namely, Rural Commune as non-government organization (NGO), Krishi Vigyan Kendra (KVK), Dr Balasaheb Sawant Konkan Krishi Vidyapeeth Dapoli, government line department, community-based organizations and other private interest groups, with farm households as key decision makers.

Implementation of this integrated approach has been carried out through establishment of consortium of partners by adopting the concept of '4-C' principles. The first 'C' is consortium of research, education, field-based agencies and market players to implement this programme effectively on ground. The second 'C' is convergence with and within the agencies for providing programme support, execution and monitoring. The third 'C' is capacity building of the consortium partners, farmers, implementing agencies and other stakeholders. The fourth 'C' is collective action at all levels during programme implementation (Wani *et al.*, 2003b, 2008).

In the overall programme partnership, the watershed committee is a major player for execution and monitoring of the programme activities. The watershed committee is empowered regularly towards programme activities. Considering the feminization of agriculture, the project placed efforts for representation of women members in watershed committee and also focused on capacity building of women farmers and female members of households. Also ICRISAT, along with the agriculture department and Krishi Vigyan Kendra of state agricultural university, has been working on crop improvement initiatives. The Rural Commune being the field implementation partner in the location is responsible for community capacity building and institutional support for implementation of activities in a sustainable manner.

4.1.8 Interventions

Interventions were initiated with the knowledge-based entry point activity (Dixit *et al.*, 2007). Constraint analysis has helped understand the issues related with the soil. Farmers were trained to collect the soil samples in their individual fields. A random stratified soil sampling methodology (Sahrawat *et al.*, 2008) was adopted to collect the soil samples. In the six project villages, 510 soil samples were collected with random stratified method, to get an overall understanding of soil health status in these project villages (Table 4.2). In the project villages, the farmers were trained on soil sample collection and details were shared on how to collect the sample. The soil sample analysis indicated that 8% of samples were deficient in organic carbon while 37% of soil samples were deficient in available phosphorus. For micronutrients, 93% of samples were observed deficient in available sulfur, 24% were deficient in available zinc and 78% deficient in available boron in the soils. Based on the soil sample analysis, in addition to NPK (nitrogen, phosphorus, potassium) 2.5 kg/ha borax, 25 kg/ha zinc sulphate and 100 kg/ha gypsum were recommended.

4.1.9 Soil and water conservation

As mentioned earlier, the region has high rainfall and due to inadequate soil and water conservation measures, soil erosion is a regular phenomenon. To arrest soil erosion, the project promoted soil conservation measures through continuous contour trenches, staggered contour trenches, gully plugs, etc. Over a period of two years, 41 ha area was treated with various soil and water conservation activities benefiting 102 households (Figs 4.6 and 4.7).

4.1.10 Rainwater harvesting

The villages face acute water shortage in summer. Hence, the project focused on desilting and repairing of existing water bodies in the project villages. The community was motivated for desilting of the water bodies in their respective villages and the project provided support for repair of the structures, if any (Table 4.3). This has led to water availability for drinking in summer in the project villages. The project also focused on desilting of existing check-dams in the project villages to create water storage facility (Fig. 4.8). Desilting has created additional storage capacity of 31,417 m^3. This would recharge 480,680 m^3 water considering 5 cm per day infiltration rate for 150 days (July to November). A success story in Kogda village is given in Box 4.1.

4.1.11 Crop management

Although agriculture is the main source of livelihood of the households in the project villages, the crop yields are below the district yields. Productivity of paddy, which is a staple crop in the villages, is 1.9 t/ha whereas the district average is 2.56 t/ha. Productivity of other crops is also low as compared to state and national averages. ICRISAT demonstrated crop management practices in the project villages with the major crops of the villages.

Paddy

Paddy is the major *kharif* crop in the villages and is the staple food of the community. To reduce the cost of cultivation and elevate the crop yield, demonstrations were carried out by promoting integrated crop management based on the science-led interventions as needed. In this context the project adopted line sowing as well as efficient water management along with soil test-based nutrient management practices for increasing the crop productivity (Fig. 4.9). Demonstration with 87 farmers was carried out with the variety Gujarat 4. Even though the rainfall was erratic and low with two long dry spells, yield was low but comparatively good over the traditional practice with an increase in yield of about 34% (Table 4.4). Farmers are now showing interest for the improved practices and are willing to scale-up the line sowing method.

Finger millet

Finger millet is the second-largest food crop of this region. Farmers usually grow the local variety using the broadcasting method. The average yield of the crop is very low, i.e. 350 kg/ha.

Table 4.2. Soil fertility status of farmers' fields in the project villages.[a]

Villages	No. of Samples	Range of available contents (mg/kg soil)					
		OC	Av P	Av K	Av S	Av Zn	Av B
Jamsar	50	0.49–2.15 (0)	3.8–25.0 (19)	52.46–565.05 (0)	0.80–7.91 (100)	0.28–4.06 (43)	0.22–0.89 (81)
Kogda	55	0.31–2.91 (0)	1.4–74.40 (47)	55.91–545.60 (0)	0.39–23.82 (95)	0.22–7.30 (66)	0.29–1.57 (75)
Sakharshet	97	0.27–3.50 (0)	1.4–89.80 (47)	47.55–561.80 (0)	0.47–43.57 (95)	0.44–7.72 (66)	0.24–1.14 (75)
Ghivanda	98	0.18–2.65 (14)	1.8–110.40 (51)	39.89–560.20 (2)	1.03–91.86 (92)	0.08–7.62 (7)	0.14–1.08 (67)
Dabheri	96	0.25–2.28 (9)	1.6–76.40 (29)	71.005–547.00 (1)	0.89–26.02 (84)	0.44–3.66 (11)	0.18–2.03 (73)
Chambharshet	98	0.26–3.50 (5)	0.8–120.40 (55)	47.27–539.76 (0)	0.41–267.53 (93)	0.24–10.13 (21)	0.07–3.31 (88)

[a]Note: Values in parentheses indicate % fields deficient in particular nutrient, i.e. baseline status of farmers' fields, and does not involve statistics or significance. Critical value adopted for delineating % deficiency are 0.5% for OC, 5 mg/kg for P, 50 mg/kg for K, 10 mg/kg for S, 0.58 mg/kg for B and 0.75 mg/kg for Zn. Based on the soil health assessment, for deficiency of micronutrients, 25 kg/ha zinc sulphate (20% Zn), 2.5 kg/ha borax (20% B) and 100 kg/ha gypsum (15% S) were recommended. The secondary nutrient recommendations were based on the crops.

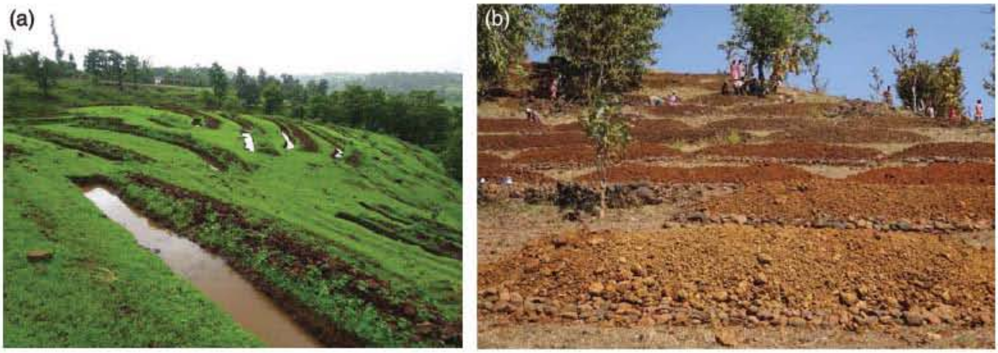

Fig. 4.6. Soil and water conservation work in (a) Kogda and (b) Sakharshet villages.

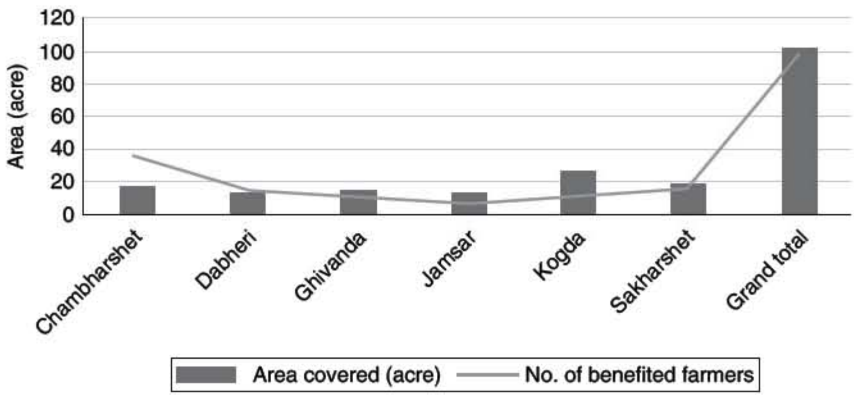

Fig. 4.7. Farmers benefiting from soil conservation work in the project villages.

Table 4.3. Repair and desiltation work in the project villages.

	No. of structures			
Village	Well repair	Well deepening	Desilting of check-dams	Desilting of lakes
Ghivanda	8	6	5	1
Jamsar	4	3	1	1
Kogda	4	5	6	0
Chambharshet	10	9	0	0
Sakharshet	4	4	5	0
Dabheri	5	3	0	0
Total	35	30	17	2

ICRISAT introduced long-duration high-yielding varieties MR 1 and GPU 28. Farmers were trained for nursery preparation and transplantation of crop. During *kharif* 2015, 44 finger millet demonstration trials covering 5.5 acres were carried out (Table 4.5). In 2015 scanty rainfall hampered crop growth; however, the demonstration plots showed 43% higher yield than the farmers' practice (Fig. 4.10).

Groundnut

A foliar-disease-tolerant new variety of groundnut ICGV 350 has been introduced to replace

Fig. 4.8. Desilted check-dam in Kogda village.

the traditional variety used by the farmers in the project villages. In addition to the varietal change, raised bed and broad-bed and furrow system have been introduced in groundnut crop. This has helped drain excess water from the field. With the recommended dose of fertilizers, the crop has shown encouraging results (Fig. 4.11). In the demonstration plots, 48% higher yield (1520 kg/ha) was obtained as compared to farmers' practice (1020 kg/ha).

Pigeonpea

Pigeonpea crop too has a prominent place in the diet of the local people. As a new initiative, demonstrations of pigeonpea and groundnut intercropping were carried out. Traditionally, farmers use the broadcasting method of sowing, so more seed is required. ICRISAT provided seed of improved varieties ICPL 88039, ICPL 87119 (Asha) and ICPH 2740. The hybrid ICPH 2740 performed very well in the project villages and produced 85% higher yield and ICPL 87119 and ICPL 88039 produced 51% higher yield as compared to the local variety (Fig. 4.12).

4.1.12 Crop diversification

Farmers' incomes were low with traditional crops. To enhance income at household level and for optimum utilization of available resources, ICRISAT promoted and demonstrated the post-monsoon crops as cash crops as well. The post-monsoon crops helped farmers to obtain more grain yield and cash crops helped gain additional income at household level. The project promoted cultivation of creeper vegetables in the project villages, initially focusing on bitter gourd covering 81 farmers in 15 ha (Fig. 4.13; also see Box 4.2). These interventions have helped farmers gain additional income at household level. Based on the experiences and output achieved in bitter gourd cultivation, the project supported the farmers for diversified vegetable cultivation in the project villages covering a 23.4 ha area (Table 4.6).

Box 4.1. Desilting old structures to enable fertile lands.

Mahadu Sakharam Bhoye is a farmer from Bhoyepada hamlet of Kogda panchayat in Jawhar taluk. He has a family consisting of nine members. With the introduction of the JSW project in his village, Rural Commune has started working in his village. A watershed committee has been elected in the village and a main watershed body of six villages was formed in which 12 members have been appointed and the farmer has been chosen as the secretary of the committee named 'Pragati Bahuudheshya Sevabhavi Sansthan'.

Most of the agriculture in the village is rainfed and farmers are totally dependent on rainfall to raise their crops. In the village, there are three masonry check-dams which were built by the agriculture department in 2001. Despite this intervention, the village is facing water scarcity for agriculture purpose as the water was used as last source for irrigation in long dry spells during the rainy season. Due to rainfall of the past few years, silt had been deposited from 2001 and desiltation work had never been carried out. In 2015, with the help of Rural Commune, it was proposed to desilt two check-dams in the village. About ₹92,180 was spent to revive two check-dams with pitching in both sides. The community actively participated in the work and also donated ₹2,538 in the form of voluntary labour. The farmer later applied all the removed silt (i.e. approximately 250 tons) to his barren wasteland of about 0.2 ha, thus transforming it into highly fertile land. After the application, the farmer harvested vegetable crops like brinjal (513 kg), chilli (1620 kg) and pigeonpea (180 kg) and sold the vegetables for ₹12,825, ₹48,600 and ₹14,400 respectively.

The farmer was surprised by the beneficial result of applying silt to his barren land and decided to apply silt to the rest of his agricultural land and motivated his colleagues to do the same to increase the productivity of their land. He says that this method can help retain lost fertility of soil; and old water-holding structures will be recycled, resulting in the increase of the groundwater table. During the *rabi* season, with the help of lift irrigation from the desilted check-dams, the farmer decided to harvest chickpea, onion, groundnut and maize in the silt applied area. Also, neighbouring farmers are lifting water from the desilted check-dam and growing vegetables like cabbage, okra, guar (cluster beans), tomato, onion, fenugreek and bottle gourd. In total, 3.04 ha of land was irrigated during the *rabi* season in 2015 after desilting of check-dams and vegetable crops were then cultivated.

Horticulture plantation

In the villages, most of the uplands remain barren. These are mostly cultivable wastelands where farmers cultivate finger millet and foxtail millet based on the availability of seed and time during the monsoon season. However, the land remains barren. After soil and water conservation works in the land, the project promoted cultivation of horticulture and forestry plantation. Horticulture plantation has been carried out in all the six project villages, covering 798 households (Table 4.7).

Rice fallow management

In the project villages, cultivating *rabi* crop is a bonus for small and marginal farmers. Due to lack of irrigation facilities at household level and non-availability of irrigation infrastructure the villagers were dependent only on the monsoon crops. Post-rainy season agriculture lands used to remain barren. The project helped the farmers to utilize the available soil moisture for the second crop and introduced chickpea (JG 11) in the project villages. About 135 farmers participated in the crop demonstration across six villages (Fig. 4.14). The crop was grown only on the available soil moisture after harvesting paddy. Chickpea yield was 46% higher in the demonstration plots as compared to farmers' practice.

Promotion of post-monsoon crops

The project has also focused on creating irrigation infrastructure in the project villages, mainly promotion of irrigation pumps, pipe lines, sprinklers, etc. Irrigation facilities were provided to the villagers on a group basis to generate ownership among the community and also revenue for future management and maintenance of the asset created. The project has provided six irrigation pumps and pipelines to women self-help groups (SHGs), who are caretakers of these assets and generate revenue by providing these pumps to individuals. After establishing irrigation

Fig. 4.9. Improved paddy crop management practice in Sakharshet village.

Table 4.4. Paddy yield and benefits with improved cultivation practices in project villages.[a]

Village	No. of trials	Crop yield (kg/ha)		Additional return with BN (₹)	Additional cost on BN (₹)	Benefit–cost ratio
		FP	BN			
Jamsar	9	1240	1680	6298	2100	3
Kogda	15	930	2220	18180	2100	8.66
Sakharshet	17	2950	3560	8626	2100	4.11
Ghivanda	14	2220	2820	8379	2100	3.99
Dabheri	9	2920	3650	10246	2100	4.88
Chambharshet	23	2200	2800	8411	2100	4.01

[a]FP = Farmers' practice; and BN = Balanced nutrition.

Table 4.5. Finger millet crop yield with balanced nutrient management.[a]

Village	No. of trials	Crop yield (kg/ha)		Additional return with BN (₹)	Additional cost on BN (₹)	Benefit-cost ratio
		FP	BN			
Kogda	18	320	690	6068	2100	2.89
Ghivanda	13	310	870	9193	2100	4.38
Dabheri	13	430	670	3935	2100	1.87

[a]FP = Farmers's practice; and BN = Balanced nutrition.

Fig. 4.10. High-yielding finger millet crop in Sakharshet village.

Fig. 4.11. Groundnut crop in Ghivanda village.

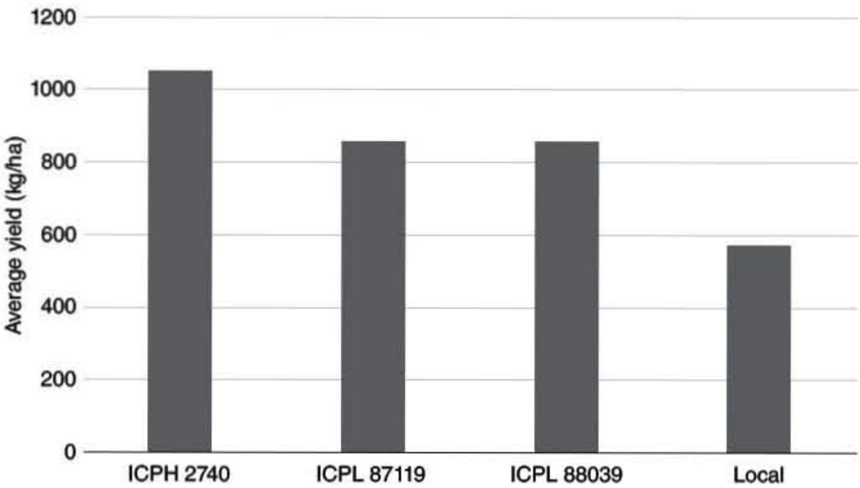

Fig. 4.12. Yield of improved pigeonpea varieties compared with local cultivar.

Fig. 4.13. Bitter gourd cultivation in Sakhershet village.

infrastructure, green gram (LGG 460) and wheat (HI 1531) were introduced in the project villages. Green gram has shown 24% higher yield with irrigation as compared to farmers' practice. In case of wheat, only three demonstrations could be worked out with assured irrigation possibility. Control plots with local variety available with the farmers were also established. The demonstration plots have recorded 29% higher yield as against the control plot (Fig. 4.15).

4.1.13 Graduation of tribal farmers to protected cultivation of vegetables

Vegetable cultivation has helped the farmers to gain confidence and understand the benefit of cash crops. Building on the assurance, the project promoted cultivation of high-value cash crops. Following discussions with the community, a group-based net house was established in five villages based on the demand (Fig. 4.16). The project provided soft loan to these members for infrastructure establishment. The output of first year interventions is given in Table 4.8. In a span of 150 to 180 days, farmers earned ₹3000 to ₹10,000 from protected cultivation.

4.1.14 Microenterprises

Small-scale entrepreneurship through watershed development plays a significant role in poor people's lives and is one of the key factors to uplift people out of poverty (Anantha *et al.*, 2009). Some of the activities are the backbone on which the rural society survives in most arid and semiarid regions. Watershed development is primarily aimed at sustainable management of natural resources contributing to overall agricultural development and livelihood promotion in rural areas. The project focuses on establishing microenterprises in the project villages. Village seed bank and nursery raising have been introduced in the project villages as income-generating activities.

Village seed bank

The introduction of hybrid technology made farmers depend on external sources for replenishing

Box 4.2. Technical guidance from JSW-ICRISAT programme helps farmer overcome debt trap.

Vijay Balwant Bhoye, a farmer from Kogda village has 3 acres of land. His family consists of six members and the entire family depends on agriculture for their livelihood. He usually harvests crops such as finger millet, paddy, pigeonpea, black gram and safflower, mainly grown under rainfed conditions. During the recent decade due to irregular rainfall and late arrival of the monsoon, sowing was delayed and resulted in reduced productivity for the farmer and his family, which eventually forced them to migrate to Thane or Palghar for earning their livelihood.

After migration, the farmer was in debt as the contractors did not pay him on time and his family was struggling for food. He was also burdened with the additional expenses of his children's education and his parents' health care. It was after the introduction of the JSW-ICRISAT programme, that the farmer's life gradually started to improve. Also, regular meetings by the Rural Commune (RC) staff helped motivate the farmer to improve productivity.

After a series of meetings with the RC staff, the farmer tried cultivating bitter gourd by the *mandav* (trellis system) method, which helped him make a regular income. During May 2015 in about 1 acre of land, the farmer dug pits and filled them with farmyard manure (FYM). He also procured a loan from neighbouring farmers for purchasing bamboo, strings, ropes and FYM for raising the *mandav* for bitter gourd. The expenditure incurred was ₹16,525.

The production of bitter gourd started from the first week of August. With proper guidance from the RC staff for collective marketing, the farmer took the produce to a common collection spot where they would weigh the produce. The vehicle used would take all the vegetable produce of his village and other neighbouring villages to Vashi wholesale vegetable market in Mumbai. The calculation of the profit was done on a weekly basis and he started to earn money from it. The farmer sold a total of 8500 kg of bitter gourd from 1 acre of land. Also, the RC staff had motivated him to keep a note on the details of expenditure and profit. He procured an income of ₹76,500 from selling bitter gourd, with net profit of ₹59,975.

The farmer's net profit helped him pay old debts. Due to the meetings with the RC, he was motivated and learnt new techniques and now he is growing more vegetables such as cabbage, tomato, cowpea and chilli in *rabi* season. In 2015 during 'Farmers' Day' farmers visited his farm. The event has made the farmer very proud. He is also working in watershed activities taken by the project and is thankful to ICRISAT for helping farmers.

Table 4.6. Vegetable cultivation in project villages.

Vegetable	No. of farmers	Area covered (ha)
Onion	29	2
Chilli	25	1
Brinjal	25	1.5
Tomato	49	2
Cowpea	2	0.2
Cluster bean	4	1
Cucumber	4	1
Okra	33	9
Broad bean	7	1.2
Bottle gourd	4	1.5
Sponge gourd	6	2.5
Pumpkin	2	0.5

seeds every season to gain higher productivity. The inability of small and marginal farmers to purchase hybrid seeds every season and availability of quality seeds in the rural market is a cause of concern. Therefore, the project made an attempt to establish village seed bank as an income-generating activity to meet self-sufficiency in production and distribution of quality seeds. This involved four women SHGs and one farmers' group. The current availability of seeds in the village level seed bank is given in Table 4.9.

Nursery raising

Nursery raising is a means of livelihood for a large number of people. It provides income-generating opportunities for the local communities. It also enables capacity building and upgrading skills of members of the communities. Nursery raising generates cash income for poverty alleviation. It provides an opportunity for women and aged people to contribute to income generation with flexible working hours. Overall, six nursery raising units in the project villages have been promoted covering six women SHGs. This has helped earn additional income of ₹20,000 to ₹50,000 per group.

Table 4.7. Horticulture plantation in project villages.

Village	No. of farmers	Mango	Cashew	Sapota	Guava	Lemon	Custard apple
Sakharshet	89	841	396	315	90	0	0
Chambharshet	110	110	230	110	110	0	0
Kogda	38	280	106	141	115	0	0
Jamsar	368	368	165	131	166	0	0
Ghivanda	1210	1210	369	252	302	70	34
Dabheri	325	325	112	55	55	0	0
Total	2140	3134	1378	1004	838	70	34

Fig. 4.14. Chickpea crop demonstration in Chambharshet village.

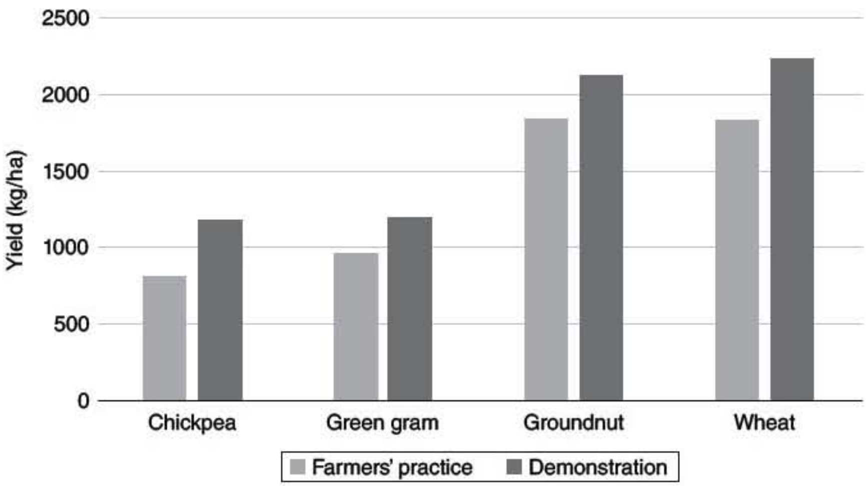

Fig. 4.15. Yield of crops in demonstration plots compared with farmers' practice.

Fig. 4.16. Protected cultivation of cucumber in Chambershet village.

Table 4.8. Farmer income from protected cultivation.

Village	No. of farmers	Net house area (m²)	Crop	Yield (kg)	Total income (₹)	Income per farmer (₹)
Kogda	4	784	Bitter gourd	1,078	42,385	10,596
Ghivanda	4	952	Cucumber	2,384	34,740	8,685
Jamsar	4	748	Cucumber	1,019	14,400	3,600
Sakharshet	2	352	Cucumber	350	6,200	3,100
Chambharshet	6	1,024	Cucumber	1,177	22,294	3,716

Table 4.9. Seed bank in project villages with seed (kg) of five crops.

Village	Pearl millet	Finger millet	Paddy	Groundnut	Pigeonpea
Ghivanda	0	4	8	70	3
Jamsar	0	3	5	100	2
Kogda	0	0	10	40	0
Sakharshet	0	10	7	93	0.5
Dabheri	1	0	0	55	3.5
Chambharshet	2	6	30	70	2
Total	3	23	60	428	11

4.1.15 Market linkages

The project has shown farmers the ways and means of improved production and to harvest additional benefits from the available resources within the villages. However, the project area being in the interior part of the district, accessibility to the market is an issue. The two nearest markets to the project locations are Nashik and Navi Mumbai. The project focuses on collectivization of the produce at the central place, the produce gets sorted and graded, farmer-wise quantity gets recorded and the produce is transported to the Navi Mumbai or Nashik Market. At both the markets, the identified dealer communicates the price and the produce is sold to the respective market. The transport cost incurred is divided among the farmers, based on the quantity each individual is sending to the market.

4.1.16 Overcoming malnutrition

As mentioned earlier, the project area has been facing a severe problem of malnutrition. The project exclusively targeted families having malnourished children as identified under the Government of Maharashtra's Integrated Child Development programme. Specific interventions, mainly vegetable cultivation as kitchen garden for consumption purpose were promoted. Under the cropping system, the project focused on introduction of its iron-rich pearl millet variety 'Dhanshakti' for consumption purpose along with the promotion of chickpea (see Box 4.3).

4.1.17 Marching towards mechanization

Farmers in the project villages mainly constitute small and marginal farmers having small landholdings. During the monsoon season availability of labour is an issue. The conventional tractor-based farm equipment are not suitable for field operations. The project invested in suitable small equipment like power tillers which help support easy farm operations.

4.1.18 Impact

The watershed project had positive impacts on the livelihoods of the community and on the natural resource base. Community-based organizations were strengthened and led to greater social capital for the rural population. Incomes and employment opportunities increased leading to reduction in outbound labour migration. Water availability significantly increased. Creation of water harvesting structures helped harvest 1,361,927 m^3 of water. Improved agricultural practices showed increase in crop yields by 35% to 75% resulting in additional income of ₹15,000 to ₹25,000 per ha. Promotion of cash crops, mainly vegetable cultivation, helped gain additional ₹8,000 to ₹10,000. Capacity building measures and the empowerment of farmers, NGOs, extension workers and SHG members were enhanced.

4.2 Low-rainfall Zone – Ballari, Karnataka

4.2.1 Site specification

One of the requirements from JSW was to select villages in vicinity to their factory. The team comprising scientist from ICRISAT, officials from Department of Agriculture, Karnataka, and JSW have visited villages in Sandur taluk to identify the project locations. The four villages identified for the project were Dodda Anthapura, Chikka Anthapura, Kodalu and Joga. In these villages 1930 families are practising agriculture, while 293 families are landless. The villages are located about 25 km from the JSW factory in Toranagallu and 35 km from Ballari district headquarter.

There is a variation in resource endowments in these villages showing the opportunity to introduce different activities for the betterment of the community. The area is undulating and mainly depends on rainfall. The main sources of irrigation are bore well and open well. Each family generally has landholding of 2–5 acres, with a few families having up to 10 acres. Type of soil is red, loamy with few

Box 4.3. Preventing malnutrition through proper guidance.

Rajendra Mahale, a farmer from Sakharshet village, belongs to a joint family with 12 members. He is currently a watershed committee member in the village. He is working in the project implemented by ICRISAT and Rural Commune supported by JSW Foundation. The project team has been working extremely hard to eradicate malnutrition in the village and Rajendra regularly attends the monthly meetings in which the team takes decisions and brainstorm about the activities and issues happening in the project area. Rajendra's daughter, who is 3 years old, is severely underweight and it was only after attending the meetings that Rajendra became aware about the issue of malnutrition.

In September 2016, the project team had detailed the members about their approach towards eradicating malnutrition from the selected villages by motivating farmers to undertake nutrient enriched *rabi* crop and reduce migration of farmers to towns and cities during dry season. Rajendra decided to cultivate chickpea crop as it has good protein source. He cultivated the crop on 0.05 ha land as per the guidance of the project staff. He invested about ₹1094 for irrigation, labour and harvesting. He harvested about 62 kg of chickpea, which he utilized to feed his family. It was the first time Rajendra had cultivated chickpea crop and he is now thankful to JSW, ICRISAT and Rural Commune for helping his village to combat malnutrition and prevent migration.

patches of black soil. The decadal analysis of rainfall data (1996–2005) showed that the highest rainfall occurred in Sandur taluk (752 mm) and the lowest at Ballary (452 mm) with annual normal mean rainfall of 611 mm in the district. The southwest monsoon contributes 73% of the total rainfall in the district, while the northeast monsoon contributes 27% of total rainfall in the district. The mean maximum temperature in the district is 40.4°C and the mean minimum temperature is 14.3°C (January). Relative humidity ranges from 48% to 74% in the morning and 27% to 61% in the evening.

Agriculture contributes major portion of the income of the taluk. The main food crops are sorghum, paddy, maize and pulses, while the important commercial crops are sunflower, safflower and cotton. Though the productivity has shown a declining trend in the past few years, performance is better than the state average in terms of production and yield with reference to paddy, pulses, sorghum and cotton. Major horticultural crops grown in the district are chilli, coriander, pomegranate, mango and coconut. The current yield level is lower by 2–3 times the achievable potential yield of major dryland crops in the taluk. Even in irrigated belts of the taluk also the paddy yield is quite low. Overall, the yield of major dryland crops is far below the achievable yield.

4.2.2 Challenges and opportunities

Shift from agriculture to industry

The district is endowed with iron ore and famous for mining and related industrial activities which has provided employment opportunities for the young population. As a result of the available industrial employment opportunities, agriculture is left for elders and women, coupled with unavailability of labour force and falling returns due to low crop yields and price constraints.

Land use pattern

The average landholding is about 2.6 ha per household. In *kharif* season, 1.18 ha of land is irrigated, 1.14 ha is rainfed and rest is fallow land. During *rabi*, about 0.42 ha land is irrigated and rest is fallow. Similarly, in summer only 0.52 ha of land is irrigated and the rest is fallow. This land use pattern shows the lack of irrigation facility, which has implications on *rabi* and summer season cultivation.

Water resources

The unpredictable distribution of rainfall was affecting crop growth and total yield. Large numbers of bore wells and open wells are defunct, and need recharging structures. This provides an opportunity to improve groundwater resources by adopting proper land and water management interventions.

Market availability

Currently farmers sell their agricultural products in nearby district markets such as Ballary, Davanagere and Raichur. Good numbers of agricultural producers' marketing cooperatives are available to store their products. Apart from local markets, farmers sell their agricultural produce like horticultural produce to distant markets in Bengaluru and Hyderabad. The presence of JSW township is also a good opportunity to market their produce.

Land degradation

Due to persistent mining activities in and around the project villages and poor land management practices, agricultural lands in these villages are severely degraded. Lands are undulating with shallow soils and low in organic carbon. Water-holding capacity is poor. Thus, levelling and trench cum bunds (staggered trenches) across the slopes are required in order to conserve the soil and water.

4.2.3 Interventions

Soil test-based balanced nutrition trials

Farmer participatory approach was followed for collecting soil samples from selected villages. Stratified soil sampling methodology was adopted for sampling. The area was divided based on topography and cropping system. Farmers were trained for collecting soil samples from their fields. In total, 100 soil samples were collected in the selected villages. Analysis of soil for macro- and micronutrients was completed at ICRISAT laboratory.

The soil analysis results are presented in Table 4.10. Organic carbon is used as a proxy for nitrogen. The results revealed that most of the farmers' fields had sufficient amount of major nutrients. For example, none of the fields was deficient in potassium and very few fields were deficient in phosphorus and had low organic carbon content. Similarly, only 20% and 8% of fields were deficient in sulfur and boron respectively. The only deficient micronutrient was zinc. Based on these results, soil health cards were prepared and distributed to farmers in all four selected villages. The soil health cards include information on farmers' land, soil fertility status and nutrient recommendations for major crops grown in this region.

Soil test-based balanced fertilizer trials were conducted in famers' fields in selected villages to demonstrate the advantage of micronutrient application in addition to the application of nitrogen, phosphorus and potassium fertilizers. Farmers applied 200 kg gypsum, 12.5 kg zinc sulphate and 2.5 kg borax per hectare in improved practice and compared with farmers' practice. The treatments were imposed on plots, side by side and uniform crop management practices were ensured in all the treatments. Application of all the nutrients except nitrogen was made as basal: 50% of nitrogen dose to non-legumes was added as basal and the remaining in two equal splits at one-month intervals.

Farmer participatory evaluation of improved cultivars

Many farmers in selected villages use low-yielding old or local cultivars. Farmers' participatory varietal evaluation trials were conducted to demonstrate the yield advantage of improved crop cultivars as compared to existing low-yielding cultivars. The important crop cultivars included in these trials were with castor DCH 519, pearl millet

Table 4.10. Chemical analysis of soil from selected villages.

	Deficiency (%)					
Village	Organic carbon	Phosphorus	Potassium	Sulfur	Zinc	Boron
Chikanthapur	0	20	0	0	90	0
Doddanthapur	27	13	0	10	77	10
Joga	5	15	0	5	80	15
Kodalu	18	4	0	21	75	7

ICTP 8203, pigeonpea ICPL 87119, ICPH 2671 and ICPH 2740, groundnut ICGV 91114 and sorghum PVK 801, CHS 14, CSV 23 and CSV 15.

Rainwater harvesting

The ridge to valley approach was followed for achieving equity and access to water. The low-cost structures are proven for sustainability, equity as well as cost-effectiveness. The location, number of structures and designs were evaluated by ICRISAT and executed by locally appointed organization. The impact of rainwater harvesting on water resources was evaluated by monitoring groundwater levels. Fifty-two wells were selected across the topo-sequence for measuring groundwater level at a fortnightly interval. An automatic weather station has been established to collect weather data on rainfall, air and soil temperature, solar radiation and wind velocity and direction. Rainfall monitoring is necessary to help quantify the amount of moisture availability in different phenophases of crop growth, to estimate the crop water requirements, and also to assess runoff, soil loss and groundwater recharge. Most importantly, it helps the community to understand about crop water usage and for irrigation scheduling.

Capacity building programmes to improve livelihoods

Capacity building programme is very important activity in the watershed programme for sustainability of the interventions implemented and to carry forward the activities after the project period. Several capacity building programmes including technical training, field days, exposure visits were conducted for farmers and women's self-help groups (SHGs) to train and build their capacity for enhancing crop productivities and improving livelihoods. In addition to the formal training programme, awareness-building campaigns were organized on the occasions of events such as International Women's Day and World Environment Day. A total of 50 capacity-building programmes were conducted during the project period, benefiting all the farmers in the villages.

4.2.4 Impact

Increase in crop productivity with balanced nutrient management

In all the trials, yields were recorded at maturity by harvesting the crop at three spots in a treatment measuring 3 x 3 m and the average of three was used to compute yield in kg/ha. Results from farmers' field trials indicated that crop yield can be increased with improved agronomic practices. Figure 4.17 indicates grain yield increase from 8% to 29% for all the crops with the application of micronutrients. Maximum yield increase was observed in cotton (29%). The cost of micronutrient for 1 ha of land was ₹953 (₹2.2 per kg for gypsum, ₹33 per kg for zinc sulphate

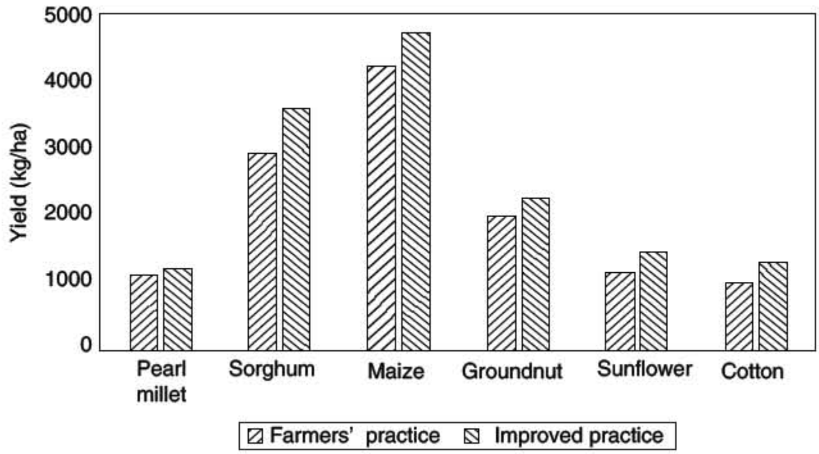

Fig. 4.17. Grain yield of major crops under farmers' practice (NPK only) and improved practice (NPK+Zn+S+B).

and ₹40 per kg for borax). The observed additional grain yield was 100, 660, 500, 280, 310 and 294 kg/ha for pearl millet, sorghum, maize, groundnut, sunflower and cotton respectively. This clearly indicated a return of ₹1.6, 10.4, 6.3, 10.9, 9.8 and 9.3 respectively on every rupee spent on micronutrients.

Soil analysis revealed a sufficient amount of phosphorus in the soils; however, farmers were using diammonium phosphate (DAP) fertilizer as source of nitrogen. Unknowingly, farmers were applying the phosphate fertilizer. In this context, phosphorus fertilizer trials were designed (with and without phosphorus application) for different crops to investigate the effect on crop performance. The results of these trials are presented in Fig. 4.18. Grain yield in the treatments was generally similar. Thus, it was scientifically established that crops cultivated in these soils do not require phosphorus fertilizer and DAP could be replaced by urea as source of nitrogen.

High-yielding improved cultivars

The grain yield of different crop cultivars is shown in Fig. 4.19. There was 28% grain yield advantage of castor hybrid DCH 519 over farmers' variety. Pearl millet variety ICTP 8203 gave

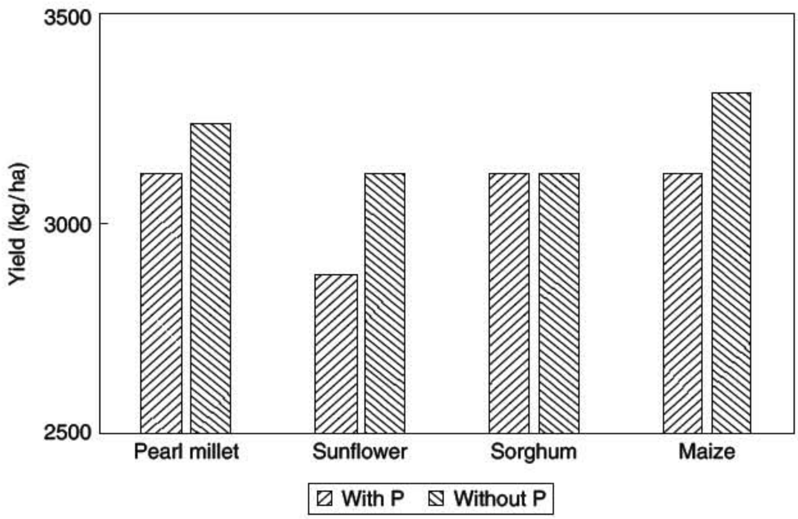

Fig. 4.18. Grain yield of different crops with and without phosphorus (P) application.

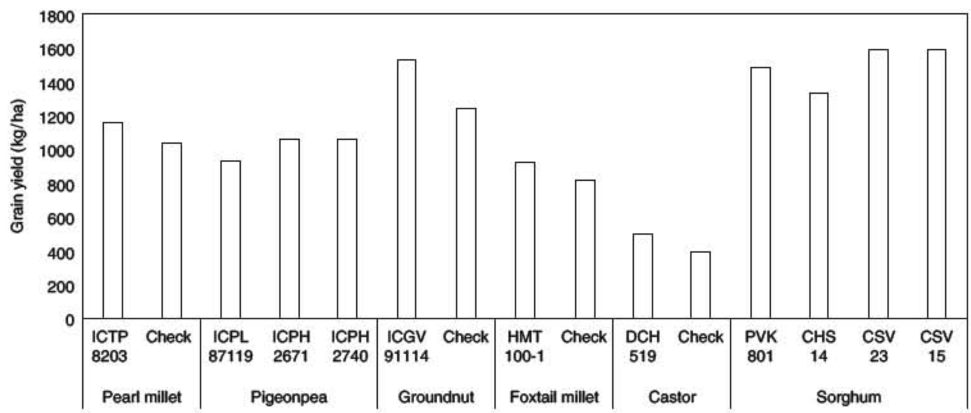

Fig. 4.19. Yield advantage of improved crop cultivars over existing cultivar in use.

17% grain yield increase over farmers' variety. Pigeonpea hybrids ICPH 2671 and ICPH 2740 and variety ICPL 87119 showed yield increase of 17, 38 and 17% respectively as compared to existing cultivars. In the case of sorghum, PVK 801 had increase in grain yield by 12% and CSV 23 by 16% compared to local varieties.

Increase in water availability

Various soil and water conservation structures were constructed in selected villages for minimizing land degradation and improving groundwater recharge. Rainwater harvesting structures such as farm ponds, check-dams (Fig. 4.20), bore well recharge pits and percolation tanks were established in consultation with the village community. Also, runoff was diverted to defunct open well and existing structures were rejuvenated. Similarly, gully plugs and field bunding were constructed for reducing soil erosion. Table 4.11 shows the total number of structures established during the three years of the project. Through these efforts a total of 33,000 m^3 of rainwater is expected to be harvested during a normal monsoon season. The impact of these rainwater harvesting structures was clearly visible from observed groundwater levels near rainwater harvesting structure and levels away from the structure. Figure 4.21 clearly indicates the rise in groundwater level near the structure during monsoon as compared to level away from the structure. During the post-rainy season the levels for both the locations were similar indicating the depletion of level as a result of irrigation or groundwater recharge.

Livelihood activities

Several income-generating activities viz. *agarbathi* (incense sticks) making, kitchen gardening, Gliricidia nursery, vermicompost preparation have been introduced in the villages. The necessary training and financial support were provided to women self-help groups through the project. These activities have contributed to increase income of beneficiaries, for example, nursery preparation activity earned Rs 22,000 per year. Kitchen garden initiative has provided additional income of Rs 500–800 per month in addition to improved home nutrition through consumption of vegetables. Animal health developmental programmes and activities were also taken up in all the watershed villages for improvement of livestock in watershed villages every year. About 700–800 livestock were treated to prevent diseases and thus improved milk production (average 0.5–1.0 l/day/animal).

4.3 The Way Forward

The small farm holders in these regions have shown potential to bridge the large yield gaps by actively adopting to the change, and they continue to do so; however, these efforts need to be supported by capacity building efforts. As the terrain is undulating providing reduced space for traditional agriculture, tree-based farming needs to be considered on priority basis. The project has initiated market linkages, which need to be further strengthened with the value chain adaptation approach. Both the locations face

Fig. 4.20. Check-dam full with rainwater in (a) Kodalu and (b) Chikanthapur villages.

Table 4.11. Soil and water conservation and water harvesting structures constructed in selected villages.

Structure	2013–14	2014–15	2015–16	2016–17	Potential rainwater harvesting capacity (m³)	Beneficiaries (no.)
Gully plugs (no.)	90	0	0	6	480	46
Farm pond (no.)	9	3	5	7	6,000	24
Mini-percolation tank (no.)	2	1	0	0	300	4
Bore well recharge pit (no.)	15	1	0	3	60	19
Nala bund (no.)	1	0	0	1	12,000	20
Check wall (no.)	1	0	0	5	3,000	6
Check-dam (no.)	3	7	2	7	6,600	60
Wastewater treatment tank (no.)	1	0	0		1,500	5
Field bunding (m)	17,137	2,967	4,020	12,500	–	126
Silt removed from old check-dams (m³)	360	819	165	4,300	4,400	50
Open well recharging (no.)	0	4	0	2	300	6
Total	–	–	–		34,640	366

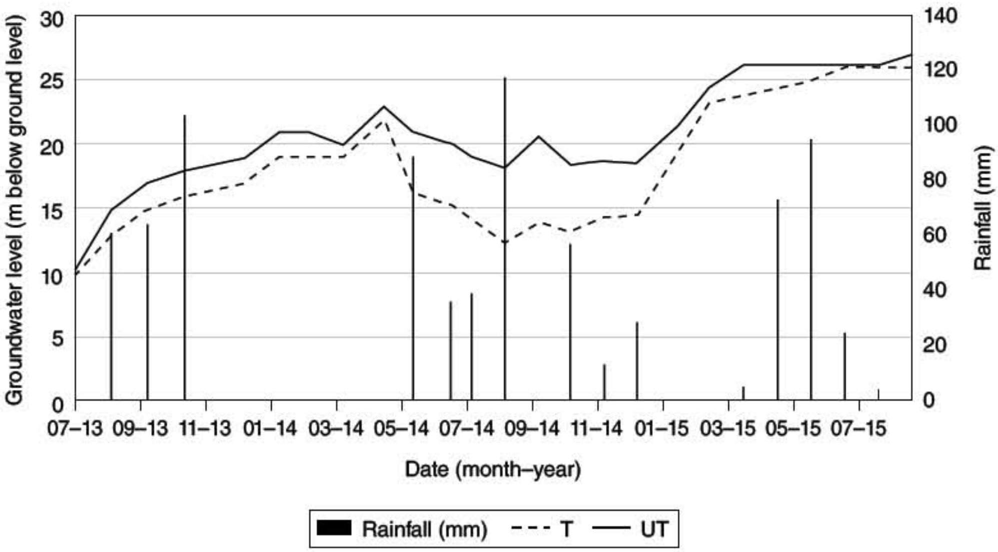

Fig. 4.21. Impact of rainwater harvesting (RWH) on groundwater level at Doddanthapur village. (T = near RWH structure; UT = away from REH structures.)

scarcity of water during the post-monsoon period irrespective of amount of rainfall received. Thus effective water management practices coupled with micro-irrigation practices need to be promoted.

The sustainability of the watershed programme after the project phase will be ensured by the four key factors, viz. effective participation of large numbers of community people (clearly indicating that they got tangible economic benefits and the watershed interventions met their needs), presence of strong and effective community-based organizations, availability of watershed development fund (for repair and maintenance of the structures during the post-project phase) and strong linkage with the village panchayats. During the watershed programme, community-based organizations were given high priority to make them effective and strong. This will be further strengthened through capacity building

Box 4.4. Increasing yield through use of wastewater.

A decentralized wastewater treatment unit was constructed in Doddanthapur, which receives domestic wastewater from 250 households. This treated water was used by three farmers for irrigating cotton and pearl millet crops. Ms Thayamma, one of the farmers, harvested an additional 800 kg yield in cotton crop compared to non-irrigated crop. This has resulted in an additional income of Rs 34,000 with the use of treated wastewater. She also cultivated pearl millet in summer season using wastewater. Pearl millet crop gave higher yield (1000 kg) and earned income of about Rs 22,000. Before the project, Ms Thayamma used to cultivate one crop through wastewater without treatment and suffered skin problems. Now she is happy that the wastewater that accumulates around her house has been put to productive use while preventing health problems.

Box 4.5. JSW watershed initiative brings changes in SHG women's lives.

Mrs Vanajakshi is the group leader of *Manasa* women's self-help group in Joga village. Her husband works as an agricultural labourer. Under the active leadership of Manasa SHG has grown Gliricidia nursery. The saplings were provided to project and in the village, which gave an additional income of more than Rs 22,000 per year out of season.

Mrs Vanajakshi was also proactive and instrumental in taking up an income-generating activity of vegetable cultivation in a small piece of a land (100 sq m). These vegetables were primarily used for household consumption and excess quantity was sold in the village that also gave additional income of about Rs 500–800 per month.

The watershed project helped Vanajakshi to adopting income-generating activities, she became the proud owner of a small grocery store and net savings of about Rs 500 per month. Before the watershed project her financial condition was precarious. The additional income has helped to support her family expenditure.

and financial support, and by providing strong linkage with various institutions like market, banks, etc. These factors will go a long way in sustaining the impact of the watershed programme after the project phase.

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