Annual Report
2012-13

Integrated Water and Resource Management for Improved Productivity of Farming Systems through Participatory Research-cum-Demonstration in Madhya Pradesh and Jharkhand States of India

Submitted to
Sir Ratan Tata Trust

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

Integrated Water and Resource Management for Improved Productivity of Farming Systems through Participatory Research cum Demonstration in Madhya Pradesh and Jharkhand States of India

Annual Report
(2012-13)

Submitted to
Sir Ratan Tata Trust (SRTT)
Mumbai

ICRISAT
Science with a human face

International Crops Research Institute for the Semi-Arid Tropics

Patancheru 502 324, Andhra Pradesh, India

Table of Contents

Executive Summary

Under the Sir Ratan Tata Trust (SRTT) supported, science-led interventions have been scaled-up in a large number of farmers' fields. This report covers the work undertaken from 2011 rainy season to 2012-13 postrainy in Jharkhand, and from 2011-12 post-rainy season to 2012-13 postrainy in Madhya Pradesh. Results showed that farmers benefited by adopting soil test-based balanced nutrition (BN) approach over the farmer's practice (FP) in terms of increased grain and straw yield of paddy, maize, pigeonpea, black gram, soybean, groundnut, chickpea and wheat crops. However, the adoption of an integrated nutrient management (INM) strategy by partially substituting chemical fertilizers with vermicompost proved better than the balanced nutrition treatment. Residual effects of sulfur (S), boron (B) and zinc (Zn) were recorded; ; and the residual effects of balanced nutrition lasted up to three seasons after application.

Chickpea cultivation in the postrainy fallow lands along with seed priming proved effective in extending the crop to postrainy fallows, resulting in significant increase in farmers' incomes. Growing of improved varieties of chickpea gave grain yield ranging from 1280 to 1520 kg ha^{-1}. Trials with improved varieties of other crops also out-yielded the local cultivars. For example, the yield with improved cultivars of pigeonpea ranged from 760 to 2290 kg ha^{-1}; while those with improved black gram cultivars ranged from 710 to 790 kg ha^{-1} .

During April 2012, soil samples were collected from farmers' fields of the newly added districts of Deoghar and Hazaribagh in Jharkhand and Keonjhar in Orissa. The results of analyses of these samples in the ICRISAT laboratory once more revealed widespread deficiencies of S, B and Zn. Nutrient management strategy was developed at a block level in the target cluster of villages; and this included applications of S, B and Zn in along with N, P and K. As usual, we applied full rate of a nutrient if its deficiency was prevalent in > 50% farmers' fields, and half the rate was added if its deficiency was on <50% farms. The fertilizer recommendations for N, P and K were modified from those recommended by the State Agricultural Universities (SAUs) by considering the actual soil nutrient status at the block level. The rates of applications of S, B and Zn were 30 kg S, 10 kg Zn and 0.5 kg B, applied every alternate years.. .

Village-based seed banks in Mandla and Jhabua districts in MP, and Gumla and Saraikela districts in Jharkhand have been producing seeds of improved varieties of chickpea, wheat, groundnut, pigeonpea soybean and maize. In Jhabua district, "Kisan Laxmi Beej Udpadak Sahkari Samiti Maryadit" has been operating in Gadwara village; and during 2012 rainy season produced and sold 2000 kg of JS 9560 and 1000 kg of JS 9305 soybean seeds to the department of agriculture. In Jhabua district, "Makka Vikas Samiti" operated by 20 members at Chota Guda village, also distributed 2000 kg seeds of improved maize (JVM 421) to 500 farmers and helped replace the traditional low yielding varieties. Overall, this effort helped farmers to use good quality seeds of improved cultivars of crops.

To generate biomass for improving soil fertility, 10000 N-rich *Gliricidia* seedlings were raised in Gumla and 6000 seedlings in Sariekela-Kharshaw districts of Hharkhand by women self-help groups and youth club members. .

Quality fodder production was promoted by 19 farmers in Jhabua district and 4 farmers in Mandla district. One animal health camp each in Jhabua and Mandla districts were also organized. During poultry vaccination camp in Mandla, around 628 chicks/birds were vaccinated. One animal health camp was also organized in Jhabua district where 145 animals belonging to 115 farmers were treated.

To ensure sustainability of best practices, farmers were made aware on the importance of of soil test based nutrient management, use of vermicomposting, INM, *Gliricidia*; nursery raising, kitchen gardening, landform management, seed priming in chickpea, improved crop varieties, seed storage among other best crop management practices. Through farmer training, around 2000 farmers were trained during 2011-12 and 2012-13 in the Jharkhand state. Similarly, >200 farmers were trained in Madhya PRadesh during 2012-13. One farmer day at a large scale was organized in Gumla during 2012-13 in which >450 farmers participated; while four farmer days were organized in Madhya Pradesh, two each in Jhabua and Mandla, in which around 450 farmers participated. A three- day program of Exposure Visit to the ICRISAT center, Patancheru was organized for 29 farmers from Jhabua and Mandla during $^{28\text{-}30}$ January, 2013. Similarly, an exposure visit to the ICRISAT was arranged for 46 farmers from Sariekela-Kharsawan, Bokaro and Jamshedpur districts of Jharkhand during 8 - 13 June, 2013. These visits immensely benefited the farmers by broadening their experience and perception.

Following discussions with CINI, two new districts of Deoghar and Hazaribagh in Jharkhand and one of Keonjhar in Orissa have been included for scaling-up the best-bet options.

Background

Current farmers' yields of rainfed crops are lower by two to four folds than the yield from researcher managed or commercial plots. In order to meet the food demand and reduce poverty, there is an urgent need to unlock the potential of rainfed agriculture in general and particularly in target regions in Central India. Soil degradation in target regions in terms of soil infertility is a major factor for low crop yields. Low cropping intensity in eastern district of MP and extensive tracts of land in the Jharkhand state due to fallow after harvest of the rainy season crop is another reason for low overall production and benefits to farmers in the region. However sufficient stored moisture remains in the soil for growing a post-rainy season crop, and so the potential for double cropping in these regions remains untapped due to the lack of availability of proper technology. Therefore, appropriate soil, nutrient, water and crop management practices that increase crop yield and conserve natural resources in the rainfed areas of MP and Jharkhand assume greater significance. In order to bridge the yield gap, ICRISAT and its partners have adopted Integrated Genetic and Natural Resource Management (IGNRM) and associated livelihood activities guided by Inclusive Market Oriented Development (IMOD) philosophy leading to linking farmers with markets and reaping in the benefits of productivity enhancement initiative.

The overall objective of this project is to increase the impact of the development projects in Central India through technical backstopping and empowerment of stakeholders to improve livelihoods through increased agricultural productivity and livelihood opportunities via sustainable use of natural resources.

The specific objectives of this technical assistance program are:

- To establish a holistic participatory IGNRM model for the convergence of activities in four nucleus clusters (five villages in each cluster) encompassing suitable technical, institutional, gender equity, and policy options for enhanced agricultural productivity and crop-livestock management systems to alleviate poverty; and
- To provide technical know-how to farmers, landless rural people in the target districts, and partner NGOs supported by the SRTT in the region through empowerment by bringing together learnings from the national and international experience.

Target Eco-regions

The target districts for pilot scale interventions are Gumla and Saraikela-Kharshaw in Jharkhand and Jhabua and Mandla in Madhya Pradesh. Annual rainfall in Jharkhand varies from 1000 to 1600 mm, while in Madhya Pradesh it varies from 600 to 1600 mm. About 70-80 per cent of the annual rainfall is received during the southwest monsoon period (June-September). Soils are predominantly black (Vertisols, Vertic Inceptisols), as well as Entisols and Alfisols varying in soil depth. Jhabua and Mandla districts receive annual rainfall of 885 and 1580 mm respectively, while Gumla and Saraikela-Kharshaw receive 1100 and 1400 mm respectively. These districts in general are dominated by an agrarian economy. Jamshedpur is however known for its industrial development. There are six agro-ecological sub regions (AESR) in Jharkhand, and seven in Madhya Pradesh as per the NBSS and LUP. Length of growing period (LGP) varies from 120-240 days in the target eco-region (Figure 1).

Temperatures of above 45°C are common in the summer months while in winter they could be as low as 10°C.

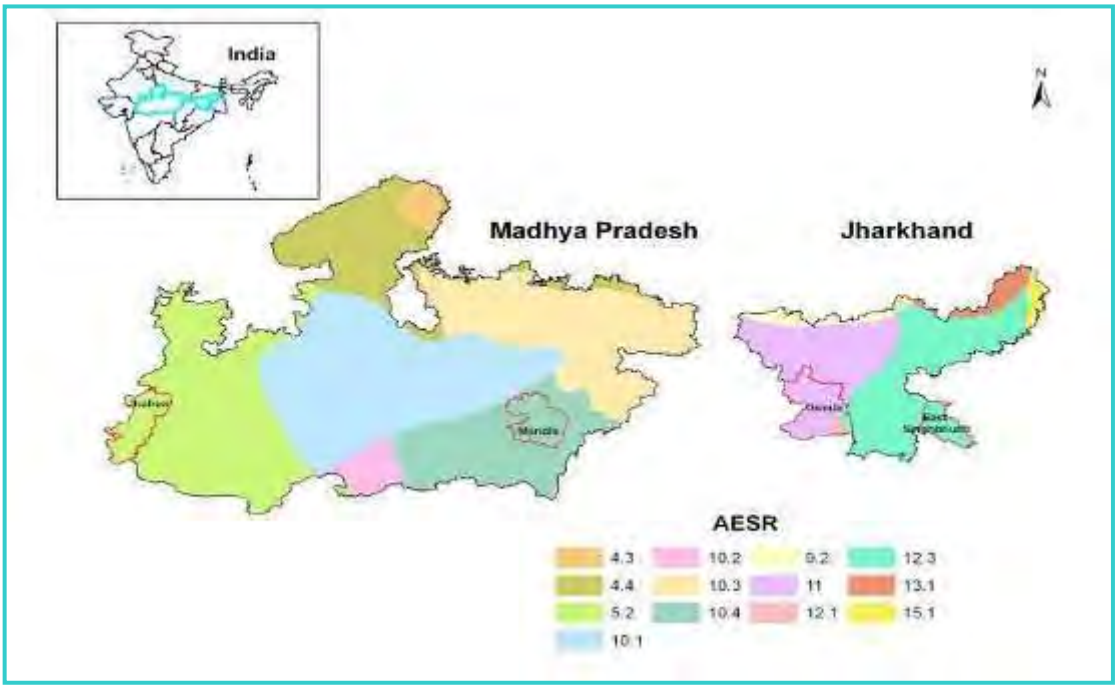


Figure 1. Target eco-region of Madhya Pradesh and Jharkhand: AESR

The ICRISAT facilitates the implementation of the project in partnership with national research institutions, universities and NGOs. The details of sites and partners for various activities undertaken during 2011 and 2012 are given in Table 1.

Table 1. Detail of target sites and concerned partner in target districts

S. No	State	District	Block	NGO-Partner
1	Jharkhand	Gumla	Raideh	Tata Rural Development Trust (TSRDS)- Jamshedpur- Jharkand
		Saraikela-Kharshaw	Kharshaw	PRADHAN- Gumla, Jharkand
2	Madhya Pradesh	Jhabua	Jhabua and Meghnagar	Gramin Vikas Trust (GVT) Jhabhua, MP
		Mandla	Nivas	Foundation for Ecological Security (FES) - Mandla MP.

In addition to the NGO partners, we have important partners such as state agricultural universities (Jawaharlal Nehru Krishi Vishva Vidyalaya, Jabalpur; M Ahilyabai Holkar Agril. Univ.; BAU, Ranchi); national research institutes (Indian Institute of Soil Science, Bhopal. M.P; National Research Center for Soybean, Indore), and Jain Irrigation Ltd., Jalgaon, Maharashtra in the consortium, and integrated programs like Integrated Watershed Management Programs in target states, All India Coordinated Research Project for Dryland Areas (AICRPDA-CRIDA).

Jharkhand

Productivity Enhancement Interventions

Weather Monitoring

In Jharkhand, weather monitoring using water recording censors and dual recording rainguages, rainfall and other weather parameters including minimum and maximum temperature and relative humidity were recorded from two villages - Teleya in Gumla district and Sherbida village for Saraikela-Kharshaw district. The rainfall received during the year 2011 and 2012 is given in Table 2.

During 2011, a good rainfall was received especially in Saraikela-Kharshaw district and by June month all sowing/planting operations were done. Upland crops like maize, black gram and pigeon pea were sown during the month of June. In Gumla district, there was some delay in receiving rainfall and planting paddy and other crops was delayed. However, later on good rains were received. Again there were good rain events in September month and few rain events in October at Gumla and Saraikela. Rabi crops were grown with residual moisture and also with supplemental irrigation from seepage ponds having sufficient stored water.

During the year 2012 rainfall received until September month 2012 is 935 mm and 227 mm in Gumla and Saraikela districts, respectively. The rainfall is in general normal in Gumla with good distribution over the growing period, but it is very less and quite below the normal rainfall at Saraikela-Kharshaw.

Table 2. Monthly rainfall received during the year 2011 and 2012 at Teleya, Gumla district and at Sherbida, Saraikela-Kharshaw district in Jharkand

Month	Gumla (mm)		Saraikela-Kharshaw (mm)	
	2011	2012	2011	2012
Jan	0	8.5	0	0
Feb	0	0.0	0	0
March	8	20.0	0	0
April	0	7.5	20	0
May	65	25.0	33	0
June	65	190.0	384	91
July	150	210.0	162	111
August	536	270.0	334	233
September	515	194.0	295	308
October	20	7.0	32	2
November	18	0.0	-	0
December	0	13.0	-	5.2
Total	1377	935 (till 30 Sept)	1260	749.8

2011 Rainy Season Farmer Participatory R4D Trials

As an effort to promote improved crop cultivars and balanced fertilization, ICRISAT arranged to provide through NGO partners the seeds of improved crop cultivars and micronutrients during rainy season 2011 viz, 990 kg maize seed (Kavei 235, Bio-seed 9220 and TX 369), 80

kg pigeonpea (ICPL 7035, ICPL 87119), 150 groundnut (ICGV 91114), 392 kg blackgram (T9), 4 kg *Gliricidia* seed, 7500 kg zinc sulphate and 750 kg agribor.

We adopted participatory research and development (PR and D) approach with farmers to demonstrate and evaluate the science-led interventions.

Paddy crop in wet lands

Trials were conducted with paddy crop to demonstrate and evaluate the benefits through addition of micronutrients boron (agribor), and zinc (zinc sulphate) along with DAP and FYM in different villages in Gumla (16 villages) and Saraikela-Kharshaw (8 villages) districts.

In Gumla district, paddy grown under improved (balanced nutrient) management which also included micro-nutrients, yielded on an average 6740 kg ha^{-1} as compared with 6110 kg ha^{-1} under the farmers' management practice (Table 3), thus recording an increase of 10% under the improved management.

Similarly in Saraikela-Kharshaw district, paddy grown with addition of micro-nutrients on an average yielded 4100 kg ha^{-1} as against 3620 kg ha^{-1} under farmers' traditional practice. Improved management as such recorded an increase of 13.5% over the farmers' practice (Table 3; Figure 2). The improved management practice through maintained soil fertility is helping in growing an additional crop of chickpea crop in winter with residual moisture which is benefitting farmers with additional income.

Figure 2. Paddy fields with micronutrient application in Masoodhi village, Saraikela-Kharshaw district during rainy season 2011.

Table 3. Effects of balanced nutrient management on rice grain yield during rainy season 2011

District	No. of farmers	Area (ha)	No. of villages	Grain yield (kg ha^{-1})		% gain in grain yield	LSD (5%)
				FP	BN		
Saraikela-Kharshaw	186	120	8	3620	4100	13.5	129
Gumla	254	96	16	6110	6740	10.2	120

Maize cultivation in midland and uplands

Maize cultivation was introduced in this area which has given good yield with farmer's practice of FYM+ DAP+ Urea. Therefore, trials/demonstrations were conducted during rainy season 2011 to evaluate the addition of deficient micronutrients (zinc and Boron) over and above the farmers' practice.

In Saraikela district, the benefits of micronutrients were evaluated in different maize varieties (Bio seed 9220, Kaveri 235; TX 13) grown in 13 villages. The benefits were evident in productivity improvement in all varieties varying from 18% to 27% (Table 4; Figure 3). On an average, maize productivity improved by 24% with micronutrient addition over the farmers practice.

Table 4. Effects of micronutrients on maize grain yield in 13 villages of Saraikela-Kharshaw district, Jharkhand during rainy season 2011

S. No	Maize Variety	No of Farmers	Area under treatment (Acre)	Yield Kg ha^{-1}		% increase over FP	LSD (5%)
				Farmer practice	Improved Practice		
1	Bio seed 9220	16	1.6	5100	6460	27	1133
2	Kaveri 235	24	2.15	5250	6180	18	968
3	TX 369	13	1.45	5130	6500	27	983
	Total	**53**	**5.2**				
	Mean			**5160**	**6380**	**24**	
Note: FP=Farmer Practice-DAP 150 kg, Urea 100 kg, Potash 25 kg, IP= Improved Practice = FP+ Zinc Sulphate 25 kg, Agribor 2.5 kg, lime 200 kg							

Figure 3. Maize crop grown in farmer's field in Jojo village of Saraikela –Kharshaw district during rainy season 2011

Similarly in Gumla district, the application of micronutrients was evaluated in 3 maize varieties viz. Bio seed 9220, Kaveri 235; and local grown in 6 villages. In Gumla, the balanced nutrition recorded an increase of 28% to 46% over the farmers practice (Table 5).

Table 5. Effects of micronutrients on maize grain yield in 6 villages of Gumla district, Jharkhand during rainy season 2011

S.No	Maize Variety	No of Farmers	Area under treatment (Acre)	Average Yield (Kg ha^{-1})		% increase over FP	LSD (5%)
				Farmer practice	Improved Practice		
1	Bio seed 9220	26	14.2	2500	3560	42	844
2	Kaveri 235	49	33.25	2460	3580	46	533
3	Local	12	2	2220	2850	28	376
	Total	**87**	**49.45**				
	Mean			**2390**	**3330**	**39**	
Note: FP = Farmer Practice-DAP 125 kg, Urea 100 kg, Potash-25 kg, IP = Improved Practice = FP+ Zinc Sulphate 25 kg, Agribor 2.5 kg							

Pigeonpea and blackgram in midland and uplands

During rainy season 2011, high yielding varieties of pigeonpea were evaluated by 21 farmers in 6 villages of Saraikela-Kharshaw district; while high yielding varieties of blackgram were also evaluated by 45 farmers in 12 villages in Saraikela-Kharsha and 59 farmers in 8 villages in Gumla district.

In Saraikela district, pigeonpea crop was grown with recommended inputs of DAP, MOP, Urea, FYM, zinc sulphate and agribor. The crop varieties proved very successful and recorded a yield of 1320 kg ha^{-1} with ICPL 87119 variety in Saraikela block and 1380 kg ha^{-1} with ICP 7035 in Kharshaw block (Table 6).

Table 6. Pigeonpea yield in different villages of Saraikela district, Jharkhand during rainy season 2011

S. No.	Name of the Block	Pigeonpea variety	No of farmers	No of villages	Area under trials (Acre)	Average Yield (kg ha^{-1})
1	Saraikela	ICPL 87119	12	3	13.5	1320
2	Kharshaw	ICP 7035	9	3	3.24	1380
	Total		21	6	16.74	

Similarly Black gram T 9 variety was grown by many farmers with addition of micronutrients (zinc, boron) along with DAP, Urea and FYM. The yield obtained was very good compared to local variety and the yields were almost double and crop matured early. The average yields were 710 kg ha^{-1} in Saraikela-Kharshaw and 790 kg ha^{-1} in Gumla district during rainy season 2011 (Table 7).

Table 7. Blackgram yield in different villages of Saraikela and Gumla district, Jharkhand during rainy season 2011

S. No.	District	No of farmers	No of Villages	Trial area (acre)	Black gram yield (kg ha^{-1})
1	Saraikela-Kharshaw	45	12	18.64	710
2	Gumla	59	8	10.3	790
	Total	104	20	28.94	

2011-12 Post-rainy Season Farmer Participatory R4D Trials

As an effort to promote crop cultivars and balanced fertilization, ICRISAT arranged to provide through NGO partners the seeds of improved crop cultivars and micronutrients like zinc and boron during post-rainy season 2011-12 (Table 4) – 1425 kg chickpea seed (KAK 2, ICCV 2, JG 11), 300 kg greengram (PS 16, LGG 460), 5 kg *Rhizobium* culture, 1 kg sodium molybdate, 6 kg captan (fungicide), 200 kg zinc sulphate and 200 kg agribor.

During post-rainy season 2011, improved chickpea cultivar like KAK 2, ICCV 2and desi type JG11 which were promising last year were used for cultivation this year. Chickpea trials were conducted in 50 farmer fields in 8 villages of Saraikela-Kharshaw district. Similarly 93 farmers in 5 villages of Gumla district cultivated chickpea crop of Kabuli variety. The chickpea was cultivated on residual soil moisture of rice fields with seed priming technique using *Rhizobium* culture and sodium molybdate solution. The seeds of chickpea were soaked for 3-4 hours with solution of rhizobium culture and sodium molybdate. After complete water was absorbed by seeds, they are dried in shade and then sowing was done. Three varieties were cultivated in Saraikela-Kharshaw district villages. Most of the farmers sold chickpea as green pod (Figure 4) and very few farmers harvested for grain. Due to moisture stress yields were relatively low compared to last year. The chickpea grain yield varied between 860 kg ha^{-1} in Saraikela-Kharshaw and 950 kg ha^{-1} in Gumla district during the rabi season 2011-12 (Table 8).

Figure 4. Chickpea crop grown through seed priming under residual moisture and farmer selling green chickpea pods

Table 8. Yield of chickpea crop grown with seed priming in different villages of Saraikela and Gumla districts

District	No. of farmers participated	No of villages	Area sown (ha)	Grain yield (kg ha^{-1})
Saraikela-Kharshaw	50	8	10	860
Gumla	93	5	17	950
Total	143	13	27	

2012 Rainy Season Farmer Participatory R4D Trials

During April 2012, soil samples were collected from different locations of Jharkhand (Deoghar, Hazaribagh district) and Orissa (Keonjhar district). Based on the deficiency and sufficiency level fertilizer recommendations were designed for different crops. All the soil analysis results (Table 9) and recommendations (Table 10) developed were shared with the farmers. The soil analysis results showed widespread deficiencies of S, Zn and B along with that of N (as a function of C), and P. Potassium as such was not a problem in Jharkhand, but majority fields were deficient in Orissa.

Table 9. Soil analysis results of farmers' fields in Jharkhand and Orissa states, India

District/ State	Village	% deficiency of available nutrients					
Jharkand		Organic C	P	K	S	Zn	B
Deoghar-	Khairwar	91	45	9	100	55	100
Hazaribagh-	Kurra	90	55	5	80	75	100
Keonjhar-Orissa	Rohi	20	100	55	85	65	100

Table 10. Soil test based fertilizer recommendations for different crops (kg ha^{-1})

1	Crop: Paddy (Kharif)								
			N	P_2O_5	K_2O	S	Zn	B	
	Recommended dose (kg ha^{-1})		90	55	40	30	10	0.5	
	Jharkand		Urea	DAP	MOP	Gypsum	$ZnSO_4$	Agribor or Borax	
	Deoghar-	Khairwar	172	60	33	200	50	2.5	5
	Hazaribagh-	Kurra	149	120	33	200	50	2.5	5
	Keonjhar-Orissa	Rohi	51	120	67	200	50	2.5	5
2	Crop: Paddy (Rabi)								
			N	P_2O_5	K_2O	S	Zn	B	
	Recommended dose (kg ha^{-1})		120	60	40	30	10	0.5	
	Jharkand		Urea	DAP	MOP	Gypsum	$ZnSO_4$	Agribor or Borax	
	Deoghar-	Khairwar	235	65	33	200	50	2.5	5
	Hazaribagh-	Kurra	210	130	33	200	50	2.5	5
	Keonjhar-Orissa	Rohi	80	130	67	200	50	2.5	5
3	Crop: Maize (Kharif)								
			N	P_2O_5	K_2O	S	Zn	B	
	Recommended dose(kg ha^{-1})		100	50	40	30	10	0.5	
	Jharkand		Urea	DAP	MOP	Gypsum	$ZnSO_4$	Agribor or Borax	

	Deoghar-	Khairwar	196	54	33	200	50	2.5	5
	Hazaribagh-	Kurra	175	109	33	200	50	2.5	5
	Keonjhar-Orissa	Rohi	66	109	67	200	50	2.5	5
4	Crop:Maize (Rabi)								1,2,3,8
			N	P_2O_5	K_2O	S	Zn	B	
	Recommended dose (kg ha^{-1})		120	60	50	30	10	0.5	
	Jharkand		Urea	DAP	MOP	Gypsum	$ZnSO_4$	Agribor or Borax	
	Deoghar	Khairwar	235	65	42	200	50	2.5	5
	Hazaribagh	Kurra	210	130	42	200	50	2.5	5
	Keonjhar Orissa	Rohi	80	130	83	200	50	2.5	5
5	Crop: Pigeonpea								
			N	P_2O_5	K_2O	S	Zn	B	
	Recommended dose (kg ha^{-1})		20	50	0	30	10	0.5	
	Jharkand	Taluk	Urea	DAP	MOP	Gypsum	$ZnSO_4$	Agribor or Borax	
	Deoghar	Khairwar	22	54	0	200	50	2.5	5
	Hazaribagh	Kurra	1	109	0	200	50	2.5	5
	Keonjhar Orissa	Rohi	0	109	0	200	50	2.5	5
6	Crop: Green gram and Black gram								
			N	P_2O_5	K_2O	S	Zn	B	
	Recommended dose (kg ha^{-1})		20	50	0	30	10	0.5	
	Jharkand	Taluk	Urea	DAP	MOP	Gypsum	$ZnSO_4$	Agribor or Borax	
	Deoghar	Khairwar	22	54	0	200	50	2.5	5
	Hazaribagh	Kurra	1	109	0	200	50	2.5	5
	Keonjhar Orissa	Rohi	0	109	0	200	50	2.5	5
7	Crop: Groundnut(Irrigated)								
			N	P_2O_5	K_2O	S	Zn	B	
	Recommended dose (kg ha^{-1})		30	40	50	30	5	0.5	
	Jharkand		Urea	DAP	MOP	Gypsum	$ZnSO_4$	Agribor or Borax	
	Deoghar	Khairwar	48	43	42	200	25	2.5	5
	Hazaribagh	Kurra	31	87	42	200	25	2.5	5
	Keonjhar Orissa	Rohi	0	87	83	200	25	2.5	5
8	Crop: Groundnut (Rainfed)								
			N	P_2O_5	K_2O	S	Zn	B	
	Recommended dose (kg ha^{-1})		20	40	50	30	5	0.5	
	Jharkand		Urea	DAP	MOP	Gypsum	$ZnSO_4$	Agribor or Borax	
	Deoghar	Khairwar	27	43	42	200	25	2.5	5
	Hazaribagh	Kurra	9	87	42	200	25	2.5	5
	Keonjhar Orissa	Rohi	0	87	83	200	25	2.5	5
9	Crop: Tomato								
			N	P_2O_5	K_2O	S	Zn	B	
	Recommended dose (kg ha^{-1})		150	60	60	30	5	0.5	
	Jharkand	Taluk	Urea	DAP	MOP	Gypsum	$ZnSO_4$	Agribor or Borax	
	Deoghar	Khairwar	301	65	50	200	25	2.5	5
	Hazaribagh	Kurra	275	130	50	200	25	2.5	5
	Keonjhar Orissa	Rohi	112	130	100	200	25	2.5	5

10	Crop: Brinjal								
			N	P_2O_5	K_2O	S	Zn	B	
	Recommended dose (kg ha^{-1})		100	60	60	75	5	0.5	
	Jharkand	Taluk	Urea	DAP	MOP	Gypsum	$ZnSO_4$	Agribor or Borax	
	Deoghar	Khairwar	192	65	50	500	25	2.5	5
	Hazaribagh	Kurra	167	130	50	500	25	2.5	5
	Keonjhar Orissa	Rohi	58	130	100	500	25	2.5	5
11	Crop: Cabbage								
			N	P_2O_5	K_2O	S	Zn	B	
	Recommended dose (kg ha^{-1})		80	100	100	75	5	0.5	
	Jharkand		Urea	DAP	MOP	Gypsum	$ZnSO_4$	Agribor or Borax	
	Deoghar	Khairwar	131	109	83	500	25	2.5	5
	Hazaribagh	Kurra	89	217	83	500	25	2.5	5
	Keonjhar Orissa	Rohi	2	217	167	500	25	2.5	5
12	Crop:Cauliflower								
			N	P_2O_5	K_2O	S	Zn	B	
	Recommended dose (kg ha^{-1})		80	80	100	30	5	0.5	
	Jharkand		Urea	DAP	MOP	Gypsum	$ZnSO_4$	Agribor or Borax	
	Deoghar	Khairwar	140	87	83	200	25	2.5	5
	Hazaribagh	Kurra	106	174	83	200	25	2.5	5
	Keonjhar Orissa	Rohi	19	174	167	200	25	2.5	5
13	Crop:Potato								
			N	P_2O_5	K_2O	S	Zn	B	
	Recommended dose (kg ha^{-1})		50	25	35	30	5	0.5	
	Jharkand		Urea	DAP	MOP	Gypsum	$ZnSO_4$	Agribor or Borax	
	Deoghar	Khairwar	98	27	29	200	25	2.5	5
	Hazaribagh	Kurra	88	54	29	200	25	2.5	5
	Keonjhar Orissa	Rohi	33	54	58	200	25	2.5	5
14	Crop: Chillies (Irrigated)								
			N	P_2O_5	K_2O	S	Zn	B	
	Recommended dose (kg ha^{-1})		300	60	120	30	5	0.5	
	Jharkand		Urea	DAP	MOP	Gypsum	$ZnSO_4$	Agribor or Borax	
	Deoghar	Khairwar	627	65	100	200	25	2.5	5
	Hazaribagh	Kurra	601	130	100	200	25	2.5	5
	Keonjhar Orissa	Rohi	275	130	200	200	25	2.5	5
15	Crop: Chillies (Rainfed)								
			N	P_2O_5	K_2O	S	Zn	B	
	Recommended dose (kg ha^{-1})		60	40	50	30	5	0.5	
	Jharkand		Urea	DAP	MOP	Gypsum	$ZnSO_4$	Agribor or Borax	
	Deoghar	Khairwar	114	43	42	200	25	2.5	5
	Hazaribagh	Kurra	96	87	42	200	25	2.5	5
	Keonjhar Orissa	Rohi	31	87	83	200	25	2.5	5

Seeds and micronutrients were made available to 7 locations of CINI partners for conducting trials and also scaling up activities (Table 11) during 2012 rainy season.

Table 11. Seed and micronutrient inputs arranged during 2012 for trials/demonstrations in Jharkhand

Inputs for Rainy season 2012			PRADAN-Gumla	TSRDS-Jamshedpur	CINI-Partners Jamshedpur
S.No	Crop	Variety/nutrient	Quantity (kg)	Quantity (kg)	Quantity (kg)
1	Sorghum	CSV 15	10	10	30
2	Pigeon pea	ICPL 85063	10	10	5
		ICPH 2671	5	10	80
		ICPL 88034	10		
		ICPL 87119	15	15	
3	Black gram	T 9	396	52	362
4	Maize	Kaveri 2288	120	60	75
		Bioseed 9220	135	75	180
		Hytec 5401	40	40	
		Prabhat 2201	90	45	45
5	Maize	Pusa 3 composite	20	20	50
6	Pearl millet	ICP 8203	20	20	10
		Hytech Hybri 4201	25	25	20
		HHB 67	10	10	30
7	Finger millet	MR 1	50	50	80
8	Zinc Sulphate	Zinc	500	300	2670
9	Agribor	Agribor	150	50	273
10	Glyricidia	Greenmanure	1	1	8

Trials were conducted with paddy crop for scaling up the improved practice through conducting large number of demonstrations. Addition of micronutrients agribor and zinc sulphate was done along with DAP and FYM in 178 farmers' fields (58 ha) in 13 villages in Gumla and in 371 farmers' field (60 ha) in 16 villages in Sariekela-Karshaw districts, Jharkhand (Table 12, 13).

Figure 5. Paddy crop with and without micronutrient during rainy season 2012

Table 12. Trials to evaluate the effects of micronutrients with paddy crop in Seraikela-Kharsawan district, Jharkhand

S. No.	Name of the Village	No. of Farmers	Area (ha)
1	Dangardiha	21	2.1
2	Nayadih	45	4.5
3	Kanchanpur	42	9.7
4	Saherbeda	27	5.7
5	Tetultand	31	5.0
6	Sarmali	12	1.2
7	Kamalpur	83	8.3
8	Rakakocha	16	5.6
9	Kadambera	31	5.8
10	Koira	6	0.8
11	Jojo	9	1.0
12	Mosodih	35	8.2
13	Dungridih	6	0.9
14	Kurshopur	1	0.1
15	Baksahi	6	1.2
	Total	**371**	60.1

Table 13. Trials to evaluate the effects of micronutrients with paddy crop in Raidih, Jharkhand

S. No	Village	No. of Farmers	Area (ha)
1	Mariumtoli	21	10.8
2	S. Bartoli	6	1.2
3	Sipringa	11	2.4
4	Sopo	13	3.1
5	Teleya	24	4.8
6	Tukutoli	2	1.8
7	Unchdih	21	4.4
8	Khursuta	5	2.6
9	Shahitoli	9	2.8
10	Parsa Navatoli	13	3.4
11	Patratoli	10	3.6
12	Katkaya	12	3.2
13	Pogra	31	13.6
	Total	178	57.9

2012-13 Post-Rainy Season Farmer Participatory R4D Trials

During 2012-13 post-rainy season, trials were conducted with chickpea crop primarily in the post-rainy fallow regions (Table 14, 15, 16). The required *Rhizobium* culture, sodium molybdate for chickpea seed priming trials was made available in required small packets for the farmers.

Table 14. Detail of inputs provided for farmers through TSRDS Sariekela-Karshawn and PRADAN Gumla during post-rainy season 2012-13

S.No	Seeds	Variety	PRADAN, Gumla	TSRDS, Sariekela-Karshawn
			Quantity Kg	Quantity Kg
1	Chickpea Kabuli	KAK-2	600	600
	Chickpea Desi	JACKI9218	100	300
	Chickpea Desi	JG11	100	200
2	Rhizobium Culture		1.6	5kg
3	Sodium Molybdate		0.4(2.5gm 100 pkt,5gm 30pkt)	0.50(5.0gm 100pkt)

Table 15. Detail of inputs provided for farmers through CINi partners in JHARKAND during post-rainy season, 2012-13

Sl No	Address	Chickpea	Quantity	Remarks
1	RDA ,Ghatsila	JG11	25	50gm Rzbm, 2.5g, 5 Pkt of Sod Mol
2	SRSMM, Hazaribagh	KAK2	40	80gm Rzbm, 2.5g, 8 Pkt of Sod Mol
3	SUPPORT, MANDU, RAMGARH	KAK2	40	80gm Rzbm, 2.5g, 8 Pkt of Sod Mol
4	NEEDS, Deoghar	KAK2	100	200gm Rzbm, 2.5g, 20Pkt of Sod Mol
5	SHRISTI, Keonjar Orissa	KAK2	140	280gm Rzbm, 2.5g, 28Pkt of Sod Mol
		Total	345kg	

Table 16. Details of trials conducted in Jharkhand during post-rainy season 2012-13

S. No.	Trial type	District	Crop	Cultivar	No. of trials
1	Chickpea cultivation in post-rainy fallow regions	Gumla	Chickpea	KAK 2	95
				JG 11	14
		Seraikella-Kharsawan	Chickpea	KAK 2	22
				JG 11	21
2	Evaluation of pigeonpea cultivars	Hazaribagh	Pigeonpea	Asha (ICPL 87119)	74
				Laxmi (ICPL 85063)	18
				Puskar (ICPH 2671)	2
		Deogarh	Pigeonpea	Asha (ICPL 87119)	8
				Laxmi (ICPL 85063)	15

Trials with chickpea in rice fallow region

Participatory trials with a purpose to demonstrate and evaluate chickpea cultivars (JG 11, JGK 9218 and KAK 2) in post-rainy fallow regions were done with 250 farmers in five districts of Jharkhand and one district of Odisha. The crop was introduced in the rice fallows after seed treatment with the *Rhizobium* culture. Farmers are getting good demand for their chickpea crop. Farmers sell green plant bunches (2-4 plants) (@ Rs 5-10 per bunch) in the local market when pods are still green with fully formed seeds inside.

Crop cutting experiments in Gumla district in Jharkhand showed that farmers harvested 1520 kg ha^{-1} with KAK 2 variety of chickpea, and 1340 kg ha^{-1} with JG 11 variety of chickpea (Table 17; Figure 6). Similarly, in Seraikella-Kharsawan district, they got yield of 1490 kg ha^{-1} with KAK 2 variety and 1280 kg ha^{-1} with JG11 variety of chickpea (Table 18; Figure 6). Results clearly demonstrated that chickpea is a suitable crop to grow after rice in otherwise fallow regions and that is bringing dividends for the farmers through additional income as well as by enhancing rainwater use efficiency.

Table 17. Evaluation of chickpea cultivars in rice fallows in Raideh block, Gumla district, Jharkhand, post-rainy 2012-13 season

S. No.	Village	Variety	No. of farmers	Area (ha)	Yield (kg ha^{-1})
1	Beritoli	KAK 2	8	0.26	1480
2	Sopo	KAK 2	18	1.32	1400
3	Parsa Navatoli	KAK 2	7	0.57	1460
4	Parsa	KAK 2	5	0.25	1370
5	Semartoli	KAK 2	3	0.20	1460
6	Bansidih	KAK 2	3	0.18	1420
7	Mahuatoli	KAK 2	10	0.57	1400
8	Tetardih	KAK 2	2	0.16	1510
9	Teleya	KAK 2	11	0.65	1640
10	Pogra	KAK 2	3	0.12	1550
11	Patratoli	KAK 2	3	0.15	1620
12	Gorhitoli	KAK 2	8	0.85	1650
13	Shahitoli	KAK 2	6	0.23	1570
14	Dartoli	KAK 2	4	0.27	1620
15	Sipringa	KAK 2	4	0.12	1600
			95		**1520**
1	Beritoli	JG 11	2	0.06	1450
2	Sopo	JG 11	1	0.08	1530
3	Mahuatoli	JG 11	3	0.18	1220
4	Tetardih	JG 11	5	0.29	1470
5	Katkaya	JG 11	1	0.14	1000
6	Gorhitoli	JG 11	2	0.13	1390
			14		**1340**

Table 18. Evaluation of chickpea cultivars in rice fallows in Seraikella-Kharsawan district, Jharkhand, post-rainy 2012-13 season

S. No	Village	Block	Kabuli variety (KAK 2)			Desi variety (JG 11)		
			No of Famers	Area (ha)	Yield (kg ha^{-1})	No of Famers	Area (ha)	Yield (kg ha^{-1})
1	Koira	Sariekela	14	2.10	1420	7	0.96	1210
2	Begnadih	Sariekela	4	0.58	1500	8	0.88	1250
3	Sherbida	Karshaw	4	1.18	1560			
4	Tetlutanda	Sariekela				6	0.84	1370
	Total/Average		**22**	**3.86**	**1490**	**21**	**2.68**	**1280**

Figure 6. Trials with chickpea (KAK-2) crop in rice fallows in Jharkhand; Left: Teleya village, Gumla district, Right: Sherbida village, Saraikela-Kharsawan district

Evaluation of pigeonpea cultivars

Pigeonpea varietal trials with Asha (ICPL 87119) and Laxmi (ICPL 85063) varieties were conducted with 110 farmers covering ~4.25 ha in 17 villages in Hazaribagh and Deogarh districts in Jharkhand. In trials, micronutrients B and Zn were also added in addition to N, P, K and FYM. Integrated pest management technologies, such as chemical sprays (Endocil, Dithane and Ridomil), pheromone traps (particularly in Mandu, Hazaribagh and Gola, Ramgarh), and manual shaking of plants were done to control pests.

The crop cutting experiments in Hazaribagh district in Jharkhand showed a yield of 880 kg ha^{-1} with Laxmi (ICPL 85063) variety followed by 790 kg ha^{-1} with Asha (ICPL 87119) and 760 kg ha^{-1} with Puskar (ICPH 2671) variety (Table 19). In Deogarh district in Jharkhand, grain yield of 2290 kg ha^{-1} was recorded with Laxmi (ICPL 85063) variety and 2050 kg ha^{-1} with Asha (ICPL 87119) variety of pigeonpea (Table 20; Figure 7).

Table 19. Evaluation of pigeonpea cultivars in Mandu block, Hazaribagh district, Jharkhand, post-rainy 2012-13 season

S. No.	Village	Variety	No of farmers	Area (ha)	Yield (kg ha^{-1})
1	Chanaro	Asha-ICPL 87119	2	0.06	820
2	Rikwa	Asha-ICPL 87119	28	0.72	950
3	Kowad	Asha-ICPL 87119	8	0.19	750
4	Kanki	Asha-ICPL 87119	3	0.10	910
5	Khapiya	Asha-ICPL 87119	6	0.32	720
6	Bali	Asha-ICPL 87119	10	0.33	910
7	Hendegarha	Asha-ICPL 87119	4	0.18	670
8	Kura	Asha-ICPL 87119	13	0.43	610
			74	**2.34**	**790**
1	Jordag	Laxmi-ICPL 85063	6	0.26	910
2	Bali	Laxmi-ICPL 85063	3	0.08	820
3	Kanki	Laxmi-ICPL 85063	5	0.18	1120
4	Chainpur	Laxmi-ICPL 85063	4	0.16	690
			18	**0.68**	**880**
1	ManjhlaChumba	Puskar ICPH 2671	2	0.15	760
			2	**0.15**	**760**

Table 20. Evaluation of pigeonpea cultivars in Palajor block, Deoghar district, Jharkhand, post-rainy 2012-13 season

S. No.	Village	Variety	No of farmers	Area (ha)	Yield (kg ha^{-1})
1	Simla	Asha-ICPL 87119	3	0.14	2060
2	Bhouradih	Asha-ICPL 87119	5	0.24	2050
			8	**0.38**	**2050**
1	Khairwa	Laxmi-ICPL 85063	11	0.56	2310
2	Bedia	Laxmi-ICPL 85063	4	0.13	2270
			15	**0.69**	**2290**

Figure 7. Trials with pigeonpea crop in Deogarh district, Jharkhand; Left: Asha variety, Right: Lakshmi variety

Interventions during 2013-14

A very ambitious plan has been chalked out for Jharkhand sites of action in consultation with partners for implementation during 2013-14 (Table 21). In addition to large number of productivity enhancement trials, focus is also given on cultivating rice fallow regions and crop diversification to vegetables and other crops like maize, blackgram, pigeonpea. Plans are put to promote taking 3rd crop through growing short duration green gram during summer. Water augmentation to support diversification and fisheries are focused in all 4 districts. For efficient use of irrigation water, use of micro-irrigation is being promoted in all 4 districts. In order to cut use and cost of chemical fertilizers, construction of vermicomposting pits in being promoted on large scale. There are plans to grow *Gliricidia* nurseries and plant them on bunds and farm boundaries to generate biomass for recycling to maintain soil fertility. Seed banks are being promoted in Gumla and Saraikela to meet the requirements of improved seeds locally. Capacity strengthening is equally focused through exposure visits, trainings and field days.

The productivity enhancement initiatives are also being scaled up along with CINI partner in the 8 target districts in Jharkhand and Orissa. During 2013 rainy season, seeds were distributed as per detail in Table 22 to do varietal trials.

Table 21. Detail of productivity enhancement trials, related activities and capacity building planned and being implemented in Jharkhand during 2013-14

S. No.	Activity	Gumla district			Saraikela district			Deoghar district			Hazaribagh district		
		Nucleus	Sat + SU	No. of villages	Nucleus	Sat + SU	No. of villages	Nucleus	Sat + SU	No. of villages	Nucleus	Sat + SU	No. of villages
1	Productivity enhancement trials with paddy using micro-nutrients and NPK	100	1500	35	50	600	30	50	250	10	50	200	10
2	Rice fallow management by growing chickpea with seed priming and other improved management practices	100	1000	35	50	500	20	50	200	10	50	200	10
3	Crop diversification using vegetables with vermicomposting and micro-nutrients	60	120	35	30	350	30	30	150	10	30	100	10
4	Summer crop of green gram with micro-nutrients and bio fertilizers	30	400	35	10	100	10	10	50	5	10	50	5
5	Construction of farm ponds (& fish rearing)	10	40	10	5	10	5	5	20	5	5	20	5
6	Micro irrigation system to vegetable crops. Drip system	5	10	5	3	10	5	2	10	5	2	8	4
7	Crop diversification (Black gram, maize, pigeon pea, vegetables crops (upland and middle land)	150	1500	30	90	400	20	50	300	10	50	300	10
8	Vegetables with vermicomposting and micronutrients	100	300	30	25	50	20	20	50	5	20	50	5
9	Vermi-compost preparation	0	30	10	5	15	5	5	10	2	5	10	2
10	Gliricidia plantation and bunds (Nursery raising and planting)	5000	10000	20	5000	10000	20	3000	5000	5	3000	5000	5
11	Village seed banks	1000			500								
	Human development resources												
12	Trainings and Exposure visits	1 (25 farmers)	5 (175 farmers)		1 (25 farmers)	5 (175 farmers)		2 (50 farmers)	4 (150 farmers)	8	2 (50 farmers)	4 (150 farmers)	
	Exposure visits		20 farmers			20 farmers		5 farmers	15 farmers		5 farmers	15 farmers	
13	Field days	1	2		1	2		1	2	3	1	2	

Sat=Satellite; SU=Scaling-up

Table 22. Detail of improved seeds distributed for varietal evaluation trials in different districts in Jharkhans and Orissa during rainy season 2013

S. No.	District (NGO)	Black gram	Pigeonpea	Maize-composite	Maize-hyb	Gliricidia
Jharkhand						
1	Hazaribagh (SUPPORT)	500	350		60	2
2	E Singhbhum (RDA)	100	100			1
3	Deogarh (NEEDS)		150		60	2
4	Deogarh (PRAVAH)		100	60	30	1
5	Khunti (NBJK)	387				1
6	Ranchi (WOTR)	160				1
7	E Singhbhum (TSRD)		50			1
	(TSRDS)					
8	Gumla (PRADAN)	350	85		190	2
9	Saraikela-Kharasawan (TSRDS)	52	60		90	3
Orissa						
10	Keonjhar (SHRISTI)	376	229	200		2

Other Income Generating Activities

Horticulture Plantations and Vegetable Cultivation

Many farmers in Sipringa, Teleya, Parsanowatoli and many villages in Raideh block of Gumla district have done mango plantations. There was serious problem of flower dropping in mango plants which was controlled by foliar spray of agribor for boron deficiency. The farmers were also advised for foliar spray of both zinc sulphate and agribor for good quality and higher mango yields. The recent survey revealed that Gumla is self-sufficient in mango production and no mango produce has come from outside market. The production has gone up in the area with more number of mango plantations have coming up. The mango varieties mainly grown are Amrapali for which yields are very good. Vermicompost and micronutrient application has been adopted by the farmers.

The space between the horticulture plants like mango was cultivated with vegetables like cabbage (Figure 8), tomato and onion etc. During rainy season 2011, tomato was grown in Gumla district under rainfed condition with addition of zinc sulphate, agribor and vermicompost along with DAP and urea The average yields in 5 villages under improved management practice with addition of micronutrients was almost 74% more as compared to farmers practice without micronutrients. (Table 23). Similarly in villages of Saraikela-Kharshaw district, farmers cultivated vegetables like cabbage, tomato and got higher benefits under improved management.

Table: 23. Effects of balanced nutrition on tomato yield in different villages of Gumla district, Jharkand during rainy season 2011

S. No.	Village	No of farmers	Tomato Yield (t ha^{-1})		% Increase over FP	LSD (5%)
			IP	FP		
1	Teleya	10	23.8	16.8	42	3.15
2	Marriumtoli	12	24.6	9.08	170	9.98
3	ParsaNowatoli	8	21.5	16.5	30	2.94
4	Sipringa	14	26.5	12.1	119	6.36
5	Parkartoli	6	10.2	6.92	47	4.47
	Total	**50**	**21.3**	**12.3**	**73.5**	

Figure 8. Cabbage cultivation between mango plantations in Sipringa village, Raideh block, Gumla district

Vermi-composting

Vermi- compost activity is fully active and each farmers is harvesting it 3 times in a year, each about 700-1000 kg. There are 87 units in many villages mainly Teleya, Sipringa, Tunjutoli and Parsa Novatoli producing higher quantity of compost. Training has been given to farmers for the preparation of vermi-compost using on-farm waste. Famers have arranged shades on their. The total quantity is utilized for growing the vegetables for which they are fetching good price. Each unit can produce about 350-1250 kg of vermicompost for producing the quality produce for getting higher price. A detail of vermicompost production during 2012 in Gumla district is given below (Table 24).

There are 10 units at sherbida and Jojo village of Sariekela-Kharshaw district and produced about 15 ton which his used basically for vegetable production. Farmers have grown vegetables with vermicompost which they used in cauliflower, tomato, okra and khera cultivation and got good benefit.

Table 24. Vermi-compost production during 2012 at different villages of Raideh block of Gumla district, Jharkand

S No.	Name of Farmers	Village	Tank Size	No. of Production Cycle	Total Production (KG)
1	Sukra Munda	Parsa Navatoli	12'*4'*1.5'	3	950
2	Dharma Munda	Parsa Navatoli	12'*4'*1.5'	3	950
3	Ranthu Munda	Parsa Navatoli	12'*4'*1.5'	3	950
4	Leta Munda	Parsa Navatoli	12'*4'*1.5'	2	500
5	Dashmu Munda	Parsa Navatoli	12'*4'*1.5'	2	550
6	Shivnath Singh	Sipringa	12'*4'*2.5'	2	820
7	Bandha Singh	Sipringa	12'*4'*2.5'	2	750
8	Malu Singh	Sipringa	12'*4'*2.5'	2	650
9	Sitaram Singh	Sipringa	12'*4'*2.5'	3	1050
10	Boli Singh	Sipringa	12'*4'*2.5'	2	550
11	Lalu Singh	Sipringa	12'*4'*2.5'	2	650
12	Bhukhan Singh	Sipringa	12'*4'*2.5'	2	730
13	Maghu Singh	Sipringa	12'*4'*2.5'	2	550
14	Lalku Munda	Sipringa	12'*4'*2.5'	2	800
15	Indar Singh	Sipringa	12'*4'*2.5'	2	650
16	Lahru Munda	Sipringa	12'*4'*2.5'	2	950
17	Mangru Munda	Sipringa	12'*4'*2.5'	2	850
18	Deonarayan Singh	Sipringa	12'*4'*2.5'	2	900
19	Bhagwat Singh	Sipringa	12'*4'*2.5'	2	700
20	Bishvanath Singh	Sipringa	12'*4'*2.5'	2	800
21	Dhaneswar Singh	Sipringa	12'*4'*2.5'	2	500
22	Pantu Singh	Sipringa	12'*4'*2.5'	1	400
23	Santu Singh	Sipringa	12'*4'*2.5'	2	550
24	Lal Munda	Teleya	12'*4'*2.5'	2	800
25	Ramesh Munda	Teleya	12'*4'*2.5'	3	650
26	Jhunu Oraon	Teleya	12'*4'*2.5'	3	1200
27	Kunti devi	Teleya	12'*4'*2.5'	2	450
28	Jayram Oraon	Teleya	12'*4'*2.5'	3	1000
29	Jageshwar Oraon	Teleya	12'*4'*2.5'	3	800
30	Rupeshwar Oraon	Teleya	12'*4'*2.5'	2	550
31	Birbal Oraon	Teleya	12'*4'*2.5'	3	1250
32	Libin Ekka	Teleya	12'*4'*2.5'	1	350
33	Jender Ekka	Teleya	12'*4'*2.5'	2	650
34	Bishnu Oraon	Teleya	12'*4'*2.5'	2	450
35	Jagdeo Oraon	Teleya	12'*4'*2.5'	3	750
36	Sankar Oraon	Teleya	12'*4'*2.5'	2	700

Figure 9.Vermicomposting units in Raidih block in Gumla, Jharkhand

Biomass Generation for Soil Fertility Management

Gliricidia, N-rich green manure is encouraged to grow as hedge on bunds to produce biomass from soil fertility point of view. During 2012-13, *Gliricidia* seeds were arranged for both the locations by ICRISAT, 2 kg each for Sariekela Karshaw and Gumla and also to SINI Partner locations location Kunti (0.5 kg), Keonjar (1 kg), Mandu (1 kg), Hazaribagh (0.5 kg), Needs Deoghar (2 kg), Pravah Deoghar (0.75 kg) and RDA Ghatsila (0.75 kg) were sent from ICRISAT. During 2012, 10000 seedlings were raised by women self-help groups (Mahila Samithi) and youth club members at Gumla and 6000 seedlings in Sariekela-karshaw district. Women groups were trained for raising the *Gliricidia* seedlings in polythene covers. Seeds are treated with acid for removing dormancy and planted in ploythene covers by adding soil mixed with fertilizer and vermi-compost. The seeds and polythene covers were provided to SHG groups and they have raised the nursery and sold to farmers at nominal prices to farmers. Many farmers planted the plants inside as hedge around their fields.

Earlier in 2010, around 7,000 seedlings were raised by women self-help groups (Mahila Samithi) and youth club members in Gumla (Teleya, Tunjtoli and Parsa nowatoli villages) and 5000 seedlings in Saraikela-Kharshaw (Sherbida, Masoodi and Jojo villages) district which were planted by around 20 farmers and those plants are now of 4 to 5 feet height and ready for lopping and field application. The lopping's of *Gliricidia* were applied by many farmers in paddy along with vermicompost without any chemical fertilizers and got good crop harvest.

Table 10. Gliricidia nursery at Teleya village (L), and Gliricidia planted as a fence in Sherbida village, Saraikela-Kharshaw district, Jharkand

Figure 11. Left: Glyricidia planted around horticulture plantation at Sherbida village, Sariekela-Karshaw district; Right: Grown hedge around vegetable growing field area at Teleya, Gumla district, Jharkand

Village Seed Bank

Women farmers have resorted to seed production as a livelihood activity and are thus also assisting maintaining and spreading improved crop seeds in the region. Farmers in both districts have established village seed banks and have stored different improved varieties of chickpea harvested during post-rainy season 2011-12. Jeewan Mahila Mandal women group members of seed bank in Teleya village of Raideh block of Gumla district committee stored seeds of chickpea varieties viz. KAK 2, ICCV 2 and JG 11 after proper seed treatment. Similarly, last year after rainy season, high yielding seed of paddy (Abishek), a drought tolerant early maturing variety was stored. Seed storage house for storing seeds and seed drums have been made available for proper storage. The women SHG's is having funds at around Rs. 25000/- and increasing it mainly through sales of seeds of paddy and chickpea. It provides support to all surrounding ~20 villages. The demand for chickpea seed particularly is rapidly growing every year as most of the farmers are using these improved seeds to grow chickpea and earning good by selling the green chickpea.

Water Harvesting Ponds for Lifting Agriculture

In addition to the activities like soil test-based nutrient management in crops, vermicomposting, biomass generation thru *Gliricidia*, improved crop varieties, seed priming etc; the construction of farm ponds to augment water for irrigation and fisheries has also received good attention from the beginning of the initiative. The ponds (40'*40'*40') are constructed on farmers own land with part contribution in cost by farmer also. The construction of pond costs about Rs 10,000/-. In Gumla district, 157 ponds have been constructed till date (Table 25). During the 2012-13 season, 500 g of fish seeds were released in each of the pond, and by end of a season, each pond contributed about Rs 6000/- to Rs 7000/- for farmers.

With augmented water, farmers have also started cultivating vegetables like tomato, cauliflower, cabbage, brinjal, okra, peas, potato and others during winter and summer seasons and that is also earning them the profit of Rs 8000/- Rs 10000/- in a bigha. With such benefits, the watershed model has now extended to many villages in Gumla district,

where farmers are constructing a farm pond in their own land with the support from government of Jharkhand, NGO and ICRISAT, and improving farm productivity and incomes.

Table 25. Village wise detail of farm ponds constructed in Gumla district (Raideh block), Jharkhand during 2010-1013

S. No.	Name of Village	No. of farm Ponds
1	Sipringa	6
2	Tunjtoli	3
3	Chapatoli	8
4	Teleya	35
5	Pogra	38
6	Sopo	12
7	Mariumtoli	12
8	Ghagra	1
9	Parsa	8
10	Patratoli	16
11	Cgapadih	5
12	Katkaya	13
	Total	**157**

Figure 12. Mr. Abraham at the percolation tank in Sipringa with fish culture and onion crop grown with support of tank water in Teleya village, 2013

Green gram as Summer Crop for Additional Income

With new learning, farmers are intensifying their cropping systems. In Gumla district, the farmers take post-rainy chickpea crop after paddy in rainy season. However, there remains a long gap between post-rainy chickpea and next rainy season crop and farmers are using this period to grow a short duration crop – green gram, which matures in about 70 days. During April, 2013, farmers cultivated green gram in 5 villages in Gumla district (Raideh block) in a total of ~3.6 ha area (Table 26). The average yield in different villages varied between 290 to 420 kg ha^{-1} with a mean of 370 kg ha^{-1} for 5 villages. This is a crop which is grown with little investment and thus fetches good returns in a short period of time, while being a leguminous crop builds soil health through adding nitrogen and enhanced biomass turnover.

Table 26. Grain yield of green gram grown in low lands of 5 villages in Gumla district (Raideh block), Jharkhand during summer 2013 season

S. No.	Village	Area (ha)	Grain yield (kg ha^{-1})
1	Sipringa	0.42	420
2	Sopo	0.60	400
3	Pogra	0.40	420
4	Teleya	0.36	320
5	Navatoli	1.80	290
	Total/Average	**3.58**	**370**

Figure 13. Snapshot of green gram grown in Sipringa village of Gumla district (Raideh block), Jharkhand during summer 2013 season

Capacity Building Activities

Farmer Trainings

A number of farmer trainings and farmer days were organized during 2011-12 which were not reported earlier (Table 27, Figure 14 to 17). Around 410 (250 in Gumla and 160 in Saraikela-Kharshaw) farmers were trained during rainy season 2011 on *Gliricidia* nursery raising, vermicomposting, soil test based nutrient management and best agricultural practices for paddy and other crops. Similarly, during post-rainy season 2011-12, more than 800 farmers in Gumla and 700 in Saraikela-Kharshaw were trained in seed priming in chickpea, improved chickpea varieties, soil test based nutrient management in chickpea and paddy, seed storage and best crop practices. The resource persons from KVK, DoA, and agricultural university along with ICRISAT, PRADAN and TSRDS trained the farmers.

Figure 14. Farmers training on chickpea seed priming technique at Sherbida village organized by TSRDS during November 2011

Table 27. Detail of training and farmer days programs and number of participants in the districts during 2011-12

District	Village	Training program	Date	No. of farmers
Saraikela-Kharshaw	Kanchanpur, Begnadhi, Lakhodhi and Rakakocha	Improved cropping, *Gliricidia* nursery raising, vermicomposting, seed priming and improved chickpea varieties, soil test based nutrient management	5-10 June 2011	160
Gumla	Shahitoli, Sipringa, Pogra, parkartoli and Teleya	Improved cropping, legume crop cultivation, *Gliricidia* nursery raising, vermicomposting, seed priming and improved chickpea varieties; soil test based nutrient management in rice	11-15 June 2011	250
Saraikela-Kharshaw	Kanchanpur,Begnadhi, Lakhodhi and Rakakocha	Seed priming in chickpea with *Rhizobium* culture and sodium molybdate; improved chickpea varieties, and nutrient management.	15-16 Oct 2011	150
Gumla	Shahitoli, Sipringa, Pogra, parkartoli and Teleya	Seed priming in chickpea with *Rhizobium* culture and sodium molybdate; improved chickpea varieties, and nutrient management	19-20 Oct 2011	120
Saraikela-Kharshaw	Masoodhi, Jojo	Nutrient deficiencies and soil test based balanced nutrition; vermicomposting; *Gliricidia* nursery raising; Seed priming in chickpea; crop cultivation of maize, pigeonpea, blackgram in uplands (thru farmer day)	21 and 22 Oct 11	250
Gumla	Marriamtoli	Nutrient deficiencies and soil test based balanced nutrition; vermicomposting; *Gliricidia* nursery raising; Seed priming in chickpea; crop cultivation of maize, pigeonpea, blackgram in uplands (thru farmer day)	24 Oct 11	300
Saraikela-Kharshaw	Lakhodhi and Kanchanpur	Best practice in rice crop through field day	21-22 Nov 2011	200
Gumla	Sipringa and Teleya	Best practice in rice crop through field day	24-25 Nov 11	250
Saraikela-Kharshaw	Kanchanpur, Begnadhi, Lakhodhi and Rakakocha	Chickpea and paddy Seed storage	22Feb 2012	100
Gumla	Shahitoli, Sipringa, Pogra, parkartoli and Teleya	Chickpea and paddy Seed storage	4 Mar 2012	150

Figure 15. Field day at Masoodhi village and Jojo village in Saraikela-Kharshaw district in Jharkand on 21 an 22 October 2011

Figure 16. Field day at Marriamtoli village, Raideh block and a display of paddy crop and vegetables grown using of micronutrients

Figure 17. Field day at Sipringa village, Raideh block and a visit to paddy crop and vegetables grown using micronutrients

Similarly, the detail of trainings during 2012-13 is given below (Table 28; Figure 18);

Figure 18. Training on Chickpea seed priming technique and Pheromone trap installation during the month of Oct Nov 2012 at Hazaribagh, Jharkand

Table 28. Detail of training programs organized in Jharkhand during 2012-13

District	Village	Training program	Date	No. of participating farmers
Sariekela-Karshaw	Kanchanpur, Begnadhi, Lakhodhi and Rakakocha	Seed priming technique for chickpea crop and awareness on micronutrient usage and vermicomposting	15-25 October 2012	300
Sariekela-Karshaw	Kanchanpur,Begnadhi, Lakhodhi and Rakakocha	Seed priming chickpea with Rhizobium culture and sodium molybdate and improved chickpea varieties, nutrient management.	05-10 Nov 2012	250
Gumla	Shahitoli, Sipringa, Pogra, parkartoli and Teleya	Seed priming chickpea with Rhizobium culture and sodium molybdate and availability on improved chickpea varieties, nutrient management	19-20 Oct 2012	350
Gumla	Sipringa and Teleya, Marriam toli, Sopo, Pogra	Seed priming chickpea with Rhizobium culture and sodium moly bdate and availability on improved chickpea varieties, nutrient management	24-25 Nov 2012	250
CINI Partner locations	Shristi Keomjar, NEEDS Deoghar, NBJK KHUNTI, SUPPORT	Seed priming chickpea with Rhizobium culture	October and November	500

	Mandu, RDS Ghatsil, SRMM Hazaribagh	and sodium moly bdate and availability on improved chickpea varieties, nutrient management		
CINI Partner locations	Shristi Keomjar, NEEDS Deoghar, NBJK KHUNTI, SUPPORT Mandu, RDS Ghatsil, SRMM Hazaribagh	Installation of pheromone traps and monitoring pest. DVD cd of IPM was also shown to farmers	Nov-Dec 2012	200
Gumla and Sariekela	Sipringa, Teleya, Sherbida and Jojo Sharmali	Chickpea and paddy Seed storage training	Feb 2012	200

Farmers' Days and Field Visit

During 2012-13, farmer's day was organized by PRADAN and ICRISAT at Teleya village, Raideh block, Gumla dist, Jharkhand on 06-03-2013. The main objective of the program was to highlight the advantage of seepage pits for supplemental irrigation for vegetable crops and fish cultivation and chickpea crop in rice fallow was visited by farmers. The officials from ICRISAT, PRADAN, Villages Sarpanch, Gram Seva members, Kissan club members, youth club members, Mahila mandal members and SHG groups from all the villages of the project area participated in it. More than 450 farmers from Bartoli, Pibo, Sopo, Jamgai, Tunjtoli, Tulmunga, Katkaya, Keradih, Shahitoli, Mariumtoli, Sipringa, Teleya, Unchdih, Khursuta, Parsa Navatoli, Patratoli and Pogra villages participated in the farmers' day. The farmers were guided in best practices like balanced nutrition, use of bio fertilizers, Gliricidia nursery raising, vermicomposting, farm ponds etc. Officials from SBI ensured farmers to support for crop loans.

Figure 19. Farmers' day in Teleya village, Raideh block, Gumla district, Jharkhand

Exposure Visit to ICRISAT

An exposure visit to ICRISAT was conducted for 46 farmers from Sariekela-Kharsawan, Bokaro and Jamshedpur districts of Jharkhand during 8 to 13 June, 2013 (Figure 20, 21). Farmers were exposed to improved technologies at ICRISAT campus and how farmers have adopted and benefited in nearby village Kothapally. Farmers were made to visit on-station

activities and interact with scientists. Farmers visited on-station watershed and understood the underlying principle. They learned in-situ and ex-situ conservation of rainwater. Farmers were shown tropicultor and other farm implements and how easily they can implement landform management to conserve soil structure and moisture. In current scenario of widespread soil degradation across the SAT, they learned about soil test-based nutrient management to improve productivity. Good discussions were held on rice fallows and farmers were guided about taking good chickpea crop after rice crop. They were told about improved chickpea varieties suitable for rice fallows in Jharkhand. Farmers also learned about improved varieties of pigeonpea, groundnut and other crops. They were also made to visit the experiments by Directorate of Rice Research and discussed with scientists about problems in paddy crop and best practices including suitable varieties for Jharkhand state. Scientists interacted with farmers on integrated pest management particularly in pigeonpea, groundnut and chickpea crops. During their visit, farmers had a hands-on training on making vermicompost and learned how vermicompost use can cut use and cost of chemical fertilizers while improved productivity and soil health. Farmers also learned about biomass generation through *Gliricidia* for improving soil fertility. They learned about raising *Gliricidia* nursery, planting, chopping and incorporation of *Gliricidia* biomass. In addition farmers visited gene bank of ICRISAT and saw huge genetic variability across the crops. Farmers were also given hands on training of IPM techniques and seed treatment for sowing.

In addition to on-station activities, farmers were made to visit the nearby Adarsha Watershed Kothapally, where farmers have adopted the best practices and improved crop productivity and their livelihoods. The visiting farmers interacted with local farmers and that boosted their confidence that they can also replicate the success story. Farmers learned there how water table of the village is improved with simple in-situ, ex-situ structures. They were impressed with the simple low-cost recharging pits to fill their wells having hard strata. They saw how increased water availability has improved crop yields and enabled farmers to shift to high value agriculture. Farmers from Jharkhand saw in Kothapally farmers' fields the benefits of best practices like improved cultivars, IPM, vermicomposting and others. Farmers witnessed the importance of related activities intended to improve cattle breed, increase fodder availability and that has significantly increased milk production and incomes for farmers. This visit to Kothapally as told by farmers themselves boosted their confidence and they were now planning to implement all learnt technologies in their fields.

At the end of the visit and training program, there was an interaction with scientists to solve their queries. Farmer was very happy with exposure visit to ICRISAT and assured that they will adopt most of the technologies and guide other fellow farmers in the region.

Figure 20. Learning improved technologies to improve productivity and livelihoods - Left: on-station watershed at ICRISAT; Right: Adarsha watershed Kothapally

Figure 21. Hands-on training for Jharkhand farmers at ICRISAT – Left: seed treatment; Right: IPM techniques

Scaling-up Activities in Jharkhand during 2012-13

An initiative "Increasing Agricultural Productivity of Farming Systems in Parts of Central India through Participatory Research-cum-Demonstrations and Knowledge Sharing Innovations – Farmer Participatory trials for Up-scaling with CINI partners in Jharkhand" was undertaken for expanding the technology to other districts of Jharkhand.

In order to initiate activity Dr Wani along with Mr Sudipto Das of CINI visited Kherwa village in Paljor block of Deoghar district in Jharkand and interacted with famers and also visited fields. The farmers told in the meeting that they are getting poor yields and need support for improving the crop yields and livelihood. The soils of the region are eroded and shallow. The main crop grown in this area is paddy in the rainy season and summer vegetables in small areas. The villages also told there is acute shortage of drinking water and woman get water from distant places. Dr Wani advised farmers to grow chickpea with seed priming immediately after rice crop which has been successfully implemented in Gumla and Saraikela-Kharshaw districts. He also reiterated the need to apply deficient secondary and

micronutrients and grow green manure plant *Gliricidia* as hedge for biomass generation from soil fertility point of view.

Figure 22. Dr. Wani in meeting with farmers in Kherwa village in Palajor block, Deoghar district, Jharkhand during January 2012

Figure 23. Dr. Wani in meeting with farmers in Kherwa village in Palajor block, Deoghar district and a summer tomato crop with well irrigation in the month of January 2012

Figure 24. Soil profile with very low soil depth and a degraded fields in Kherwa village in Palajor block, Deoghar district, Jharkand during January 2012

Visit of SRTT Review Team to Gumla

SRTT reviewers' team comprising Dr Diet, Ms Varthika Jain, Ms Mala Roy and Mr Kiran Pitare along with Dr SP Wani visited Parsa Navatoli and Sipringa villages on 29th December 2011 for reviewing ongoing activities. In meeting, farmers eagerly displayed harvested paddy grains, and vegetables grown using vermicompost and micro nutrient application. Farmers happily shared project benefits they are deriving through the interventions like micronutrient treatment and vermicompost use in vegetables crops. They also told that they are getting higher yields in paddy and benefitted with additional crop of chickpea which is supporting their income. The horticulture plantations specially mango cultivations are increasing and use of foliar spray of micronutrient zinc-sulphate and agribor benefitted a lot. They were also very happy with maize crop diversification and more returns from sale of green cob. The team visited and saw themselves the vegetable crops, vermicomposting units, seepage tanks and vegetable seedling nursery. The farmers informed that working in a group has eased their marketing problem and were able to get good price. Farmers expressed the requirement of some more water harvesting and soil and water conservation structures for their fields. The review team was very happy and satisfied hearing the benefits of project expressed by farmers during the visit.

Figure 25. Farmer meeting in Parsa Novatoli village and Dr. Wani advising farmer in best practices for tomato crop at Sipringa village

Figure 26. Dr Wani and SRTT team interacting with farmers during the visit

Madhya Pradesh

Productivity Enhancement Interventions

Weather Monitoring

The data was recorded during the year 2012 for rainfall events with the help of rain gauge installed at the on-farm sites (Table 29).

Table 29. Monthly rainfall received during 2012 at Mandla and Jhabua in Madhya Pradesh

Month	Rainfall (mm)	
	Jhabua	Mandla
January	0	0
February	0	0
March	0	0
April	0	0
May	0	0
June	12	11
July	346	625
August	657	448
September	355	158
October	0	25
November	0	20
December	0	0

2011-12 Post-rainy Season Farmer Participatory R4D Trials

In order to improve agricultural productivity in the target region, on-farm trials were conducted during post-rainy season 2011-12 (Table 30). The trials were conducted in a participatory mode to evaluate and demonstrate the need based improved technology. The inputs like secondary and micro nutrients were arranged by ICRISAT on a cost sharing basis. Prominent technologies evaluated in participatory mode included – balanced (BN) and integrated nutrient management (INM) involving secondary and micro nutrients plus vermicompost; residual effects of secondary and micronutrients; residual effects of integrated nutrient management involving the use of vermicompost. The BN practice was scaled up in large number of farmers' fields. In addition, water use efficiency through balanced nutrition trials were conducted in Jhabua and Mandla districts.

Table 30. Detail of participatory research and development (PR and D) trials conducted under SRTT in Jhabua, Madhya Pradesh, India during post- rainy season 2011-12

S.No.	Trial type	Crop(s)	Jhabua	Mandla
1	Balanced and integrated nutrient management involving secondary and micro nutrients	Chickpea,	5	15
		Wheat	11	15
2	Residual effects of secondary and micro nutrients	Chickpea,	7	5
		Wheat	13	15
3	Residual effects of integrated nutrient management involving the use of vermicomposting	Chickpea,	5	3
		Wheat	5	7
4	Scaling up of balanced nutrition	Chickpea,	-	25
		Wheat	60	-
	Total		**106**	**85**

Balanced and Integrated Nutrient Management Trials

On-farm trials were conducted on the use of on-farm produced vermicompost as a source of plant nutrients to partially replace chemical fertilizers. Vermicompost was added on the basis to replace 50% of N requirement in non-legumes and 50% of P requirement in legumes. There were three treatments: (1) Farmer's practice (FP) of application of N, P and K, (2) Balanced nutrition (BN) involving application of FP + S + B + Zn and (3) 50% dose of BN+VC (INM). These treatments were imposed on adjoining plots measuring 2000 m^2. Applications of S, B, Zn and vermicompost were made as basal at sowing of the crop.

The benefit of BN treatment over the FP was evident as increased grain and straw yield of chickpea and wheat crops both in Jhabua and Mandla districts (Figure 27 and 28). Chickpea grain yield increased by 5% both in Jhabua and Mandla, while wheat grain yield increased by 2% in Jhabua and 9% in Mandla. But, the INM treatment of partially replacing chemical fertilizers with the VC proved better over the BN treatment in terms of grain and straw yield advantage. Under the INM treatment, chickpea yield increased over the FP by 11% in Jhabua and 5% in Mandla district, and wheat yield increased by 6% in Jhabua and 8% in Mandla district. The results showed INM approach superior over the BN by way of cutting the use and cost of chemical fertilizers and still getting higher yields than the BN of applying nutrients solely through chemical fertilizers. Moreover, INM leads to a very efficient nutrient recycling through vermicomposting of on-farm wastes.

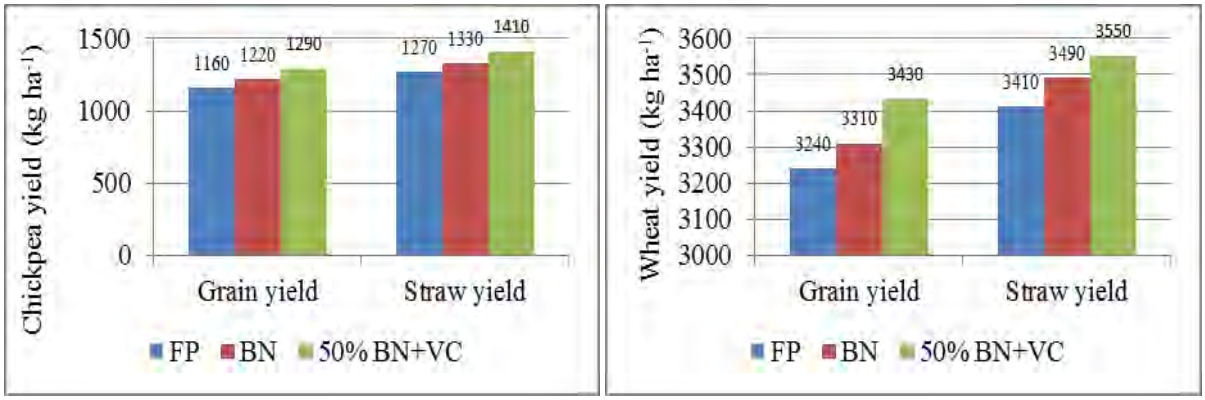


Figure 27. Effects of balanced nutrition (BN) and integrated nutrient management (INM) on chickpea (left) and wheat (right) yield in Jhabua, post-rainy season 2011-12

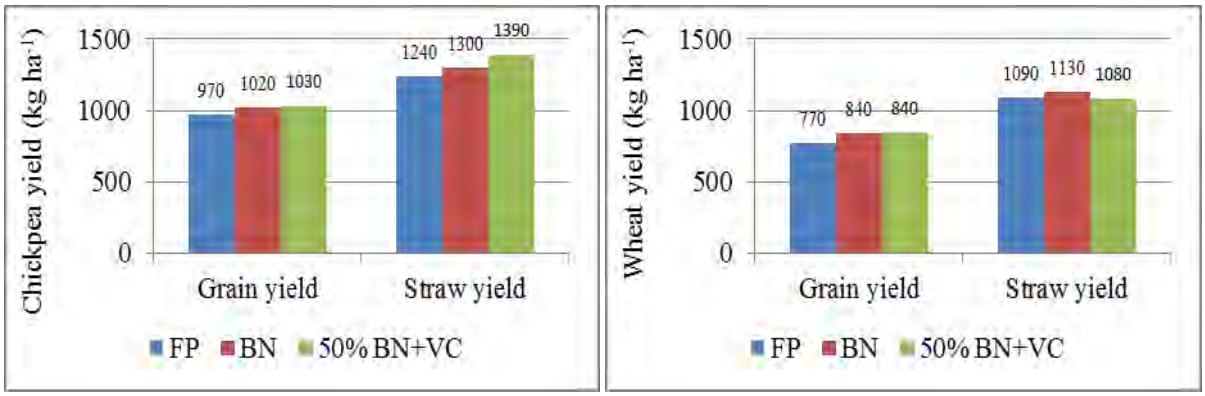


Figure 28. Effects of balanced nutrition (BN) and integrated nutrient management (INM) on chickpea (left) and wheat (right) yield in Mandla, post-rainy season 2011-12

Residual Benefits of Secondary and Micronutrients

Keeping in mind the small quantities of the micronutrients required and their residual effects, the participatory on-farm trials were conducted in 2011-12 post-rainy season to determine the residual effects of the S, B and Zn applied in 2010 rainy season, 2010-11 post-rainy season and 2011 rainy season. The 1, 2 and 3 season residual benefits were evident in increase in grain and straw yield as compared with the FP treatment (Table 31).

Table 31. The residual effects of sulphur + boron + zinc applied in on the crop yield in Jhabua and Mandla districts in Madhya Pradesh, post-rainy season 2011-12

District	Crop	No. of trials	Grain yield (kg ha^{-1})		LSD (5%)	Straw yield (kg ha^{-1})		LSD (5%)
			FP	BN		FP	BN	
S, B and Zn applied in rainy season 2011								
Mandla	Chickpea	2	1050	1080	413	1170	1250	604
Mandla	Wheat	8	740	760	19.1	1230	1260	20.2
S, B and Zn applied in post-rainy season 2010-11								
Jhabua	Chickpea	4	950	1000	65.0	1010	1050	76.2
Jhabua	Wheat	6	3150	3200	33.2	3460	3500	69.7
S, B and Zn applied in rainy season 2010								
Jhabua	Chickpea	3	1000	1100		1050	1133	71.7
Jhabua	Wheat	7	3130	3180	26.7	3370	3440	143
Mandla	Chickpea	3	970	910	453	1180	1220	330
Mandla	Wheat	7	760	790	8.74	1190	1140	187

Residual Effects of INM involving the use of Vermicomposting

The residual benefits were also studied in integrated nutrient management options involving the use of vermicompost in chickpea and wheat crops in Jhabua and Mandla districts (Table 32). The balanced nutrition through chemical fertilizers as in other trials increased chickpea and wheat grain yield over the farmers practice by 2 to 7%. The plot having vermicompost addition on the basis of replacing 50% N requirement in wheat and 50% P requirement in chickpea, resulted a 3 to 10% increase in crop grain yield. The study thus proved that vermicompost should be used to cut cost on chemical fertilizers, through better recycling of farm wastes resulting higher yields than sole use of chemical fertilizers even in balanced way.

Table 32. Residual effects of balanced nutrient management (BN, nutrients added through chemical fertilizers) and INM on crop yield under rainfed conditions in Jhabua, Madhya Pradesh, post-rainy season 2011-12

District	Crop	No. of trials	Grain yield (kg ha^{-1})			LSD (5%)	Straw yield (kg ha^{-1})			LSD (5%)
			FP	BN	50% BN+VC		FP	BN	50% BN+VC	
S, B and Zn applied in rainy season 2011										
Jhabua	Chickpea	5	980	1050	1080	48.0	1070	1130	1120	35.2
Jhabua	Wheat	5	3250	3300	3350	55.7	3340	3500	3540	175
Mandla	Chickpea	3	860	920	900	57.9	1390	1470	1460	25.8
Mandla	Wheat	7	730	780	764	17.1	1210	1280	1270	24.7

Scaling Up of Balanced Nutrition

Scaling up of soil test based application of S, B and Zn along with improved cultivar was done in 60 farmers' fields (wheat) in Jhabua and 25 farmers' fields (chickpea) in Mandla district (Figure 29).

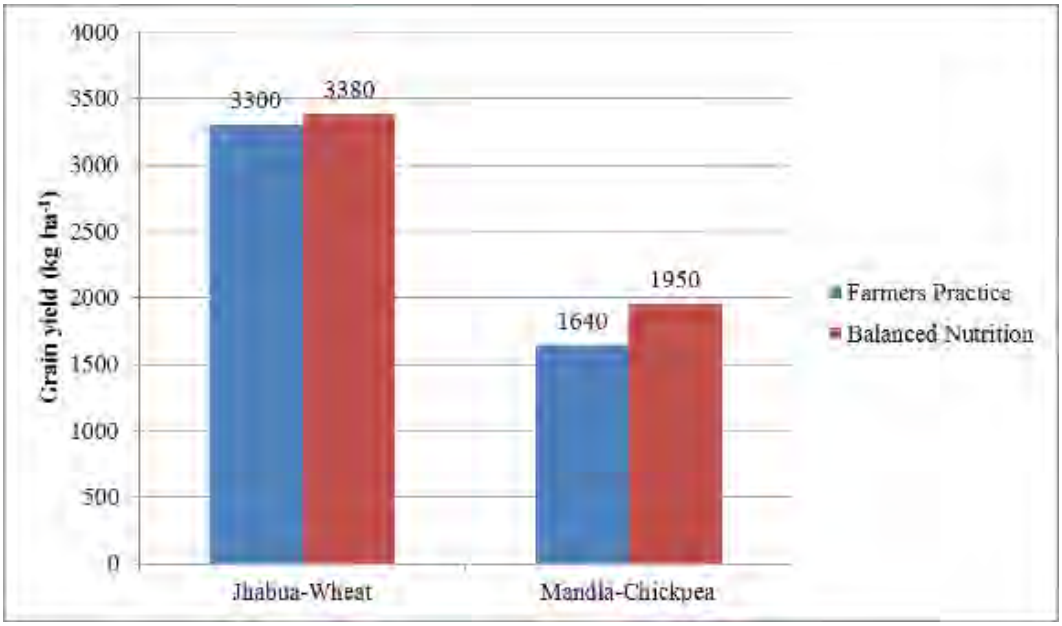


Figure 29. Scaling up of soil test-based balanced nutrition in Madhya Pradesh, India, post-rainy season 2011-12

2012 Rainy Season Farmer Participatory R4D Trials

In order to improve agricultural productivity in the target region, on-farm trials were conducted during rainy season 2012 (Table 33). The trials were conducted in a participatory mode to evaluate and demonstrate the need based improved technology. The inputs like secondary and micro nutrients were arranged by ICRISAT on a cost sharing basis. Prominent technologies evaluated in participatory mode included – balanced nutrient (BN) management involving secondary and micro nutrients along with primary nutrients N, P and K; residual effects of secondary and micronutrients.

Table 33. Detail of participatory research and development (PR &D) trials conducted under SRTT project in Madhya Pradesh, India during rainy season 12

S. No.	Trial type	Crop	District	No. of trials
1	Balanced nutrient management involving secondary and micro nutrients	Paddy	Mandla	50
		Soybean	Jhabua	21
		Maize	Jhabua	16
		Groundnut	Mandla	5
2	Residual effects of S, B and Zn			
	Applied in post-rainy 2011-12	Soybean	Jhabua	4
	Applied in post-rainy 2011-12	Paddy	Mandla	4
	Applied in rainy 2011	Soybean	Jhabua	4
	Applied in rainy 2011	Paddy	Mandla	4
	Applied in post-rainy 2010-11	Soybean	Jhabua	4
	Applied in post-rainy 2010-11	Paddy	Mandla	4

Balanced Nutrient Management Trials

On-farm trials were conducted to evaluate soil test based addition of S, B and Zn along with N, P and K. There were two treatments: (1) Farmer's practice (FP) of application of N, P and K, (2) Balanced nutrition (BN) involving application of FP + S + B + Zn. These treatments were imposed on adjoining plots measuring 2000 m^2. Due to delay in soil application of S, B and Zn, these have been applied to crops through foliar application of zinc sulphate (0.5%) and agribor (0.1%) twice during crop growth period (Figure 30).

Figure 30. Foliar application of micronutrients in standing crops in Katangsivni, Mandla (left); and Shivgarh, Jhabua (Right)

The benefit of BN treatment over the FP was evident as increased crop grain and straw yield both in Jhabua and Mandla districts (Table 34; Figure 31). As such crop grain/pod yield increased by 19% in soybean, 8% in maize, 3% in paddy and 22% in groundnut as compared with the FP. Similar increase in straw yield (1 to 20%) was also recorded across all the crops.

Table 34. Effects of balanced nutrient (BN) and farmer's practice (FP) treatment applications on crop yield in Madhya Pradesh, rainy season 2012

District	Crop	No. of trials	Grain/pod yield (kg ha^{-1})		LSD (5%)	Straw yield (kg ha^{-1})		LSD (5%)
			FP	BN		FP	BN	
Jhabua	Soybean	21	1150	1370	51.7	1070	1160	28.3
	Maize	16	2960	3190	37.5	3000	3040	29.9
Mandla	Paddy	50	3920	4050	56.5	2990	3190	61.1
	Groundnut	5	270	330	30.8	350	420	40.7

Figure 31. Farmers' practice (left) vs balanced nutrition (right) with soybean crop in Jhabua

Residual Benefits of Secondary and Micronutrients

Keeping in mind the small quantities of the micronutrients required and their residual effects, the participatory on-farm trials were conducted in 2012 rainy season to determine the residual effects of the S, B and Zn applied in 2010-11 post- rainy season, 2011 rainy season and 2011-12 post-rainy season. The 1, 2 and 3 season residual benefits were evident in increase in grain and straw yield as compared with the FP treatment (Table 35). In case of paddy crop in Mandla district, the residual effect were seen as increased grain yield under BN added plots – by 4% in post-rainy-2010-2011 added plots, 7% in rainy-2011 plots and 12% in post-rainy-2011-2012 plots. Similarly in soybean crop in Jhabua, the residual effect were seen as increased grain yield under BN added plots – by 12% in post-rainy-2010-11 added plots, 13% in rainy-2011 plots and 27% in post-rainy-2011-12 plots.

Table 35. The residual effects of sulphur + boron + zinc applied in the 2010 rainy season on crop grain and straw yield in Madhya Pradesh, rainy season 2012

District	Crop	No. of trials	Grain yield (kg ha^{-1})		LSD (5%)	Straw yield (kg ha^{-1})		LSD (5%)
			FP	BN		FP	BN	
1 Season (S,B and Zn applied in post-rainy-2011-2012)								
Jhabua	Soybean	4	1130	1430	113	1050	1180	138
Mandla	Paddy	4	3690	4150	928	3380	3450	200
2 Seasons (S,B and Zn applied in rainy-2011)								
Jhabua	Soybean	4	1000	1130	103	940	1150	100
Mandla	Paddy	4	3810	4080	303	3310	3710	275
3 Seasons (S,B and Zn applied in post-rainy-2010-2011)								
Jhabua	Soybean	4	980	1100	79.6	960	1080	100
Mandla	Paddy	4	3680	3830	158	3290	3300	171

2012-13 Post-rainy Season Farmer Participatory R4D Trials

During the post-rainy season 2012-13, participatory trials for impact were conducted on aspects of balanced nutrition, water use efficiency, and residual effects of balanced nutrition (Table 36).

Table 36. Detail of trials conducted in Madhya Pradesh during post-rainy season 2012-13

SNo	Trial type	Crop	District	No. of trials
1	Balanced nutrient management involving secondary and micronutrients	Chickpea	Jhabua, Mandla	31
		Wheat	Jhabua, Mandla	58
2	Water use efficiency trials	Chickpea	Mandla	3
3	Residual effects of S, B and Zn			
	Applied in rainy 2012	Chickpea	Jhabua	3
		Wheat	Jhabua	4
	Applied in post-rainy 2011-12	Chickpea	Jhabua, Mandla	8
		Wheat	Jhabua	4
	Applied in rainy 2011	Chickpea	Jhabua, Mandla	8
		Wheat	Jhabua	4
4	Scaling up trials	Chickpea	Jhabua, Mandla	21
		Wheat	Jhabua, Mandla	78

The scaling up trials on balanced nutrition were also conducted to evaluate and demonstrate benefits on a large number of farmers' fields. A total of 222 trials were conducted in SRTT locations of Jhabua and Mandla in Madhya Pradesh during the post-rainy 2012-13 season as per details in Table 30.

Balanced Nutrient Management Trials

In the context of widespread deficiencies of multiple nutrients, farmer participatory trials were conducted to evaluate soil test-based addition of sulphur (S), boron (B) and zinc (Zn) in addition to nitrogen (N), phosphorus (P) and potassium (K). There were two treatments: (1) Farmer's practice (FP) of application of N, P and K; and (2) Balanced nutrition (BN) involving application of FP + S + B + Zn. These treatments were imposed on adjoining plots measuring 2000 m^2. All nutrients including S, B, Zn were added as basal at sowing time, except N in non-legumes in two equal splits at sowing and one month after sowing. At maturity, yield was estimated both in FP and BN treatments in a 3m X 3m sub-plot and converted into kg ha^{-1}. The results of trials during post-rainy 2012-13 season with chickpea and wheat crops are presented in Table 37; Figure 32.

Results of on-farm trials showed significant yield improvement with soil test-based application of deficient S, B and Zn plus N, P and K (BN) as compared with farmers' practice of adding only N, P and K in both chickpea and wheat crops (Table 37). There was an improvement up to 20% in grain yield of chickpea, while it was up to 10% in the case of wheat. Similarly, straw yield also increased up to 14% in chickpea crop, and by 6% in wheat crop.

Table 37. Effects of balanced nutrient (BN) and farmer's practice (FP) treatment applications on crop yield in Madhya Pradesh, post-rainy season 2012-13

District	Crop	No. of trials	Grain/pod yield (kg ha-1)		LSD (5%)	Straw yield (kg ha-1)		LSD (5%)
			FP	BN		FP	BN	
Jhabua	Chickpea	20	1180	1420	51.6	1450	1550	40.5
Mandla	Chickpea	11	840	900	33.4	350	430	42.0
Jhabua	Wheat	40	2810	3020	48.4	2790	2940	72.5
Mandla	Wheat	18	1110	1230	33.9	1250	1330	17.9

Figure 32. Balanced nutrient managed plots in Jhabua; Left: Chickpea crop; Right: Wheat crop

Water Use Efficiency Trials

Keeping in mind scarce water resources in the semi-arid tropics (SAT) and projected water scarcity in view of the looming climate change scenario, increasing water use efficiency (WUE) in crop production is a priority for scientists. Balanced nutrition is one of the important water management strategies to enable plants to effectively utilize available water and convert unproductive evaporation into productive transpiration. In Vertisols of SAT, landform management like broad bed and furrow (BBF) or conservation furrow (CF) offers significant opportunity to enhance WUE. Findings of post-rainy 2012-13 season trials in Mandla district showed the benefit of BN+CF/BBF treatment in increased grain yield of chickpea by 8% over farmers' practice (Table 38). The increased grain yield under improved practice is recorded from the same water resources as under farmers' practice, thereby increasing food production per drop of water or water use efficiency.

Table 38. Effects of nutrient and landform management practices on crop yield/WUE in Madhya Pradesh, post-rainy season 2012-13

District	Crop	No. of trials	Grain/pod yield (kg ha^{-1})		LSD (5%)	Straw yield (kg ha^{-1})		LSD (5%)
			FP	BN+CF/BBF		FP	BN	
Mandla	Chickpea	3	790	860	37.9	320	370	32.9

Residual benefits of secondary and micronutrients

The deficient secondary and micronutrients S, B and Zn are recommended for application only once in 2 years. Therefore, on-farm trials were conducted to document the benefits of previously added S, B and Zn. During the 2012 rainy season, residual effects were studied in plots where S, B and Zn were added during 2012 rainy season (1 season before), 2011-12 post-rainy season (2 seasons before) and 2011 rainy season (3 seasons before). The 1, 2 and 3 season residual benefits were evident in increased grain and straw yield both in chickpea and wheat crops as compared with the FP treatment (Table 39). In case of chickpea, the residual benefit in grain yield was to the tune of 22% after one season, 13 to 18% after two seasons, and 9 to 17% after three seasons. Similarly in wheat grain yield, the residual benefit in grain yield was 9% after one season, 6% after two seasons and 7% after three seasons. In addition to grain yield, residual effects of S, B and Zn were also recorded in straw yield both in chickpea and wheat crops.

Table 39. The residual effects of sulphur + boron + zinc on crop grain and straw yield in Madhya Pradesh, post-rainy season 2012-13

District	Crop	No. of trials	Grain yield (kg ha^{-1})		LSD (5%)	Straw yield (kg ha^{-1})		LSD (5%)
			FP	BN		FP	BN	
1 Season (S, B and Zn applied in rainy-2012)								
Jhabua	Chickpea	3	1150	1400	248	1370	1480	71.7
Mandla	Chickpea	-	-	-	-	-	-	-
Jhabua	Wheat	4	2790	3050	193	2680	3020	221
2 Seasons (S, B and Zn applied in post-rainy-2011-12)								
Jhabua	Chickpea	4	1160	1380	164	1460	1580	100
Mandla	Chickpea	4	790	890	180	300	360	123
Jhabua	Wheat	4	2810	2980	100	2690	2990	195

3 Seasons (S, B and Zn applied in rainy-2011)								
Jhabua	Chickpea	4	1175	1375	252	1550	1625	200
Mandla	Chickpea	4	830	900	92.9	320	360	49.5
Jhabua	Wheat	4	2925	3125	225	2860	2925	590

Scaling-Up of Balanced Nutrition

With a view to evaluate and demonstrate the benefits of soil test-based application of deficient nutrients to a large number of farmers to bring in the impact in the region, a large number of scaling-up trials were conducted in both Jhabua and Mandla districts in Madhya Pradesh. Trials were conducted in the format of balanced nutrient management trials described earlier. At maturity, yield data was recorded from farmers.

Results of scaling-up trials are presented in Table 40. Data show that farmers recorded 13 to 22% higher grain yield in chickpea and 6 to 8% higher grain yield in wheat by following balanced nutrition as compared with farmers' practice.

Table 40. Scaling up of soil test-based balanced nutrition in Madhya Pradesh, India, post-rainy season 2012-13

District	Crop	No. of trials	Grain yield (kg ha^{-1})		LSD (5%)
			FP	BN	
Jhabua	Chickpea	15	1150	1400	64.4
Mandla	Chickpea	6	910	1030	115
Jhabua	Wheat	68	2790	3020	27.9
Mandla	Wheat	10	1140	1210	30.8

2013 Rainy Season Farmer Participatory R4D Trials

Rainy season plans to conduct total 249 farmers participatory trials were prepared in consultation with the partners in Mandla and Jhabua districts, Madhya Pradesh (Table 41). In Mandla district, a total of 62 trials are being conducted with paddy crop; while in Jhabua district, a total of 187 trials are being conducted with maize and soybean crops. The prominent technology to evaluate/demonstrate/scale-up is soil test-based balanced nutrition. In addition, in some of the selected fields, residual benefits of previously added (during last 3 seasons) S, B and Zn will also be evaluated.

Table 41. Detail of trials planned and being conducted in Madhya Pradesh during rainy season 2013

S. No.	District	Trial type	Crop	No. of trials
1	**Mandla**	BN	Paddy	30
	FES	Scaling up	Paddy	20
		Residual (1, 2, 3 seasons)	Paddy	12
2	**Jhabua**	BN	Maize	25
	GVT		Soybean	75
		Scaling up	Maize	25
			Soybean	50
		Residual (1, 2, 3 seasons)	Maize/Soybean	12
	Total			**249**

Other Income Generating Activities

Diversification including with High-value Vegetables with Micronutrient

In Mandla district, scientist from ICRISAT participated in farmers' day. During farmers' day a group of female farmers of Bharadwara Maal village and farmers from other villages were organized and motivated to start vegetable cultivation. They were thoroughly guided on best practices of vegetable cultivation and assured support throughout the season. Through project, seeds of vegetables and fertilizers such as gypsum, zinc sulphate and agribor were provided to farmers. Details of type of vegetables seeds and total quantity of seed provided in Mandla district are as follows (Table 42);

Table 42. Detail of vegetable seeds (kg) provided to farmers in Mandla district, Madhya Pradesh

S. No.	Crop	Quantity of seed (kg)
1.	Tomato	1
2.	Brinjal	1
3.	Capsicum	1
4.	Spinach	4
5.	Fenugreek	7

Three female farmers of Bharadwara Maal village raised the nursery 500 gm each of tomato, brinjal, capsicum and fenugreek (5 kg) and spinach (2 kg). Female farmer's group and other farmers raising nursery were also provided with fertilizers such as Sulton (S), Zinc sulphate (Zn) and Agribor (B). Farmer wise seed and fertilizers provided in Mandla district for nursery are mentioned in Table 43 as below.

Table 43. Detail of farmers (groups) and inputs distributed for nursery raising in Mandla district, Madhya Pradesh

S. No.	Farmers Name	Village	Seed provided (gm)				
			Tomato	Brinjal	Capsicum	Spinach	Fenugreek
1.	Group of female farmers (Chhatarvati Bai, Kunti Bai and Ginda Bai)	Bhardwara Maal	500	500	500	2000	5000
2.	Gohra Singh^	Katangsivni	250	250	250	1000	1000
3.	Zaaduram*	MawaiMaal	100	100	100	1000	1000
4.	Chain Singh	MawaiRayat	150	150	150	-	-

^Capsicum seed not sown; *Capsicum seedlings in nursery damaged due to frost in January, 2013

Prior to starting the activity, training on seed bed preparation and nursery raising for vegetables was organized for farmers. As discussed in the farmers meetings, the seeds were given free of cost to farmers with the condition to sell seedlings to other farmers at a discounted rate. By now, around 1000 seedlings were sold to 10 farmers in 3 villages. The group of female farmers sold seedling to other farmers as per detail given below (Table 44);

Table 44. Detail of vegetable seedlings sold by women group

S. No.	Vegetable	No. of seedlings provided	No. of farmers	No. of villages
1.	Tomato	620	8	3
2.	Brinjal	150	2	2
3.	Capsicum	170	Seedlings damaged due to frost in the month of January, 2013.	

The female farmers' group informed that they are able to fulfill vegetable requirement of family and surplus production will be sold in the market. Important advantage of vegetable cultivation in village is availability of fresh vegetable in the same village for which otherwise peoples needed to go 12-15 km to purchase that.

Figure 33. Left: women farmers irrigating vegetable bursary; Right: Fruiting in tomato

Forage Cultivation

A cattle rearing is done in almost each and every farming household in the target region, however scarcity of fodder particularly in post-rainy season is a problem affecting cattle nutrition and productivity. In this context improved varieties of fodder are promoted in the region to ensure sufficient fodder for cattle (Table 45). Berseem as a forage crop was promoted to be cultivated by 19 farmers in 6 villages of Jhabua district. Similarly in Mandla district, 4 farmers were motivated to grow berseem and seeds were distributed. But only one farmer has grown Berseem on about 2000 m^2 area, while rest farmers could not do due to insufficient moisture and plan to do the next year.

Table 45. Detail of fodder promotion activity in Jhabua and Mandla districts, Madhya Pradesh

S. No.	District	NGO	No. of farmers	No. of villages	Area (ha)
1.	Jhabua	GVT	19	6	0.72
2.	Mandla	FES	4	2	0.20

Animal Deworming/Vaccination and Health Camp

Backyard poultry rearing is common practice in project area of Mandla district. In *Kharif* season, while conducting farmers' day farmers raised the issue of "Ranikhet" diseases in

chicks. Therefore during farmers' day, it was decided by scientist of ICRISAT to organized poultry vaccination camp in the month of November, 2012. Accordingly, poultry vaccination camp was organized in six villages (Katangsivni, MawaiMaal, Mawai Rayat, Bharadwara Maal, Bharadwara Rayat and Padarpaani) in Mandla district. During poultry vaccination camp around 628 chicks/birds were vaccinated.

Similarly, one animal health camp was organized in Jhabua district and about 145 animals of 115 farmers were treated. Two more animal health camps in Jhabua are proposed. Details of Animal health Camp and chicks vaccinated are presented in Table 46.

Table 46. Detail of animal health camps organized in Jhabua and Mandla districts, Madhya Pradesh

S. No.	Date	Village(s)	District	NGO	Number of animals treated/vaccinated
1.	18/03/13	Nawapada Bhandariya	Jhabua	GVT	145
2.	08/11/12	All six villages	Mandla	FES	628

In addition to the camps organized, still 2 more are planned in Gopalpura and Gadwara villages in Jhabua district to be organized by end of March or beginning of April.

Figure 34. Cattle expert vaccinating, Left: Goat in Jhabua district; Right: Poultry bird in Mandla district

Vermicomposting

During the year 2012, the vermicomposting units were monitored for compost preparation. In Jhabua (Figure 23), 39 farmers (Gundipada-6; Manpura-10, Hatyadeli-7, Gadwara-16) produced 6600 kg vermicompost. Five farmers out of 39 earned additional income by selling 1500 kg vermicompost @ Rs 4/- per kg as per the detail in Table 47.

Table 47. Detail of vermicompost sale by farmers in Jhabua district during 2012

S. No.	Farmer Name	Village	Vermicompost sold (kg)	Income generated (`)
1.	RamlaPuniya	Gundhipada	500	2000/-
2.	OmkarDhuliya	Gundhipada	400	1600/-
3.	RamchandraMangaliya	Gundhipada	200	800/-
4.	CheniyaRoopa	Manpura	200	800/-
5.	PunjiNanaji	Manpura	200	800/-

Figure 35. Vermicomposting unit of farmers in Jhabua district (clockwise) – Mr Bhurji Parmar in Gundipada village; Ms Shanu Parmar in Gundipada village; Mr Kailash Sawaliya in Hatyadeli village; and Mr Andru Makna in Gadwada village

Similarly, in Mandla district, 11 farmers (out of 23) successfully operated their units constructed under the initiative and produced 11500 kg vermicompost during 2012 which they used for crop production and cut cost of chemical fertilizers.

Biomass Generation for Soil Fertility Management

Gliricidia is a fast growing green leaf manure tree. The nutrient rich foliage can be used as green manure which adds plant nutrients and organic matter to the soil and increase crop productivity on infertile and degraded soils. It also increases nutrient availability in the soil due to production of carbon dioxide and organic acids during decomposition of the plant material. Leaves also have insect repellent properties. Keeping this in mind, *Gliricidia* nursery was raised and distributed to farmers in Jhabua during 2011. This year, the plants are being established on other farmers' fields through cuttings from established (Figure 24) plants of last year.

Figure 36. Gliricidia planted along the fence in farmer' Mr Walchand Vesiya's land in Khedi village in Jhabua, Madhya Pradesh

Village Seed Bank

In Mandla district, 2 seed banks at Katangsivni and Mawai Rayat villages are operating. Each seed bank has a committee of 11 farmers to manage the affairs of bank. Seed bank at both the locations are maintaining and distributing among farmers the improved seeds of chickpea (JG 11), wheat (HI 1500), groundnut (ICGV 0035, ICGV 51114) and pigeonpea (ICPL 88034). In Mandla district during rainy season 2012, improved groundnut seed was distributed to 28 farmers in Katangsivni, Mawai Rayat, Padarpani, Mawai Mal and Bharadwara Mal villages. Similarly, improved pigeonpea seed was distributed among 7 farmers in Katangsivni village.

In Jhabua district, after harvest of post-rainy season 2011-12, the "Kisan Laxmi Beej Udpadak Sahkari Samiti Maryadit" operating in Gadwara village produced and stored 600 kg seed of chickpea (JG 130) and 7500 kg seed of wheat (HI 1418). While during rainy season 2012, it produced and sold soybean seed to department of agriculture – 2000 kg JS 9560 variety and 1000 kg of JS 9305. In Jhabua district, "Makka Vikas Samiti" being operated by 20 members at Chota Guda village has distributed 2000 kg improved maize (JVM 421) seed to 500 farmers and replaced traditional low yielding varieties. Details of seed bank with quantity of seed stored after rainy 2012 season are given in following Table 48;

Table 48. Detail of seed banks and seed stored in Jhabua district, Madhya Pradesh

S. No.	Name of seed bank	Village	NGO	Crops	Variety	Quantity of Seed stored (q)
1.	Makka Vikas Samittee	Chota Guda	GVT	Soybean	JS-9560	42
				Maize	JVM-421	Expected to receive 37 qtl
2.	Kisan Laxmi Beej Utpadak Shakari Samittee	Gadwada	GVT	Soybean	JS-9305	93
					JS-9560	29
				Wheat	HI-1418	Expected to receive 97 qtl

The seed bank in Mandla district is also storing paddy seed.

Activities during 2013-14

Along with participatory trials on soil test-based balanced nutrition, other related activities are equally focused under the SRTT initiative to have a denting impact in improving farm based livelihoods. The selected activities in general lies in the domain of women, and so are crucial in strengthening women and bringing in gender equity.

With a purpose to capture local market opportunities and improve household nutrition, the plan for 2013-14 encompasses the promotion of diversification to high value vegetables on a kitchen garden scale (Table 44). The women farmers will be supported technically and to some extent financially to grow vegetables on small areas (~100 to 200 m^2) as kitchen gardens and increase incomes. Soil test-based balanced nutrient management and proper landform management will be promoted to get best results. The plan is to do handholding of women farmers covering total 1 ha in each of 2 seasons in Mandla district, and 4.5 ha in each of 2 seasons in Jhabua district.

A cattle rearing is a common practice with each and every farm family in the target districts of Madhya Pradesh. Milk is a good source of nutrition for rural people. The management and little incomes whatever come from household dairy are mainly in domain of rural women. However, the productivity of local cattle is very-2 low due to lack of nutritious fodder, health issues and low yielding breeds. Therefore the initiative has encompassed to improve animal husbandry and make it an lucrative enterprise supplementing agriculture. During 2013-14, there are plans to promote nutritious fodder cultivation on smaller fields of large number of farmers (Table 44). As such, fodder promotion will be done in 1.5 ha in each of 2 seasons in Mandla district and in 1 ha in post-rainy season in Jhabua district. Infestation of cattle with worms is a common thing and there are reports that it reduces milk yield by 30-40%, while deworming can be done with relatively cheap medicines. Therefore during 2013-14, there are plans to demonstrate to farmers about the deworming practice and benefits thereafter with 200 cattle in Mandla district and 100 cattle in Jhabua districts. To improve local breeds, artificial insemination (AI) is targeted for 100 cattle in Jhabua district. Backyard poultry is also an additional activity with many of the households and vaccination of 1000 birds is planned in Mandla district.

The soil analysis results have shown multinutrient deficiencies in the target districts and so balanced nutrition is much more important to get higher productivity. Keeping in mind to cut cost of chemical fertilizers and increase fertilizer use efficiency, there is urgent need to include on-farm generated organic nutrient source in fertilization practices. In many cases in the target districts, there are competent uses of on-farm generated residues and other wastes and leave little for recycling into field from soil fertility point of view. Therefore this initiative has taken up to demonstrate/popularize /evaluate biomass generation on field bunds and farm boundaries through nutrient rich *Gliricidia*. During 2013-14, there are plans to plant new 1000 plants in Jhabua district (Table 49).

Table 49. Detail of agriculture related activities planned for SRTT districts in Madhya Pradesh during 2013-14

Activity	Mandla	Jhabua
Diversification into high value vegetables	1 ha * 2 seasons	4.5 ha * 2 seasons
Forage production	1.5 ha * 2 seasons	1 ha * 1 season
Deworming/vaccination of cattle	200	100
Vaccination of poultry	1000	
AI of cattle		100
Gliricidia plantation		1000

Capacity Building Activities

Capacity building is the core of the success of any productivity improvement initiative. It is only through capacity building which can ensure sustainability of program, inclusiveness of all and maximization of the benefits. For capacity building of farmers, farmer days are planned one each in Mandla (Katangsivni village) and Jhabua (Chota Guda village) during October, 2012. Farmer training is also planned on poultry vaccination in Mandla (Mawai Mal village) during Oct, 12.

Farmers' Training

During the post-rainy season 2012-13 around 14 formal trainings were organized to enhance farmers' skills in improved management (Table 50). During these trainings, farmers were trained by the experts from scientific institutions, agriculture departments, KVKs in addition to ICRISAT experts. Farmers' trainings were organized on seed bed preparation in nursery, Integrated Nutrient Management (INM), kitchen gardening, vermincomposting, preparation of BBF & conservation furrows and advantages.

Table 50. Details of farmers' trainings organized in Jhabua and Mandla districts, Madhya Pradesh

S. No.	NGOs	Districts	Number of Farmers training	Number of Villages	Total number of farmers
1.	FES	Mandla	10	03	106
2.	GVT	Jhabua	04	03	102

Farmers' Days and Field Visit

Farmers' days are organized regularly to show farmers in the field the benefits of improved management. During post rainy season, farmers' days were organized as per detail in Table 51; During the Farmers Days, the Scientists from ICRISAT, Krishi Vigyan Kendra and Officials from the departments of Agricultural, Animal Husbandry interacted with farmers on topics like crop production, use of balanced nutrition and fertilizer application, vermicompost, critical stages for irrigation, plant protection, BB & F and water harvesting.

Table 51. Detail of farmer days organized in Jhabua and Mandla, Madhya Pradesh

S. No.	Date	Location	District	NGOs	Male farmers	Female farmers	Total farmers
1.	11/12/12	Chotaguda	Jhabua	GVT	70	32	102
2.	02/11/12	Katangsivni	Mandla	FES	75	15	90
3.	19/01/13	Mahuda	Jhabua	GVT	105	38	143
4.	21/02/13	Bharadwara Maal	Mandla	FES	70	20	90

Figure 37. Left: ICRISAT scientist and other experts interacting with farmers during farmers' day in Jhabua district; Right: Farmers being shown the benefits of improved management in farmers' day in Jhabua

Figure 38. Left: A women farmer sharing her experience during farmer day in Mandla district; Right: coverage of farmers' day event in local newspaper

Training Cum Exposure Visits to ICRISAT

For increasing the agriculture productivity, adopting new technologies and improved package of practices (PoPs) are the tools. Therefore, to enhance farmers' awareness about new technologies, a three day program of Exposure Visit to ICRISAT, Patancheru was organized from 28th-30th January, 2013. Twenty nine farmers from Mandla and Jhabua districts of Madhya Pradesh participated in exposure visit. Out of 29 farmers, 9 were female and 20 men farmers. District wise, 15 farmers from Mandla and 14 farmers from Jhabua participated in Exposure visit to ICRISAT.

Figure 39. Dr. SP Wani addressing the farmers during Exposure Visit

Figure 40. Dr. KL Sahrawat interacting with farmer during Exposure visit

Figure 41. Dr. Pooran Gaur sharing chickpea varieties for Madhya Pradesh during Exposure visit

Figure 42. Dr. P Janila discussing importance of groundnut and varieties suitable for Central India

Capacity Building during 2013-14

Capacity strengthening of farmers and stakeholders is a key thing to ensure sustainability of best practices to improve productivity and livelihoods. Keeping this in mind exposure visits, farmer trainings and farmer days are planned during 2013-14 (Table 52). Ten new farmers each from Mandla and Jhabua districts will be brought to ICRISAT to show improved technologies and hands-on practice on some good practices. Farmer trainings will be organized on aspects of soil test-based balanced nutrition, seed treatment etc to about 150 farmers in Mandla and 75 farmers in Jhabua district. Similarly, one farmer day will be organized in each season in both Mandla and Jhabua districts.

Table 52. Detail of capacity building activities planned for SRTT districts in Madhya Pradesh during rainy season 2013

Activity	Mandla	Jhabua
Exposure visit of farmers	10	10
Farmer trainings	150	75
Farmer days	1 * 2 seasons	1 * 2 seasons

Conclusions

Farmer participatory action research under the SRTT initiative is playing a key role in capacity building of farmers to harness higher productivity and benefits on a sustainable basis. The participatory research for development trials showed the benefits of soil test-based nutrient management, land-form management, improved crop cultivars over the traditional farmers practices. Through improved management farmers are not getting higher yields only, but also cultivating otherwise fallow regions. With new techniques, farmers are also taking 3rd short duration green gram crop during summer season. The water harvesting measures in Jharkhand are augmenting water resources and enabling farmers to shift to high value vegetable cultivation and earn higher profits. The model of agricultural development adopted under the SRTT initiative has shown clearly that current farmers yields are lower not because of lack of technologies, but due to lack of knowledge. So, this farmer participatory action research needs to be spread to larger number of farmers for a real impact on farm livelihoods. In addition to productivity enhancement, other agri related technologies are also being focused to bring in synergy and improve farmers' incomes thru - diversification to vegetables; animal husbandry development thru fodder production, deworming, AI; poultry development; biomass generation for soil fertility; water augmentation; promotion of micro-irrigation. Sustainability of best practices after withdrawal of technical support is a major issue, therefore capacity strengthening is focused extensively thru exposure visits, farmer trainings and field/farmer days. The initiative seems to be in right direction by putting farmers in the center stage for decision making, owning the actions and improving their fortunes.

Success Stories

The implementation of SRTT activities in the past years in Madhya Pradesh (Jhabua, Mandla) and Jharkhand (Gumla, Saraikela) have benefitted hundreds and thousands of farmers to learn through participatory trials and other capacity building measures, to increase their on-farm productivity and improve incomes and livelihoods. The SRTT initiative in the process has produced many success stories, and some of them (described in detail in "Efforts that

brought happiness -stories of change from the people" compiled by Sandeep Khanwalkar and SP Wani) are described briefly as under;

Success Story 1:

Location: Gundipara and Manpura, District: Jhabua, State: Madhya Pradesh (Worms changed thinking of tribal farmers)

Composting is commonly not taken seriously in agriculture in the rural areas. Farmers look at it as long biological process and non-economically measurable outputs. Inappropriate composting of agricultural waste and cow dung leads to other problems in the field. Most commonly, termites can be addressed by a composting method which has major benefits on crop growth and quality and on soil health. The issue is one of attitude rather than technology.

Vermi-composting is one of the most popular methods of composting and was introduced to villages in Jhabua district as one of the project interventions. A well tried and tested method of vermi-compost making was also reintroduced; making sure that the design and the technology was well demonstrated and well executed in the field. A follow-up plan was prepared to know about the outputs of vermicompost application and its returns in field were discussed in the village.

The four-pit-model of vermicompost was devised by ICRISAT after lots of research to make the method farmer-friendly. How this technology was promoted we learn in this case study. The turning point which made this intervention successful is described.

Concept of case documented

How proper follow-up made the four-pit-model of vermicompost a successful intervention is the base of this case study. The concept of vermicompost had been introduced to Jhabua by various agencies but was not widely adopted by the tribal farmers. The one and the only reason was lack of follow-up at field level after introducing the methodology. Construction of the pits, time taken in filling them and in applying the compost in the field, are the most commonly cited difficulties for farmers in adopting the technology.

The Four Pit Model

- Dimension of pit is 1.5 m width, 4.5 m length and 0.9 m height.
- Partition walls with small holes to facilitate easy movement of earthworms from one chamber to another.
- An outlet at one corner of each chamber with a slight slope facilitates collection of excess water, which is reused later or used as earthworm leachate on the crop.
- The first chamber and then second chamber is filled layer by layer along with cow dung and then earthworm are released.
- Once the contents in the first chamber are processed the earthworm move to chamber 2, which is already filled and ready for earthworms.
- This model reduces labor cost and saves water as well as time.

The process

Ramala S/o Punia of village Gundipada took part in discussion at the village meeting. He was excited to share his learning and experiences. Two year back when he was told about the four-pit model of vermicompost then he was reluctant to adopt this method of composting at his field. The reason was simple. Who will maintain it and what additional benefit will I get if I construct one vermicomposting pit? Genuine questions from a farmer of a remote village. Answering

these questions was not easy for the field team. They patiently answered his queries and explained to him the four-pit model of vermicompost making. This was the start of the battle in the field for the GVT team.

The initial interface with Ramala was to explain about the vermicomposting process. Because he had never heard that worms can convert his cow dung and agri-waste to compost, the entire biological process was explained to him. Interestingly he agreed to construct this four pit model in his field. But he asked for financial support to construct the structure. This was the first success towards the adoption of the four-pit model in this area.

Along with Ramala, project vermicomposting started in these villages. For proper orientation and knowledge building, technical training on verimicompost methodology was organized in collaboration with Krishi Vigyan Kendra-Jhabua, GVT-Jhabua, ICRISAT–Hyderabad. Two years back Ramala made his first vermicompost after receiving training and other support. Following him, five more farmers adopted it and in Manpura ten farmers adopted this method of composting with the project support.

The hand holding support was for making the vermicompost and using it on the crops. Since farmers had never seen such compost, using it was a like a dream for them. The second big issue was to train masons of the village so that quality of the four-pit model can be maintained. These masons were also taken for exposure to a nearby village named Hatyadeli of Meghnagar block of Jhabua district.

After an initial struggle with the community, efforts started giving results when the first compost structure was filled with worms and farmers could see the vermicompost after 75 days, and it was applied in the field. Now farmers of this village are selling worms and compost to nearby villages: worms @ Rs.200/kg. and compost @Rs.4/kg. Now there are 16 vermicomposting pits in the two villages, six pits at Gundipada and ten pits at Manpura.

We build our knowledge

Knowledge building started with the first meeting with the villagers. Follow up meetings, on the job training and exposure visits continued the capacity building. Most crucial were regular field visits and explaining at every step about vermiculture and its application. An exposure visit cum training program at ICRISAT, Hyderabad for two days in January 2011 was a big confidence booster. Farmers learnt about various methods, technologies and management practices apart from vermiculture and were highly motivated.

Impact of using Vermi-compost

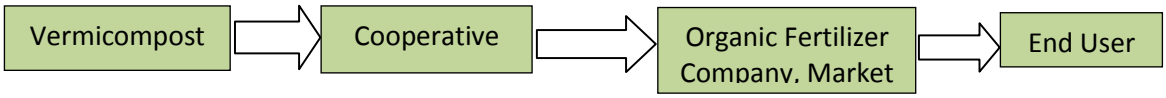
"Due to the use of vermicompost, the size of onion has increased in Gundipada" expressed one farmer named Chuniya Vesta. He has sold 1 kg worms to Buriji Basna and 2 kg worms at Opalpura, a nearby village. Ramla Puniya sold 1 kg worm to Ramchand Mangaliya. Farmers are using vermicompost in their vegetable crops such as in onion, cabbage, cauliflower, tomato, okra, methi (fengrek), dhaniya (coriander), goarphali (Cluster bean), cucumber, beans etc.

The farming communities of these villages are now producing vermicompost themselves and using it in their crops, vegetables and fruit plants. The key impact of the compost as perceived by the community is:

- The moisture retention capacity of the soil increases
- The productivity of crop increased by 15 to 25%
- The productivity in vegetables crops increase up to 25 to 30%
- Number of irrigations reduced or water saved
- Very good vegetative growth in mango and sapota plants
- Income generation due to sale of worms and vermicompost
- Soil becomes loose and porous

Future Plan

As there are SHGs, it has been planned to sell the vermicompost through co-operative directly in the market, to the organic fertilizer industry such as Kribhco, and in organic WADI project villages.



The end users are farmers, parks, gardeners, restaurants, guest houses and offices where gardening is done. Through proper packing, bagging and tagging it will be sold to the end user.

Farmers' statements:

Ramala s/o Puniya, Village Gundipada,

Chilli, cotton and mango grower

Single irrigation saved but productivity not affected; insect attack was reduced; flower dropping reduced in chilli; shape and shining was observed to be good compared to farmers traditional practice; good growth in mango and sapota plants; income increased due to sale of worms.

Khushal s/o Kasana, Village Manpura

Brinjal, chilli, tomato and mango grower

Larger size of brinjal observed and production increased; income generation due to selling of vermicompost; agriculture waste is also used in crop production; Neat and clean atmosphere.

Punjiya s/o Nanji, Village Manpura, Chilli, Tomato and Mango grower

Irrigation requirement was reduced; the expenditure on purchase of chemical fertilizer was reduced; due to good size and shining of chilli and tomato, the market price was increased by Rs 0.50 to 1.0 per kg; and good growth in mango and sapota Plants.

Shambhu s/o Maniya, Village Gundipada, Chilli, Onion and Mango grower

The size of bulb in onion was increased by 20 to 25%; yield increased by 20 to 25%; expenditure reduced; fast growth in mango and sapota plants; less insects in chilli; crop duration increased in chilli and number of picking was increased (1 to 2 more picking).

Babu s/o Chainiya, Village Manpura, Chilli and Mango grower
The expenditure for purchasing of chemical fertilizer was reduced; less attack of insects; fast vegetative growth in chilli saplings; irrigation water saved and income increased due to sale of worms.

Success Story 2:

Location: Mawairaiyat, District: Mandla, State: Madhya Pradesh

Backyard vegetable production is commonly practiced in the villages by most farmers. But very few take up vegetable farming as their main enterprise in remote villages due to poor market demand, and sometimes the food habits of the area. The Gond region of Madhya Pradesh receives good precipitation every year and has good forest cover. Water is available for much of the year. Unfortunately, Niwas block has a different story altogether with low rainfall, wastelands and poor soil health. The case which is shared here is from this region of Mandla district of Madhya Pradesh. The intervention discussed is implemented under SRTT-ICRISAT project and it was started on a pilot basis in six villages of Katangsivni Panchayat namely Mavaimaal, Mavairaiyat, Padarpani, Katangsivni, Bhardwara maal and Bhardwara raiyat of Niwas block.

This case study has focused upon Mr Chain Singh, a vegetable grower who benefitted from the program through varietal change and change in package of practices, as well as use of bio fertilizers and locally made treatments.

Concept of case documented

This is the story of a farmer who wanted to scale up the returns from his field and was supported once he showed his commitment by taking water from a very small but perennial water source close to his farm. He was doing vegetable cultivation for home consumption. When he saw one of the farmers of his village, a Mr Halku Singh, doing vegetable cultivation and earning good money out of it, he also dreamed to become a vegetable grower and earn good money out of it. But he was sure that he would go for more organically grown vegetables rather than applying chemicals. He got support from the Foundation for Ecological Security project and proved himself by producing quality vegetables and making a profit. He told us that his primary objective was to have good vegetables for own consumption, to earn money was secondary. He could achieve both successfully.

Fresh vegetables from my field

Vegetables were promoted to improve the nutritional status of people in the project area as well as to develop an alternative source of livelihood. The food habit in this area rarely includes vegetables so the individual rarely has a nutritional diet. Vegetable cultivation at a small scale was seen as an important intervention to make better use of available water resources in homestead lands as well as small patches of irrigated lands. The sowing of vegetables coincides with the time when farmers start moving to the cities for employment. Keeping these issues in mind, nine

What motivated Chain Singh

- Green vegetable fields of Halku Singh of his village motivated him to grow vegetable in his field too.
- He felt that his family should eat healthy and fresh vegetable from his own field
- Earn some money by selling vegetable in local market

farmers were selected for vegetable cultivation. Chain Singh was one of them in the year 2009-10.

Chain Singh is a vegetable grower from Mawai Rayyat. The village has low availability of ground water. He is a small farmer with five acres, most of it is un-irrigated. He had a dream to ensure that his family could eat healthy and good quality vegetables. By producing vegetables in his own farm he proved that he is not only a visionary but a strong implementer too. The year 2009-10 was the year when he could say in his neighbourhood and to his relatives: "See these are fresh vegetables from my own farm. Please take some and eat healthy like my family is eating."

Perfect selection

The implementation of any activity and identification of farmers is usually done by the Village Institution, the Gram Sabha. Organizing the Gram Sabha for every decision is not possible; so an Executive Committee was appointed by the Gram Sabha, consisting of some elderly village men and women. This Executive Committee named as "*Prakritik Sansadan Prabandhan Samiti' (PSPS)* would take decisions on behalf of the Gram Sabha.

Chain Singh has been innovative enough to use the perennial stream in the area as the source of water. He was not selected for vegetable cultivation at first. However, his effort to divert water towards his barren land through a perennial narrow stream convinced the implementing team of his success. Not only did he divert the water but collected it in a pit until it filled up. Then he would take his bucket to water the plants. Chain Singh was identified by the Executive Committee which considered him hard working and interested in taking up new initiatives, and believed that he would learn new techniques and methods, implement them and then work towards motivating other farmers to adopt the same.

Challenges for Chain Singh

The major challenge before Chain Singh was to find water for irrigating his crop. He arranged for water by diverting some water from a perennial stream and prepared a pit in his land where he would store that water. He has dug drains to water the plot. Controlling pest attacks have been a challenge for him. Changing climatic conditions also pose a challenge for Chain Singh. Erratic rainfall or frost in winters can potentially harm the plot.

Choosing the vegetables

The market is crucial for any economic intervention. Both promoter and entrepreneur must have a basic understanding of the market at the outset. This of course is most important for vegetables as a highly perishable commodity. In this case, the market analysis was first done by Mr. Chain Singh as he wanted to start vegetable production with support from the project. In a way it was good for the sustainability of the intervention.

His assessment of the market was very good with respect to selecting the vegetables to be grown at his field. He identified brinjal, tomato and potatoes as vegetables with a good demand in the local market. And he asked for technical support to produce these vegetables only. Cultivating these vegetables has developed his self-confidence. According to him, this was the first time he was consuming vegetables that he had produced by himself. Besides, using them at home their production also earned enough income for him. Thus the initial result was very good and motivating.

The way implementation took place

- Formation of village committee for proper farmer identification, to provide support, monitor the plots and verify whether the support provided has been used in properly.
- Soil testing was done. The report showed the soil of the area lacked zinc.
- Improved manure preparation techniques. Notably, the production of vermicompost has spread swiftly in the area after initial successes like Chain Singh.
- Technical support to obtain the right quantity of improved varieties of seed.
- Introducing bio fertilizers, better manure application practices and hand-holding support for implementation.
- Good quality training and capacity building about vegetable production and the use of non-pesticide techniques.
- Regular monitoring

Steps	Support provided
Seed replacement in tomato and brinjal	Improved varieties of seeds provided
Seed treatment	Training on seed treatment with *Trichoderma*
Preparing seedbed	Training on developing a raised seed bed of 15 cm height
Soil treatment	Material support in the form of vermicopost, *Trichoderma* and PSB treatment before sowing
Root treatment of saplings	Training on root treatment with *Trichoderma* to avoid fungal infection
Transplantation	Training on planting in line at a distance of 60 cm between two saplings
Mulching, weeding and watering	Mulching with vermicompost
Flowering and fruiting: Vulnerable Stage of pest attack	Training on preparing Matka khaad (the decoction of cow urine, dung, jaggery, leaves of plants with pesticidal properties like Besharam, Ramphool.

PSB: *Phosphate Solubilising Bacteria*

Crop management practices and non-pesticide management

Vegetable cultivation requires diverse skills compared to the common food grain crops. Deeper understanding about the production of different vegetables is essential when they are grown as a commercial crop. They require more time and labor than food grain crops. This was the first thing Chain Singh learnt.

Stepwise training

- Preparation of Seed bed.
- Transplantation
- Preparation and application of bio-pesticide
- Weeding
- Fruiting
- Market linkage.

Therefore he was oriented on crop management and production in detail. He was given knowledge and input support during cultivation. As he had never sown vegetables before, he was trained on-field and off-field before he started with his cultivation.

Input Cost

Name of the item provided	Name of the variety/quantity	Amount(RS)
Seeds		
▪ Tomato ▪ Brinjal	Anand (10 g) JK –kanhaiya(50 g)	240 100
Fertilizers		
▪ Zinc Sulfate ▪ Enriched FYM (enriched Farm Yard Manure) ▪ Vermicompost ▪ PSB, Azotobacter and *Trichoderma*	5 kg 200 kg 150 kg 2 kg	165 Farmers contribution (Rs.600) 600 120
Total cost (excluding labour)		1925
Total cost (including labour)	100x 15 human days (farmers contribution)	1500+1925=3425
Total farmers contribution	1500+600	2100
Contribution from FES	3425-2100	1325

Months	**Interventions**	**Vegetables**	
		Brinjal	**Tomato**
October	Seed Treatment	Seed treatment with 5 g of *Trichoderma*	
	Seed bed preparation	1m x 1m	
	Soil treatment	Soil treated with 250 g PSB, 50 g *Trichoderma* and 50 kg of vermicompost at the time of plowing	
November	Seed Germination	Germination in first ten days of November	
	Root treatment	With *Trichoderma* after keeping the sapling in shade for 15 minutes before transplanting	
	Transplantation	began while maintaining a distance of 60x45 cm.	
December	Transplantation and irrigation	Transplantation of both the crops completed and watering was done regularly.	
January	Mulching and watering	Mulching and watering	
	Weeding	Weeding operation continued. Flowering began in January	
February	Flowering	About 50% of flowering by mid-February, Fruiting by 25th February	Growth in mid-February, Flowering begins in February
	Pest attack	Treatment of pests by a decoction developed from locally available bio-pesticides, cow urine, cow dung, jaggery.	
March	Production and sale	7 quintal brinjal, partially sold for Rs. 7,000/-, the rest for self-consumption	10 quintal tomato, of which he sold the tomato worth Rs. 10,000/- and rest for self-consumption.

My capacities enhanced this way

With lots of physical exercise exerted in his vegetable production, Mr. Chain Singh has received two most crucial outputs in return. The first is nutrient security and income. The second is knowledge and capacity enhancement about vegetable farming.

Process	What he used to do before	Capacity enhancement after this interventio
Seed treatment	Not aware of seed treatment for vegetable crops	He learn how to do seed treatment using *Trichoderma* but still follow up training and handholding support for at least two – three seasons would be required
Root treatment	Completely unaware about such practices	Transplanting of saplings was done dipping them into *Trichoderma* solution
Soil treatment	Earlier he used to apply only compost in the field before transplanting of saplings	After training he applied 50 kg of vermiculture along with 250 g of PSB culture and small quantity of *Trichoderma*
Intercultural operations	Earlier he used to apply compost along with ash	He applied 50 kg of vermiculture and 250 g of PSB along with *Trichoderma*
Pesticides	Never used any pesticide	Two times used matka khad locally made by him after training.
Production	Brinjal 7.8 quintals, 1.5 quintals of Tomato, 20 kg Potato and 50 kg of Onion	10 quintal brinjal, 7 quintal tomato, 50 kg ladies finger

Outcome

- Chain Singh observes the success of vegetable production in many ways.
- One is income enhancement from adopting improved farming practices. The income of Chain Singh has risen in that particular year, as he earned about Rs. 17,000/- from the vegetables. However, the major contribution of vegetables for Chain Singh has been for home-consumption and hence improvement in nutritional status.
- Chain Singh also identifies his increased knowledge about the vegetable cultivation as important. For example: use of new types of fertilizers like vermicompost, PSB and pesticides prepared by locally available materials like matka khad etc.
- He also realizes the importance of root treatment and seed treatment. Chain Singh has not been able to continue with vegetable production this year because of health problems in the family. Yet, he is confident of continuing next season with the improved practices that he has learnt.
- Chain Singh's efforts for vegetable cultivation have been exemplary. Many locals of his village have even brought vegetables from his farm in exchange for mahua. His efforts are demonstrably visible in the village as well as outside. Though, one may not be sure exactly how many have learnt from him and applied their learning.

Learning

Chain Singh learnt that without utilizing existing resources at an optimal level it is not possible to grow vegetables successfully. He was not looking only to scale-up vegetable output but also for the nutrition and the taste of vegetables which are grown by using natural inputs. The biggest learning was that business should be controlled and monitored

by one person and s/he should be aware and knowledgeable about market. Summer vegetables are the most challenging due to high probability of grazing damage from the open grazing concept in the region. Free produce for relatives also reduces overall profit and is unavoidable due to social system and culture. Producing vegetables is round-the-clock work and needs rigorous monitoring. He says that *Palak* is the vegetable most easy to produce and *Lauki* the toughest - because of frequent disease attacks and the need to protect against them. Applying chemical inputs is good for production enhancement but it reduces quality, especially taste. Chain Singh desires more training on the appropriate use of pesticides and other inputs in vegetable production. Now Chain Singh is confident about vegetable farming. He is aware about all stages of cultivation.

FES learnt that optimal utilization of resources is possible, provided we understand all the factors that motivate the farmer and all his needs. Not only income enhancement but sustainability in terms of knowledge built about the particular intervention is necessary.

Success Story 3:

Location: Sipringa, District: Gumla, State: Jharkhand

Village Sipringa is located around 18 km from the district headquarters. You start with a good road and end with a muddy road when you reach the village. Sometimes you need to try two-three routes to reach the village as one of them may be broken or some tree is fallen across the road. This is the reality and we will tell the story of the people who live here and proved their worth to win over their adverse situation.
Agriculture is the basis for living for the local tribes, and was identified as the core development arena by the team and interventions were started through self-help group (SHG) approach.

The journey

Villages	Number of farmers	Crops covered	Year
Teliya (Nucleus village)	50	pigeonpea, black gram, groundnut, maize and green gram	2008-09
Sipringa and Tunjhtoli	120	pigeonpea, black gram, groundnut, maize, green gram, tomato and cabbage	2009-10
15 villages	1000	pigeonpea, black gram, groundnut, maize, green gram, tomato and cabbage.	2010-11

Steps

As the **first step**, soil testing was done as an essential component of the project. Boron was identified as deficient in the soil a (zinc and molybdenum deficiencies were also found). The soil was found to be acidic in nature with 4.5-5.0 pH.

Discussion with the farmers and explaining to them the concept and importance of soil testing and addressing its deficiency was most crucial. This was the **second step**.

The **third step was to d**emonstrate application of micronutrients in crop production at village level. Two types of demonstration trials were planned. The first with the main cereal crops and the second with vegetables.

Scaling-up the learning from these demonstrations with other programs was the **fourth step** for the PRADAN-ICRISAT team. This was in other interventions like orchard development in these villages with financial support of SGSY, NREGS and Tribal Welfare programs. Micronutrients were applied in fruit crops and results were really very good. Boron, an important micronutrient, was applied on fruit crops for better fruiting and quality production.

Another adoption of learning was in vegetable cultivation interventions which were promoted as an alternative approach with small holding farmers. Application of boron with balanced farmyard manure was demonstrated and the outcomes were discussed in meetings which helped in its replication.

Addressing the issue of input supply at local level

Initially it was the role of PRADAN to arrange inputs for the community, but it was a very hectic and time consuming task. In a meeting with the community it was decided to develop a simple participatory mechanism which addresses this issue. In the meeting it was also decided that PRADAN will provide necessary support to these local groups in linkages. To set up the mechanism a series of meetings was organized with numerous seed and fertilizers shops in the nearby area to ensure timely and quality inputs. The seed shops were ready to give support. The farmers started collecting money well in advance and made regular visit the shops in groups or through CSP. They jointly purchased the inputs and distributed among themselves. Sometime they even give orders to Agri-horticulture co-operative (One of the PRADAN-promoted co-operatives) to supply them the inputs. Seeing the huge demands of seeds, fertilizers and micronutrients, the seed shops were convinced that there is a huge marketing scope for them. So they started keeping these inputs. Now the communities are independently doing this task.

Community service provider (CSP)

The community service provider (CSP) provides marketing support to the farming community of the village and is a person from the community itself. When the villagers started the common nursery, the production started coming at a single time, thus there was a glut in the local market and lower prices. Then PRADAN discussed with the community to find out ways to address this issue. The outcome of this meeting was the villagers selected a person to help them in marketing the produce. It was a charged or commission-based service provided by the CSP to the farmers. The CSP can charge 0.50 paisa per kg of marketed produce. This model not only addresses the issue of marketing but also helps to encourage more farmers to join this program.

Role of Self Help Groups:

The SHGs are the basic platform which implements these interventions. Apart from these programs, SHG plays a different role in:

- Monitoring the quality of intervention.
- Helping other fellow farmers of the area.

- Motivating farmer to grow vegetable crops.
- Data keeping.
- Addressing issues such as free grazing, marketing and credit flow.

Outcome of inputs

In village Teliya overall irrigation was good but a few households had no irrigation in their field. Thus it was decided to address this issue with convergence approach. Farm concept was introduced in the village. Open wells were constructed and lift irrigation schemes were introduced in the village. Now the situation has improved and irrigation reaches up to 80 percentages from 60% before. Better crop and financial support made it possible for 25 farmers to buy their own diesel pump sets and convert their land into irrigated category.

- Boron application is now scaled-up to 100 villages with 1000 farmers who are into vegetable production and orchards.
- Now the market also has started micronutrients which were not available in large quantities.
- Interestingly hybrid maize was the biggest adoption by farmers after a few demonstrations of its benefit. Now a big area is being converted into hybrid maize cultivation resulting in better food security at household level.
- Summer fallow is reducing and an increasing number of farmers are adopting short-duration pulses like green gram. In one irrigation farmer get good production (one kg seed gives 40 kg production) and crop duration is just 65 days which provides opportunity to take better rainy crops. Green manuring also increases production of the paddy crop. Good market rate for summer pulses like green gram @40/kg is forcing factor behind high rate of adoption of summer cropping.
- Increased knowledge of farmers about summer crop and green manuring.
- Formation of farmer's club to discuss about various crops and farming practices.
- One link person is trained from each village on crucial issues.
- Small steps led to a big gain for the villagers of Sipringa. Farming was not new to these villagers but the way they were doing farming was not giving them much return from their fields. Now the situation is changed with more gain from the same land.

Change in agriculture practices

Demonstrating the use of quality seed in the ICRISAT supported project was useful for most of the farmers as they learned the benefits of line sowing to get better production. Now most of the farmers follow line sowing for their hybrid maize crop. For traditional seeds, still broadcasting is practiced.

Overall production has increased and this has reduced the dependency on forest products and laboring. It took 6–7 year to understand the importance of seed and most of the farmers are now using quality seed.

Laharu Pahan, one of the farmers shared with us that now children are also going to school because there is a school within the village. Youths do not sell wood anymore. Inter-culture operation in crops has changed and farming practices have improved. Paddy production has increased from 0.4 t to 1.6 t. Now farmers have food security at household level and do not buy rice from outside.

Practices and knowledge support that increases tomato growing area

- Nursery raising at 15 days intervals to ensure a controlled supply of vegetables so that market does not crash.
- Prepare nursery beds of 3x7 feet each. Apply compost, DAP, potash, and thimet and keep it for a day.
- Next day sow 5 g of seeds. The quantity of seeds was reduced after training farmers who earlier used about 10 g of seed in the nursery.
- Cover the bed with mosquito net to protect the saplings from white fly and also apply actara insecticide. Now they also see the expiry date of the pesticide before use. They also apply blue copper.
- Major shift in transplanting of sapling. Earlier they used to transplant after 21 days now they ensure that by 15 day sapling is transplanted.
- Inter-culture operation they do after 5 days. Apply Potash and DAP in the roots of plant. Urea application is after 15 days of transplanting.
- Farmers also know the names of chemicals, which they use for control of different diseases. This confirms their enhanced knowledge.
- Interestingly they applied boron and the production was doubled.
- Now the number of farmers who want to grow tomato is increasing year by year. The number of farmers has reached up to 100 from the earlier number of only 10–15. This shows adoption of improved practices and better return to the farmers.

Tomato fields of Gumla villages farmers with addition of zinc sulfate, agribor and vermi-compost and graded tomato for market

	Area (acre)	No of Farmers	Tomato Yield (kg ha^{-1})		Income (Rs ha^{-1})	
			Improved*	Traditional[1]	Improved*	Traditional[1]
Sipringa	2.5	25	83809	53281	296381	133559
% increase over control			**41.6**		**88.5**	
LSD %			**19072**		**6007**	

■ * Improved practices: Addition of 2.5 kg of Boron and 50 kg of Zinc Sulfate along with DAP 500 kg, MOP 250 kg and Urea 300 kg per ha

Five practices which brought change

1. Seed treatment
2. Use of improved seed
3. Balanced use of pesticides
4. Proper and timely use of fertilizers
5. Regular discussion on package of practices and on the job training

Changes

- Twelve households developed mango orchard
- 25 farmers now have Shreeram Honda kerosene pump
- There is one power tiller in village
- Tomato farming area and number of farmers increased
- Improved seed is used by most of the farmers

Challenges

- Farmers, who have land less than one acre, are facing problem in meeting their round the year requirements from their land and therefore they either migrate or labor or depend on the forest. There is need to develop a special plan for such farmers.
- Conduct soil testing for villages
- Farmers still need training on balanced application of fertilizer based on soil testing report

Success Story 4:

Location: Saherbera, District: Saraikela-Khershaw, State: Jharkhand

This is an interesting story about a village where the organization promoted one short-duration crop variety with an integrated package to change the cropping pattern. Its adoption tells of the success of the approach in the remotest villages.

Process of implementation

As with other villages, project implementation was started with soil testing, farmers' training, orientation, exposure visits and demonstrations at village level with sound technical support by the ICRISAT team. In each village a few progressive farmers-cum volunteers were identified and given training to collect information and to distribute project inputs.

The village is remotely located from district headquarters (the poor connectivity puts it in the remote category) and surrounded with dense forest. Interface with wild animals is part of daily life. Sometimes the quantum and quality of agriculture production depends on the damage by elephants and other wild animals. Elephants are the biggest enemy for these farmers. They try their best to keep elephants away from their fields but it is next to impossible.

Interface meetings, focused group discussions with the farmers and prioritization of their demands in agriculture revealed that if they are provided with short- duration crops they would be very happy. This was mainly to protect their crops from wild animals. Also short-duration crops fit in the area with weather and resources to ensure better production
.
Seed of a high-yielding variety of maize was provided to them. The crop was very healthy. Crop growth was good due to balanced application of nutrients and better intercultural operations as suggested by the scientist. Meanwhile farmers observed that damage to this variety by elephants was increasing. It was not possible for them to save the crop.

The fields of the farmers are located on the link road that connects to other villages of the area. People from these villages also work in the industrial area and there is inflow and outflow of people. When these people saw the crop they asked for green cobs. A few farmers sold and due to a better taste demand soared. Initially farmers were not interested to sell their crop green but when there was attack from elephant then they decided and sold it green and in this way a market emerged at village level itself.

A few days after farmers saw elephants damaging their crops they realized it would be good if they can sell it green. Small sales of green cobs got a better response from the people and

gradually it picked up very fast. Taste of this variety was also good and was liked by the people. Farmers who have sown this variety earned good profit compared to grain.

In this village farmers also keep fallow land due to heavy rains and lack of improved knowledge of cultivation. Introducing short-duration, improved varieties helped them to plan for taking two crops from the same field.

In the post rainy season, ICRISAT along with TSRDS team, planned planting of short-duration kabuli chickpea variety Kak 2 in the rice-fallow land of the village. This was a good experience. Farmers were happy as they tested the benefit of a new variety with good production and better returns by selling green pods. This was done with 16 farmers and the local variety JG 11 with 15 farmers. Yield details are given in the following table.

Chickpea yield with seed priming technique in rice fallow fields during winter 2008			
Chickpea variety	**No of farmers**	**Area covered**	**Grain yield (kg ha$^{-1)}$**
Kak2 (Kabuli)	16	3.20	1614
JG11 (Desi)	15	3.10	1165

Demonstration of Kak 2 gave better results compared to the traditional and other local varieties of chickpea. With improved practices, plant growth was good and grain size was also bigger than the local one. When people from other villages saw the crop they asked about the variety and some of them tested it also. The same problem of elephants occurred and people then asked about selling the green crop only due to better taste and big size of grain.

Farmers were very happy with the crop and they were not interested to sell it. When they refused then some people started stealing the crop while passing from the field and it became difficult to control this. Then it was decided by farmers to sell it as green gram and get better prices.

TSRDS and ICRISAT were very happy when they heard about these results of the crop but at the same time they were worried about their data which they required for their own record. Somehow data from some sample plots were gathered and analysis was carried out and shared with the farmers.

Constraints faced during implementation

- Remoteness: Villages selected for the project are located remotely and connectivity these villages is also not good. In rainy season it is really difficult to approach these villages.
- Poor infrastructure: There are few basic amenities within the village. All are dependent on the nearest town which is 20 km away.
- Low awareness: People still follow traditional practices in agriculture. There is no proper operational system which shares updated information with the villagers. Most depend on the market for new information and knowledge. This way one cannot ensure that whatever knowledge they are getting is good and beneficial to them.
- High expectations of community: After getting regular support from TSRDS on

various issues people held high expectation from them. Meeting all the expectations is not possible for any agency.

- Industrialization: Shift from farming to a job in factories is a big trend in this region. This is due to low or sometimes no returns from the agriculture.
- Low return from agriculture: Traditional practices, lack of knowledge about improved practices and limited resources are the main causes of poor returns from the field

TSRDS and ICRISAT focus:

- Soil test-based nutrient management, micronutrients usage for rice and other crops
- Chickpea crop after the rice fallow,
- Kharif Maize introduced in upland
- Land Management,[plowing techniques]
- Low-cost drip systems,
- Vermicompost pits,
- Nursery development (Glyricidia)
- Seed bank

Major crops promoted and their data:

Effect of Micronutrient application by spray and basal application on Paddy yields Rainy season 2009				
Treatments	**No of Farmers**	**Area Acre**	**Grain Yield (kg/ha)**	**% of increase**
FYM+DAP+Urea (Control)	10	9.3	2850	
Control+ MN spray	5	10.3	3230	13.3
Control+ MN Basal	6	10.3	3498	22.7

Chickpea grain yield in rice fallow fields sown with seed priming technique post-rainy season 2009					
S. No.	**Chickpea variety**	**Sherabida and 8 villages of Sariekela-kharsaw district.**			
		No of villages	**No of farmers**	**Area covered ha**	**Grain yield kg ha-1**
1	Kak 2 (Kabuli)	6	21	3.15	630
2	JG 11 (Desi)	9	36	2.80	590
4	ICCV 2 (Kabuli)	3	13	2.20	410

Benefits of micronutrients

- At least 25% production increase in vegetables like tomato, brinjal, and crops like paddy and maize
- good colour of grain gives better price in the market
- vegetable sold on priority basis
- plant growth is good, production enhanced, good quality fodder, disease resistance, health plant etc

Key success factors

- Roadside village
- Wildlife attack: we are taking this success because it forced them to change crop and take care of crop till it reaches to market.
- Better price for green produces like gram and maize cob
- Short-duration crop

Outcome

- Use of micronutrients increased
- Paddy production increased from 0.75 tons/acre to 1.8 tons/acre by year 2008.
- Paddy fallow land used for chickpea production.
- 20 percent farmers are now taking three crops in the village.

Changes in the post rainy crops				
Name of crop	**Before intervention**		**After intervention**	
	Area (Area in acre)	**Yield (qntl./Acre)**	**Area (Area in acre)**	**Yield (qntl./Acre)**
Oil seeds	-	-	5.20	3.00
Pulses	14	6	6.50	4.00
Vegetables	0.90	6	2.50	35.00
Wheat	-	-	4.00	7.00
Potato	-	-	2.00	25.00

Future challenges

- Sustainable availability of micronutrients at local level with good quality.
- How to shift young generation from doing labor to agriculture in industrial areas.
- Still only a few farmers are using micronutrients in some villages
- Wild life: wolves eat the groundnut crop and elephants destroy the pigeonpea crop

About ICRISAT

ICRISAT
Science with a human face

International Crops Research Institute for the Semi-Arid Tropics

CGIAR

ICRISAT is a member of the CGIAR Consortium

The **International Crops Research Institute for the Semi-Arid Tropics** (ICRISAT) is a non-profit, non-political organization that conducts agricultural research for development in Asia and sub-Saharan Africa with a wide array of partners throughout the world. Covering 6.5 million square kilometers of land in 55 countries, the semi-arid tropics have over 2 billion people, of whom 644 million are the poorest of the poor. ICRISAT innovations help the dryland poor move from poverty to prosperity by harnessing markets while managing risks – a strategy called Inclusive Market-Oriented Development (IMOD).

ICRISAT is headquartered in Patancheru near Hyderabad, Andhra Pradesh, India, with two regional hubs and five country offices in sub-Saharan Africa. It is a member of the CGIAR Consortium. CGIAR is a global research partnership for a food secure future.

ICRISAT-Patancheru (Headquarters)
Patancheru 502 324
Andhra Pradesh, India
Tel +91 40 30713071

ICRISAT-Liaison Office
CG Centers Block
NASC Complex
Dev Prakash Shastri Marg
New Delhi 110 012, India

ICRISAT-Nairobi (Regional hub ESA)
PO Box 39063,
Nairobi, Kenya

ICRISAT-Bamako (Regional hub WCA)
BP 320
Bamako, Mali

ICRISAT- Kano
PMB 3491,
Sabo Bakin Zuwo Road
Tarauni, Kano, Nigeria

ICRISAT-Niamey
BP 12404
Niamey,
Niger (Via Paris)

ICRISAT-Bulawayo
Matopos Research Station
PO Box 776
Bulawayo, Zimbabwe

ICRISAT-Lilongwe
Chitedze Agricultural Research Station
PO Box 1096
Lilongwe, Malawi

ICRISAT-Maputo
c/o IIAM, Av. das FPLM No 2698
Caixa Postal 1906
Maputo,
Mozambique

www.icrisat.org