Progress Report

Improving Livelihoods and Agricultural Productivity through Integrated Watershed Management

October 2018 to May 2019

Submitted to
Mahindra & Mahindra
Zaheerabad Mandal, Sanga Reddy District

ICRISAT DEVELOPMENT CENTER

ICRISAT
INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

Improving Livelihoods and Agricultural Productivity through Integrated Watershed Management

Submitted to

Mahindra & Mahindra

Zaheerabad Mandal, Sangareddy District

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1. Introduction

The Mahindra & Mahindra Limited has adopted an integrated watershed management program to address water scarcity, land degradation, and crop and livestock productivity which improves rural livelihood system with the help of ICRISAT Development Centre (IDC), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). In April 2017, the project has taken up in a hydrological area of around 813 ha, spread in and around Bhuchinelli village, named as Mahindra-ICRISAT Watershed. The watershed is located just 3 km away from Mahindra Farm Division Plant in Zaheerabad mandal of Sangareddy district in Telangana state as shown in Figure 1.0. The Bhuchinelli village had total population of 4030 (nos) and 405 households. The average annual rainfall in the project area is around 895 mm. The watershed area is characterized by plain topography with less than 2.0% slope. The major soils in the watershed are black (40%), red (40%) and Laterite (20%) with medium to high water-holding capacity. Of the total geographical area of the watershed, 70% of area is under agricultural use and the remaining area is under wasteland and non-agricultural use. Of the total agricultural area, 50% of area is rainfed and 50% of area is under irrigated condition. The farmers grow soybean, pigeon pea, cotton and black gram predominantly in rainfed areas and paddy and sugarcane in irrigated areas of the watershed.

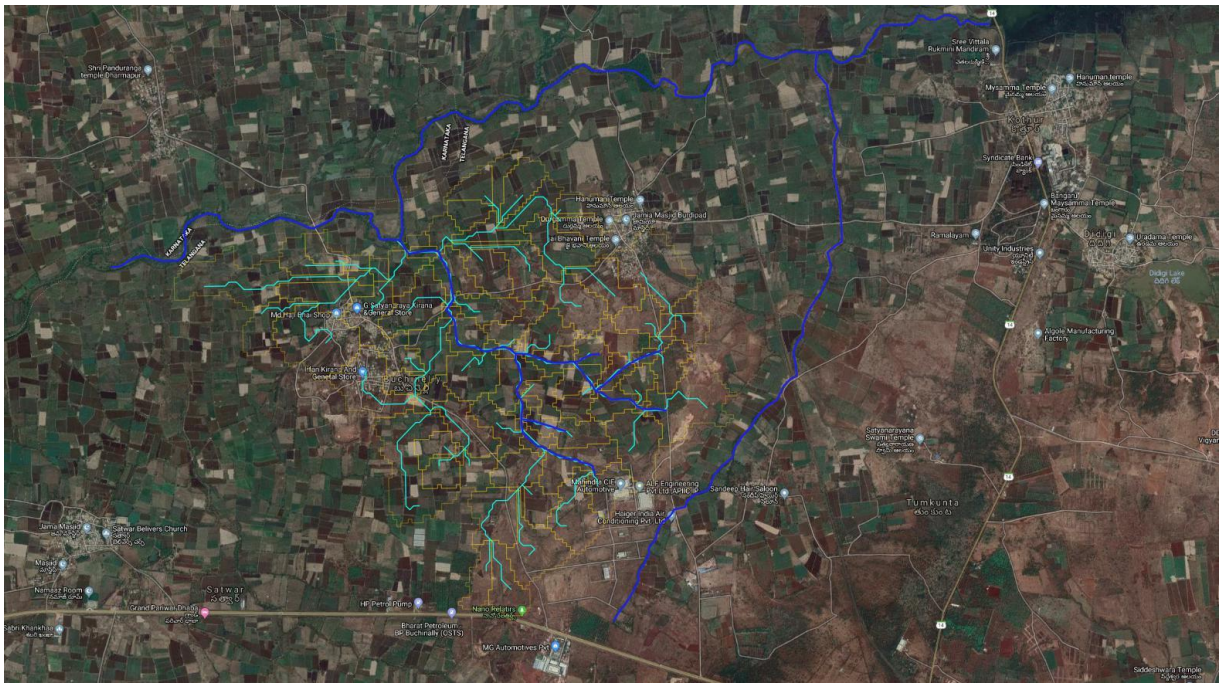

Figure 1. Google Earth image of location of Mahindra-ICRISAT watershed

2. Goals and objectives

The overall goal of this initiative is to improve agricultural productivity and the livelihoods of the rural poor in the watershed on a sustainable basis by enhancing the impact of watershed interventions through an integrated watershed management approach.

The initiative's specific objectives are:

- To enhance water availability in the watershed through rainwater harvesting and recharging of wells, to demonstrate that science-based interventions can increase water availability;
- To enhance agricultural productivity through Good Agricultural Practices (GAP);
- To establish a model village that demonstrates increased productivity and improved livelihoods; and
- To build the capacity of farmers, women and youth in the watershed.

3. Soil and water conservation measures

I. In-situ water conservation measures

To ensure equity and tangible economic benefits to small and marginal farmers, Broad Bed and Furrow (BBF) system *an in-situ* conservation intervention was initiated in the watershed (2019). Broad Bed and Furrow (BBF) system is one of the best land management practice to conserve more rain water into the soils during rainy days. In this system, the land is prepared with broad beds to a height of 20 cm above ground and two furrows on either side of each bed. The raised bed enhances soil moisture by increasing infiltration during rainfall events, which supports crop water demand during long dry spells. One tractor operated Tropicultor machine, manufactured by ICRISAT was supplied to watershed committee for promoting BBF system in the watershed. This BBF system was demonstrated on farmers' fields in the watershed using a machine called Tropicultor as shown in Figure 2.0. Nearly 20 farmers were trained on operation procedures of the Tropicultor. The machine can be utilized by any farmer in the watershed with prior booking and on the minimum payment basis. The studies indicate that the crop yield in the BBF system is higher than (15-20%) the traditional flat cultivation practice.

Figure 2. a) Tropicultor demonstration on farmers' fields and b) Conducted a training on operation of Tropicultor

II. Ex-situ water conservation measures

Excess rainwater from individual farms has been diverted and stored at suitable sites through hydrological studies and also at the locations identified by watershed committee. Demand oriented approach, in which demands or requests raised by villagers or the watershed community for harvesting rain water have been followed for immediate benefit such as construction of a check dam on a stream that flows near a community bore well (Check dam 4), construction of a percolation tank or a farm ponds near to farmers' fields. Low-cost water harvesting structures (WHS) such as check-dams, gully control structures, farm ponds and percolation tanks were designed with the technical backstopping of ICRISAT staff and constructed on a stream network by involving watershed committee and community during October 2018 to May 2019 (Figure 3 – 9). Eighteen water harvesting structures were constructed in the watershed during the project period (October 2018 to May 2019) as shown in Figure 4. A storage capacity of 9,500 cubic meter was created for the period October 2018 to May 2019, which are expected to harvest 34,000-43,000 cubic meter of surface runoff into groundwater storage in a normal year (Table 1). Overall, since the project initiation, a storage capacity of 17900 cubic meter was created so, which are expected to harvest 57000 cubic meter of rainwater in the watershed.

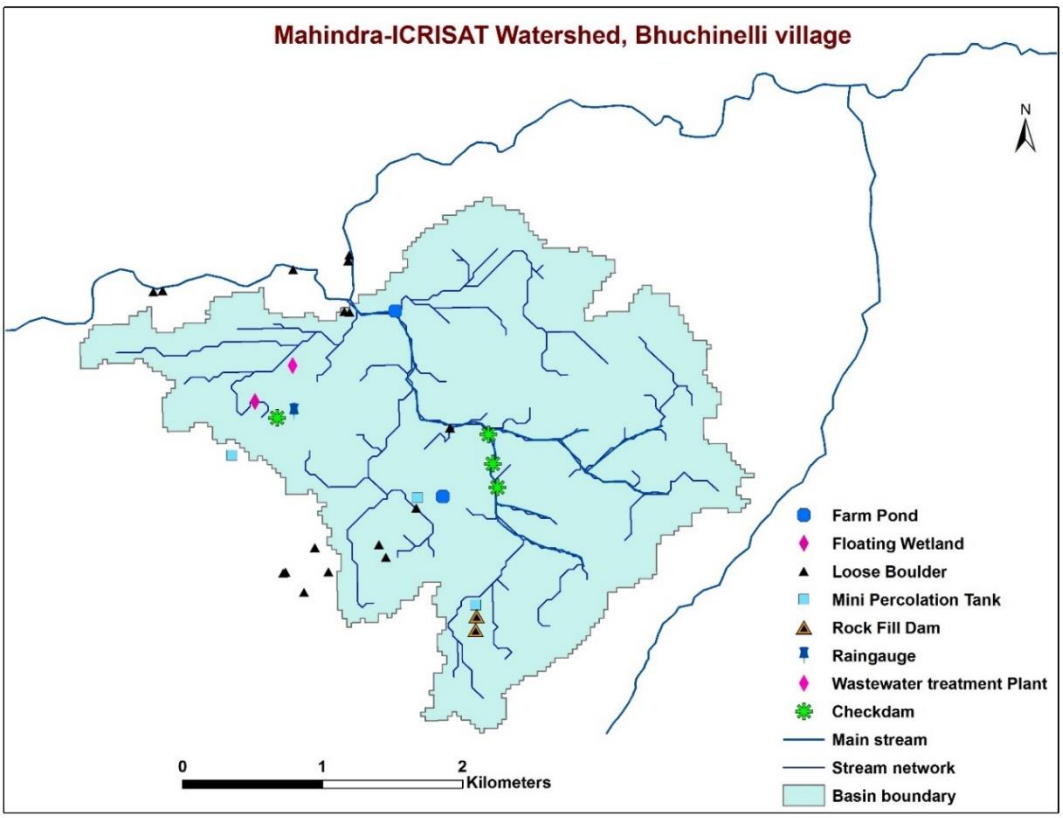

Figure 3. a) Construction of a check dam 3 (in 2019) with runoff gauging station and b) Stream widening and storage capacity creation at check dam 3 (2019).

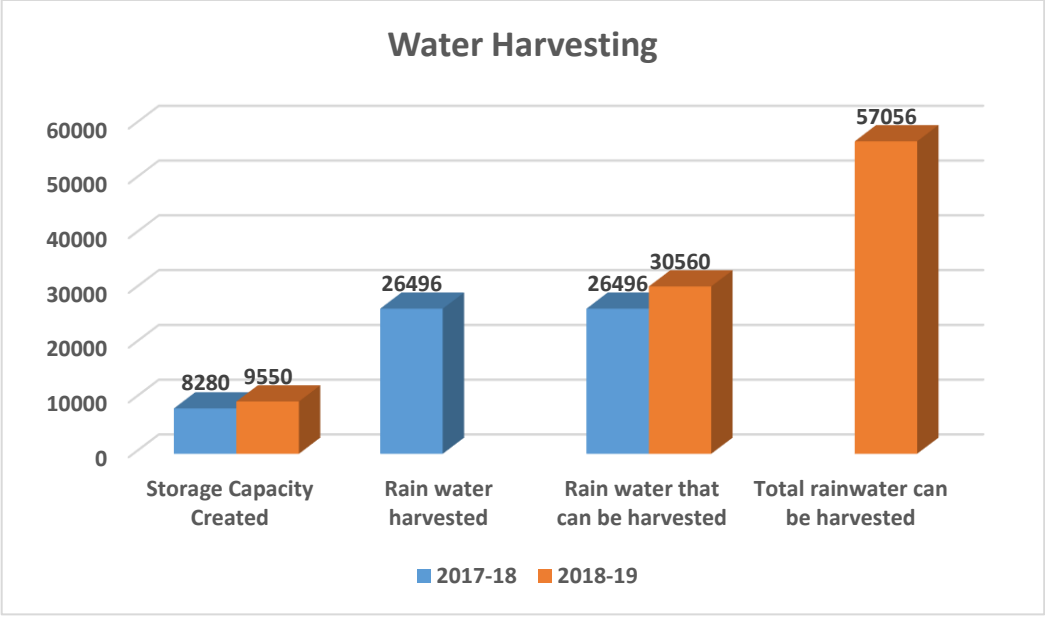

Figure 4. Trend of rainwater storage capacities created in the watershed.

Table 1. Details of different types rainwater harvesting structures constructed and their capacities in the watershed.

Year of Construction	Type of Structures	No of Structures	Storage Capacity (Cum)	Total Storage Capacity (Cum)	No of Beneficiaries (nos)
2017-18	Check dam 1 & 2	2	1500	3000	20
	Rock fill dam	4	350	1400	4
	Loose boulder	14	65	910	20
	Mini percolation tank	1	1500	1500	4
	Well recharge pits	4	125	500	4
	Sunken pit	1	35	35	
	Farm pond	1	935	935	1
Total		**27**		**8280**	**53**
2018-19	Check dam 3	1	2100	2100	10
	Check dam 4	1	1200	1200	10
	Rock fill dam	2	350	700	5
	Loose boulder	10	65	650	17
	Farm pond	2	950	1900	4
	Mini percolation tank	2	1500	3000	4
Total		**18**		**9550**	**50**
				17830	**103**

Figure 5. a) Construction of a check dam 3 (in 2019) with runoff gauging station and b) Stream widening and storage capacity creation at check dam 3 (2019).

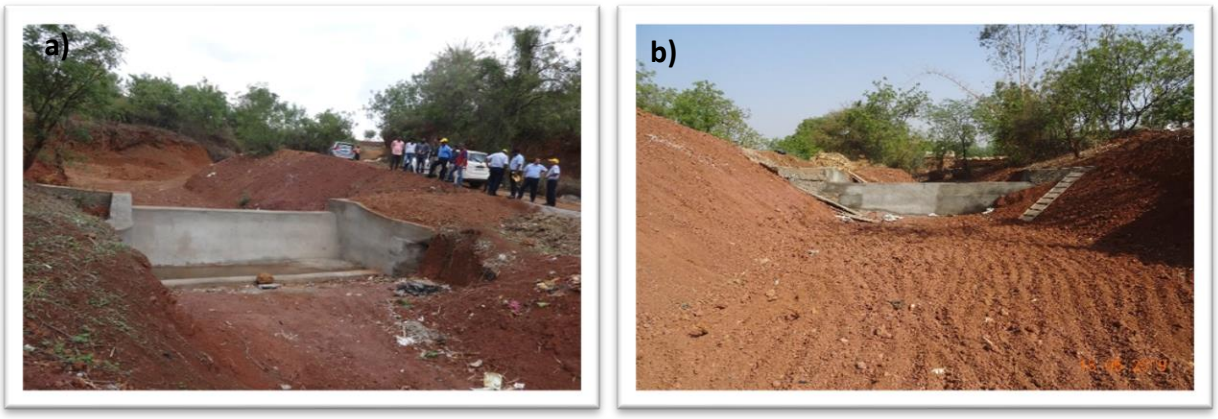

Figure 6. a) Construction of a check dam 4 (in 2019) near to community drinking water supply bore well and b) Stream widening and storage capacity creation at check dam 3 (2019) to harvest rain water.

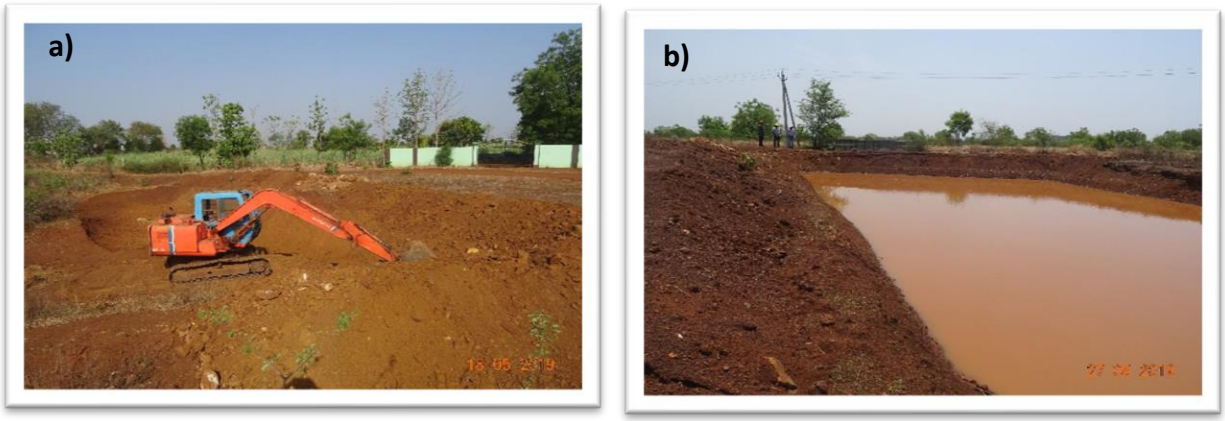

Figure 7. a) Making a mini-percolation tank near to farmer's fields and b) Mini-percolation tank harvesting rainwater during early rains in the month of June 2019.

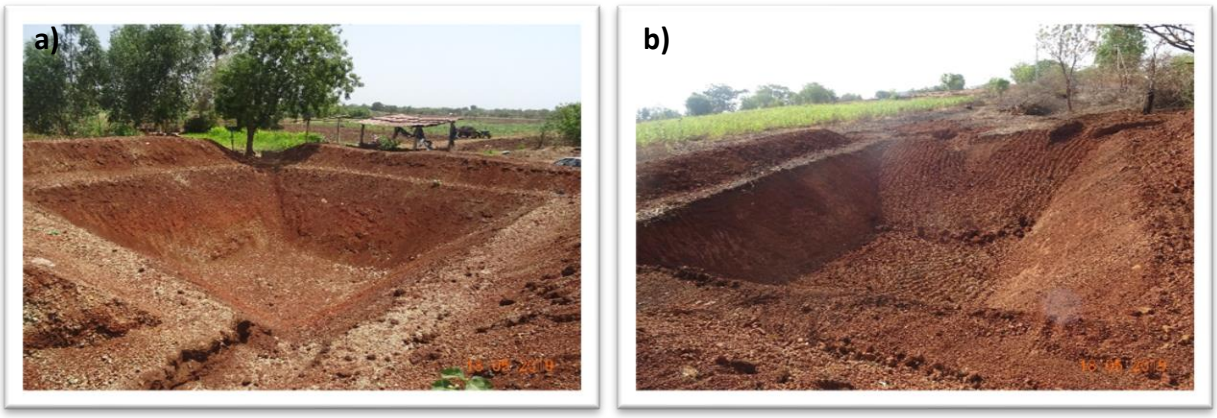

Figure 8. a) Farm pond 1 near to farmer's fields and b) Farm pond 2 near to farmer's fields to harvest rain water during rainy season and utilize as a storage tank during non-rainy season.

Figure 9. a) Rock fill dam (2 no's) and b) Lose boulder structure (11 no's) constricted in the watershed.

4. Establishment of Hydrological gauging stations (Rainfall, Runoff & Groundwater)

4.1 Rain gauge station: A rain gauge station was installed in the Upper Primary school and training imparted to school students on daily rainfall collection in the watershed. This helps students to understand in measuring rainfall, calculating rainfall quantities, number of rainfall events per month, season and year. This understand will help to aware about climate variability in the village (Figures 10). About 114 mm of total rainfall was recorded during the period from February to 19th July 2019 against 331 mm rainfall that to be occur in the watershed. Data shows that, the watershed received 23% and 86% deficient rainfalls in the month of June and July respectively, which indicated severe water stress leads to poor germination of seeds and sustainability of crops.

Figure 10.0. Explaining rain gauge working procedure a) To CSR Team and b) School students.

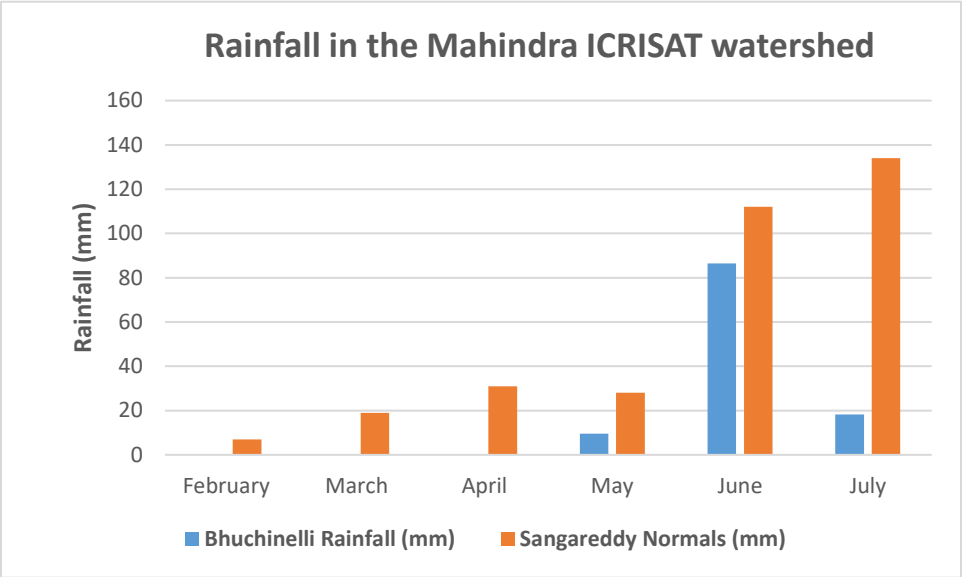

Figure 11. Comparison of Rainfall occurrence with respect to normal rainfall in the watershed.

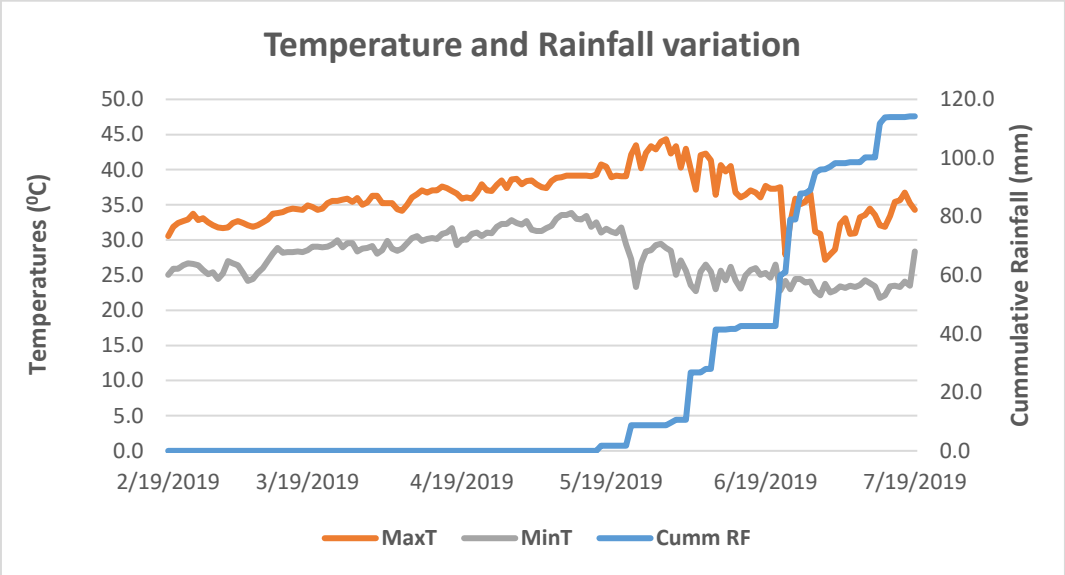

Figure 12. Climate such as minimum and maximum temperatures and rainfall variability in the watershed.

4.2 Runoff gauging station: A runoff gauging station was also set up at check dam no: 3, to estimate the quantity of surface runoff generated in the watershed and quantity of surface runoff harvested by a storage structure in the watershed as shown in Figure 13.0.

Figure 13. a) Fixing runoff gauging cylinder at check dam no: 3 and b) Explaining runoff gauging procedure to CSR team of Mahindra and Mahindra.

4.3 Gauging groundwater levels: To analyze the impact of water storage capacity created in the watershed, collecting groundwater levels of dug and bore wells at 15 day intervals has been initiated as shown in Figure 14.0.

Figure 14. a) Explaining rain gauge working procedure to CSR Team of Mahindra and Mahindra and b) Explaining rain gauge working procedure to school student in the watershed.

5. Participatory Research & Development (PR&D), Integrated Pest Management (IPM) and Integrated Nutrient Management (IPM) trials

Under Participatory Research and Development (PR&D) selection of crops and cultivars: Based on their agro-ecological potential and market demand, suitable cultivars of established and new crops were distributed to farmers in the watershed. Under this, improved crop cultivars such of Pigeon pea, Green gram, Maize, Soya bean and black gram were introduction for 60 acres during 2018-19. Our PR&D approach will enable farmers to select crops and cultivars suited to them rather than being recommended by us. Farmers were also educated on pest management strategies, use of pest management tools such as yellow sticky traps and pheromone traps so that they initiate need based (low cost) pest control measures. Installation of these traps allow farmers to monitor the pest activity regularly, so that indiscriminate use of pesticides can be avoided and spraying of insecticides can be taken up only when pest level reaches threshold level. These strategies have dual advantages first they are ecofriendly and second, are species specific that does not harm beneficial fauna in crop ecosystem. Pheromones traps were installed @ 5/ac and yellow sticky traps @ 20/ac. These traps have validity of one month after a month lures in the traps needs to be replaced (Figure 15).

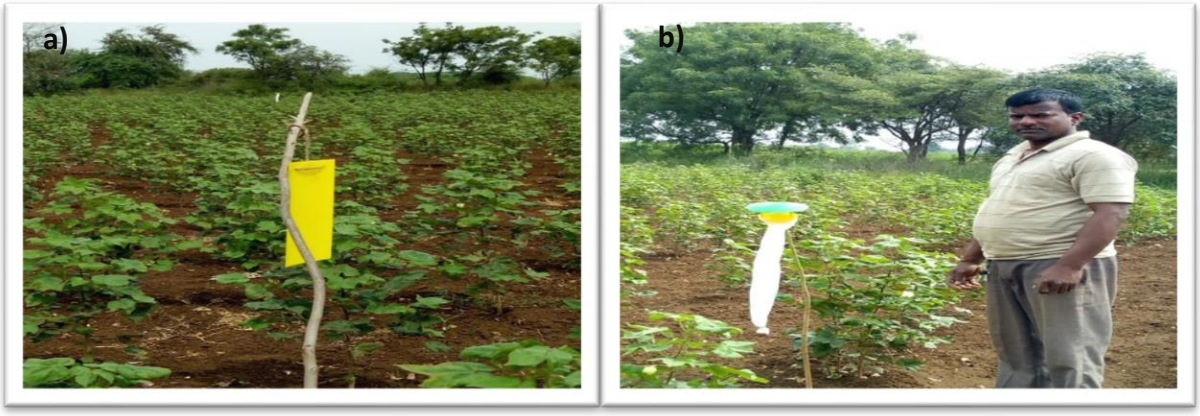

Figure 15. a) Yellow Sticky pads and b) Pheromone traps in the cotton fields.

6. Wastewater treatment at village community scale

6.1 Floating Wet Land: To reduce pollution load in the wastewater generated from the house holds of Bhuchinelli village, a floating wetland unit was set up in an existed wastewater pond (Figure 16). The floating wetland was planted with of *Cana indica* and lemon grass. Wetland plants has the innate ability to bio remediate excess nutrients and some metals from incoming untreated wastewater and they act

as bioremediation agents for these pollutants. They also reduce the surface area available for water borne disease vectors like mosquitoes. Use of lemon grass will help in reduction of mosquitoes as the odor from lemon grass plants deter mosquito activity. Through floating wetland partial treatment of wastewater contaminants can be achieved and the resulting wastewater can be reused for production of fodder and cereal crops. It is estimated that nearly 10000 m^3 of wastewater will be treated per year, that can support 2-3 acres of crop area per season.

Figure 16. a) Preparing floating wet land b) Setting up floating wetland in the waste water pond in the watershed.

6.2 Hybrid treatment wetland: To reuse domestic wastewater, a hybrid treatment wetland was set up on community wastewater drain in the watershed (Figure 17). The wastewater will be treated using combination of three treatment systems namely horizontal flow wetland, algae flow way and floating wetland in a sequential manner. Through this system we plan to establish a decentralized wastewater treatment process which harnesses the potential of natural biological agents like macrophytes and microalgae through ecological engineering. Although these treatment systems were used before individually, but this is the first time we have used it as a combined system. This combination will enhance the treatment efficiency and we are also using plant and algae based system for the first time. Wetland plants are known to remove nitrate and trace metals but they can't remove phosphate and heavy metals so by combining plants and algae we are targeting removal of both macro, micro nutrients and heavy metals. The resulting treated wastewater from hybrid treatment wetland will be used for agriculture or to grow nurseries or fodder for animals as a business model. It is estimated that nearly 60% of nutrient load can be removed from the wastewater.

Figure 15. a) Community waste water drainage b) Constructed wet land system on the drainage in the watershed.

7. Capacity Development & Training Materials Preparation (number of women number of days)

7.1 Tailoring Centre: Training, demonstration and hands-on experience on Tailoring stitching activity in addition to other watershed activities have been undertaken. Nearly 60 young and house wives were trained on tailoring different types of women dresses such as blouses, Kurtis, saree-falls, etc (Figure 18).

Figure 18. a) Tailoring training program group 1 b) Tailoring training program group 2.

7.2 Computer Training: Theoretical classes, hands-on experience and examinations on basic computer skills in addition to other watershed activities have been undertaken. Nearly 60 young and house wives were trained on different computer skills such as browsing internet, bus or train ticket booking, working Microsoft Word, Excel and PowerPoint etc (Figure 19).

Figure 19. a) Tailoring training program group 1 b) Tailoring training program group 2.

8. Field Days (photos)

Several awareness programs and regular interactions were conducted with the farming community on various project interventions and agricultural practices. The community was exposed to ICRISAT campus, Patancheru and Adarsha watershed, Kothapally to develop awareness of improved method of cultivation, best agricultural practices, soil and water conservation interventions, crop demonstration trials, etc. Nearly 80 farmers participated in various training programs, field exposure visits and field days during 2018-2019 (Figure 20 & 21).

Figure 20. a) Tailoring training program group 1 b) Tailoring training program group 2.

Figure 21. a) Exposure visit to ICRISAT, b) Exposure visit to ICRISAT.

9. Income-generating Activities

9.1 Baking Program: Income-generating activities: Income-generating activities which support agricultural value chain (inputs, outputs and by-products) will be undertaken by women, landless farmers and educated youth in the village. A baking program for 30 young and married women on baking biscuits, breads, puffs, cakes, etc., was conducted in the watershed (Figure 22).

Figure 22. a) Baking program for the self-help groups, b) Biscuits made by Self-Help Groups.

9.2 Apiculture Activity: Income-generating activities: subsidiary income generating activity such as apiculture was introduced in watershed. Maintaining bee hive in or near the agriculture fields are proven to be profitable. Bees are very good pollinators and have great impact on increasing crop yield, it has been proved that installation of bee hives in agricultural fields increases yield by 10-12%. Apart from the increased crop yield bee hives also yield honey. On an average one hive yield 30 – 40 kg honey per year, cost of honey per kg is around Rs.s.300 – R350 (Rs.10000/hive/year) this adds as additional income to

farmers apart from ecological service that bees provide. Considering this two bee hives were installed in the watershed to educate the farmers regarding the benefits of apiculture and will be scaled-up based on the farmer's interest (Figure 23).

Figure 23. Apiculture farming in the watershed.

10. Activities, milestones and impact details for the period October 2018-May 2019

SN	Line items	Physical target/ agreed	Physical target/ achieved	Work done	Outputs
1	*In-situ* moisture conservation measures	5 acres	5 acres	• Introduced Broad Bed and Furrow (BBF) land management system using Tropicultor machine. 20 farmers were trained on Tropicultor operations and BBF system.	• Farmers uses BBF system are expected to get good yields during Kharif and rabi 2019-20.
2a	*Ex-situ r*ainwater harvesting through low-cost and strong water harvesting structures	17	18	• Constructed 18 structures such as Check dams-2; Loose boulders structures-10; Farm ponds-2; Rock fill dams-2 and Percolation tanks -2.	• Created 9550 cum storage capacity and expected to harvest 30500 cum rainwater into groundwater storage in a normal year.
2b	Establishment of hydrological gauging stations (For Rain, Runoff and GW levels)	1	3	• Installed Rain gauge station at UP School; Runoff gauging station at Check dam no 3 and gauging GW Levels at 15 day interval.	• School students and their families and farmers in the watershed
3	PR&D, INM and IPM trials	30 acres	60 acres	• Introduction of improved crop cultivars such as Pigeon pea, Green gram, Maize, Soya bean and black gram for 60 acres;	•
4	Wastewater treatment at village community scale	1	2	• Construction of one floating and one Hybrid treatment wetlands (2 units) for safe reuse of wastewater in fodder lands have been completed.	•
5	Capacity development & Training materials preparation (W=women)	• 30 W	60 W	• Capacity Computer basic training to 40 young females and capacity building on bread baking for 40 women.	•
6	Field Days	2	2	• Completed	•
7	Technical support			• 10 % time of two scientists; One RT; NGO	•
8	• Income-generating activities (HH= households; W=Women and P=Plants)	• 50 HH • 50 W • 1000 P	100 HH 60 W 1000 P	• Kitchen garden promotion (50 HHs); • Stitching activity (50 women); and • Agro-forestry (1000 , ready for plantation)	•