Conjuctive Use of Water Resource Technology and Extension in Improving Productivity of Rainfed Farming: An Experience at Lalatora, Madhya Pradesh, India

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Abstract

Although Vertisols and associated soils in Lalatora, Madhya Pradesh, India are a productive group of soils, these soils have several constraints to high agricultural productivity. Low cropping intensity, waterlogging during the rainy season, and lack of farmers' inability to use modern technology are the major constraints. On-farm studies made during 1999–2001 showed that use of improved varieties of crops such as soybean and chickpea along with improved water harvesting and nutrient management (including application of micronutrients) and integrated pest management significantly increased crop productivity and income of the farmers. There is a need to further test the package of practices for improving productivity and farm income.

The concept of sustainable development cannot be discussed only in the light of economic development. The social and environmental changes and the people should be considered. Sustainable socioeconomic development is a challenge and an opportunity. Along with economic development, sustainable social development has become an integral part of the entire development process as it aims at "the improvement of the well-being of the people". The success and failure of the development program and technology interventions largely depend upon the actors involved in the process. The major stakeholders in the process of development are those who make use of natural resources. The participation of these users is very important for the management of natural resources as well as for technology adoption and success. A process oriented step-by-step approach is very effective for sustainability. Farming systems research (FSR) is a successful example of this approach, which has been tried out in many developing countries. Integration of the roles of scientist, extensionist, and farmers is the key to success in FSR approach.

The project has adopted a holistic process, i.e., FSR approach, to improve the productivity of soybean-based rainfed farming with technological interventions for sustainable use and management of natural resources. A consortium model for management and development of integrated participatory watershed is evaluated at Lalatora watershed in Vidisha district, Madhya Pradesh, India. The project aims to develop and apply environment-friendly technological options to increase the productivity in this area of medium to high water-holding capacity soils.

Area, Climate, and Physiography

Lalatora village of Vidisha district of Madhya Pradesh is located in an extensive watershed totaling about 10525 ha, lying between latitude 28°8'3" and 24°16' N and longitude 77°20'45" and 77°30'15" E at a height of 415 m above mean sea level. The Lalatora watershed is a micro-watershed within the Lateri-1 milli and is located in the northwest corner of Vidisha district. Madhya Pradesh is the largest state in India and extends into three agro-ecological zones (7, 8, and 9), which are characterized as having 120 to 180 days length of growing period; soils are largely Vertisols where the parent material is mainly alluvial. The catchment area represents the four major rivers, viz., Yamuna, Ganga, Narmada, and Godavari. The state is

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divided into six physiographic regions; the district of Vidisha is located in the Vindhya Plateau Zone.

Surface hydrology

Two digital runoff recorders along with automatic pumping sediment samplers were installed at the Lalatora watershed to monitor runoff and soil erosion from untreated and treated sub-watersheds. To monitor the outflow from entire Lalatora watershed, one digital runoff recorder was installed at the major drain. There is a significant reduction in runoff from the treated sub-watershed compared to untreated sub-watershed (Table 1). In 1999, the significant reduction in runoff from treated sub-watershed (24% less than the untreated sub-watershed) was observed. During 2001, large reduction in runoff volume (81% less compared to untreated sub-watershed) was recorded. The difference in the runoff between the treated and untreated sub-watersheds was greater during 2001 compared to 1999. This is mainly due to the fact that starting from 1999, more area was brought under improved technologies including check-dams and structures in the treated sub-watershed. The peak runoff rates from the treated sub-watershed were also significantly lower compared to untreated sub-watershed (Table 1). During 1999, the peak runoff rate in the treated watershed was only one-third that of untreated watershed. During 2001, the peak runoff rate in the treated watershed was 30% lower than untreated watershed. During three years (1999–2001), the highest peak runoff rate of 0.218 $m^3 s^{-1} ha^{-1}$ was recorded from the untreated watershed.

During all the three years (1999–2001), few major storms contributed 50–75% of the seasonal runoff (Fig. 1). During 1999, one single storm on 5 September resulted in more than 50% seasonal runoff from both treated and untreated sub-watersheds. Similar trend was seen during 2000 and 2001. The effectiveness of treated watershed in controlling runoff from small and medium storms is shown in Figure 1 for 2001. During 2001, runoff from all the small and medium storms were totally controlled in the treated watershed except for one large storm on 12 July 2001.

Groundwater hydrology

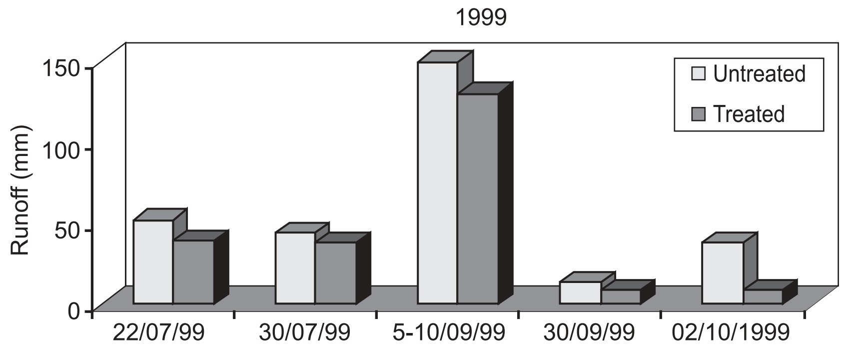
At Lalatora, 12 open wells were monitored at fortnightly intervals to record the groundwater fluctuations. The mean water level in open wells before watershed development was about 6.5–9.5 m. The water level in open wells increased substantially in subsequent years after implementing watershed development work, particularly construction of the check-dams and other water harvesting structures. During 2000, the mean water level in the wells near check-dams was consistently around 1.5–2.0 m up to October, whereas the water level in the wells located away (about 1000 m) from the check-dams was at about 8.5 m throughout the year (Fig. 2). Even during rainy season the wells away from check-dams did not show significant increase in water level, while the water levels in the open wells near the check-dams had significant increase particularly during the rainy season.

The Lateri block is considered the most underdeveloped area within the district of Vidisha, with very limited irrigation and no major or medium-scale industry. The average rainfall is 1000 mm. The soils of the area range between medium black to red soils.

Table 1. Seasonal rainfall, runoff, and peak runoff rate from two sub-watersheds at Lalatora, 1999–2001.

Year	Rainfall (mm)	Runoff from two sub-watersheds (mm)		Peak runoff rate ($m^3 s^{-1} ha^{-1}$)	
		Untreated[1]	Treated[2]	Untreated[1]	Treated[2]
1999	1203	296	224	0.218	0.065
2000	932	234	NR[3]	0.019	NR[3]
2001	1002	290	55	0.040	0.027

1. Untreated = Large watershed with most of the areas untreated.
2. Treated = Small watershed with major areas treated with improved technologies including hydraulic structure.
3. NR = Not recorded.



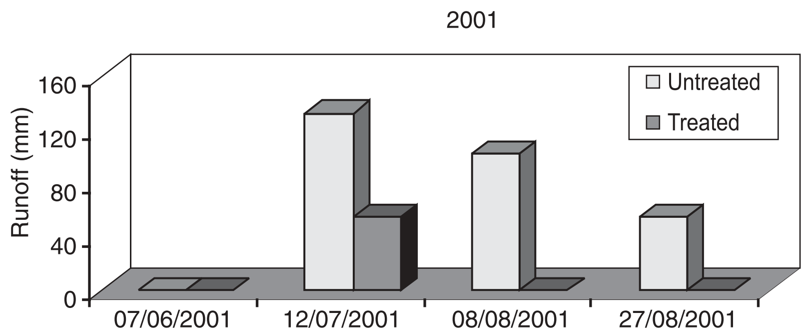


Figure 1. Daily runoff events from the treated and untreated sub-watersheds during 1999 and 2001 at Lalatora.

Agriculture is the main occupation in the block, but employment is seasonal due to lesser crop intensity because of low irrigation availability. About 20% of the population migrates seasonally. The postrainy season (rabi) is the main cropping season with 35,000 ha sown area while 10,000 ha is sown during the rainy season (kharif). Double cropping is undertaken in only 3750 ha (Rangnekar 1999). An automatic weather station was established in the watershed. Daily weather readings are collected and are maintained.

Soils

The Lalatora watershed in particular is spread on the Deccan Trap basalt where the parent material is mainly alluvial. The physiography of the area is level to very gently sloping land where certain pockets towards the north of the area are highly gullied creating a certain amount of relief, which may create further problems of management. Five soil series have been identified. These are Vertisols characterized by gray, very deep, dark grayish brown to olive brown with a clayey surface horizon and calcareous B horizon. The predominant clay mineral is montmorillonite. These soils have greater micropore volume due to high amount of very fine clay present in the soil (NBSSLUP 2000). About 60% soils are medium (30 to 60 cm depth) while 20% are deep (>60 cm depth) and 20% are shallow (<30 cm depth).

Socioeconomic Status

A baseline socioeconomic and natural resource inventory survey was conducted through a stratified detailed household survey and participatory rural appraisal (PRA) methods. Primary data have been collected from 396 households from 7 villages covering top, middle, and lower toposequence positions in Lalatora watershed. The data have been collected using an interview schedule prepared by trained investigators. The sample for the study is presented in Table 2. Low literacy rate, poor resources, and inadequate extension are the main reasons for backwardness of the community.

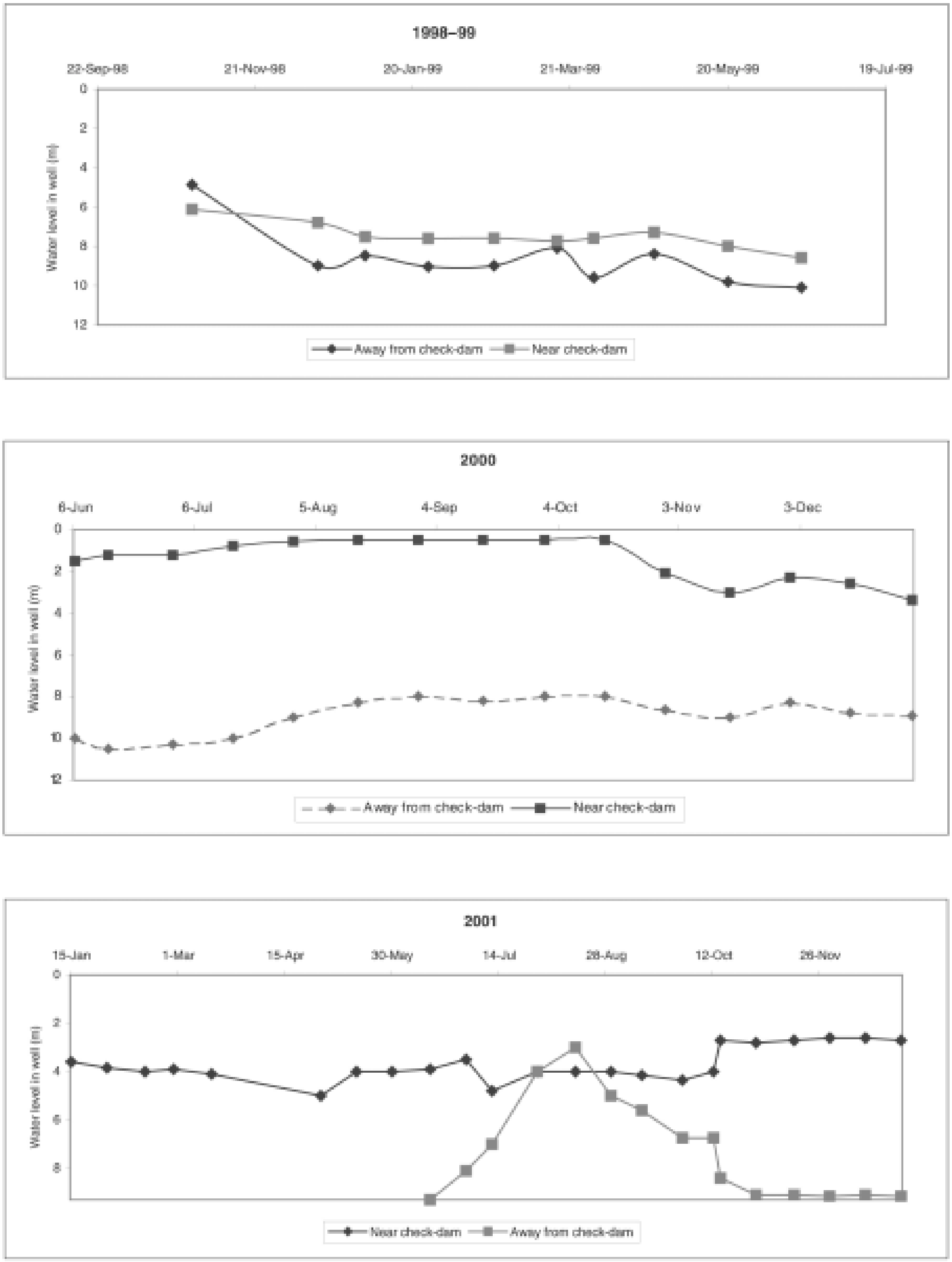


Figure 2. Groundwater levels in open wells at Lalatora watershed, 1998–2001.

Table 2. Sample area (ha) for the study at Lalatora.						
Region	Marginal farmers	Small farmers	Medium farmers	Large farmers	Landless laborers	Total
Upper area	15	15	18	14	9	71
Middle area	16	28	30	16	10	100
Lower area	17	27	29	34	23	130
Lalatora micro-watershed	23	20	14	12	26	95
Total	71	90	91	76	68	396

Table 3. Occupation categorization (%) of family members[1].

	Work					Migration		Unemployment	
Gender	Agri	Agri + NFW	NFW	Trade	Agri + Trade	For Agri	For NFW	Always	Sometimes
Male	28.8	9.8	12.2	19.3	15.7	2.7	-	2.1	9.2
Female	24.5	13.3	30.3	8.5	6.9	2.7	0.5	2.7	10.6
Overall	27.4	11.1	18.7	15.5	12.6	2.7	N	2.3	9.7

1. Agri = Agriculture; NFW = Non-farm work; N = Negligible.

Family information

Ninety-four percent of the households are male-headed and 6% are headed by females, mostly widows. Main source of income for 56% of the households was from agriculture, 28% from non-agricultural labor, 14% from agricultural labor, and around 2% from the services sector. The occupational categorization of individual family members is presented in Table 3. Lalatora has 56% small farmers (57), 29% medium farmers (30), and 15% large farmers (15). Literacy status revealed that 52% are illiterate, 29% reach up to primary education, 12% complete secondary education, and 7% complete high school education.

Social structure

The average size of the household is 9.4 persons of which 5.3 are male and 4.1 are female. The family size of the landless laborers is much smaller at 5.5 persons per household, perhaps due to lower income and assets. The availability of labor is seasonal and a greater family size would require them to migrate for work. The recent study (Vadivelu et al. 2001) revealed that in most of the cases people with some landholdings enter into share cropping contracts and these people 'crowd-out' the share croppers from the share cropping market. The obvious reason is that the landholders would assume to have a better knowledge of agricultural operations and would also be in a position to repay the borrowed money from the landlord (through growing wheat from their own land).

Land-use Pattern

About 60% soils are black soils, medium in depth (30 to 60 cm depth), 20% are deep black soils, more than 60 cm deep, and 20% are shallow soils (30 cm depth). In the Lateri block 53% of the land is used for agriculture, 17% is classified as wasteland, 25% as forest land, 4% as grazing land, and 1% as fallow land. The average landholding of the farmers from the study area is around 4 ha. The average landholding size is 4 ha, with 2.73 ha of dryland and 1.27 ha of irrigable land.

The primary data collected revealed that only soybean is grown in large areas (Rangnekar 1999). The other major rainy season crops are sorghum and maize, while pulses are grown in smaller areas. Soybean was the crop preferred by 74% of the farmers in kharif followed by rice (21%), sorghum (3%), and maize (2%). In the rabi season, wheat was preferred by 46% of the farmers followed by chickpea (43%), rice (6%), and lentil (5%).

During the rainy season, out of an average 2.73 ha of dryland, only 0.26 ha is cultivated. During the rainy season, 88% of land in Lalatora is kept fallow by the farmers. The fallow lands are largely rainfed lands without any source of irrigation and farmers traditionally grow postrainy season crops on stored soil moisture and use supplemental irrigation obtained on payment from the neighbors. Soybean is the only crop cultivated during this season with an average grain yield of 0.95 t ha^{-1}, whereas in the postrainy season, 71% area is under wheat and 24% under chickpea.

Relationship between Soil, Rainfall, and Cropping Pattern

The soils have a higher clay content characterized by greater water-holding capacity with poor drainage and problems due to waterlogging. The average annual rainfall is about 1000 mm with high intensity of rainfall resulting in runoff and soil erosion. The problem in the rainy season is ponding of water caused by high rainfall intensity.

Farmers prefer to grow the rainy season crop (soybean) under irrigation. Also, the delayed harvest of soybean does not affect the growth of the postrainy season crop chickpea and/or wheat. In drylands, farmers prefer to leave the plots fallow as sequential cropping is risky. A study by Pandey (1986) indicated that in only 9 out of 29 years, the residual moisture is sufficient for sequential cropping. Another study by Rosenzweig and Binswanger (1993), using data over 10-year period, indicated that risk-coping mechanisms (post-ante consumption smoothing mechanisms are stronger) in wealthier farmers are higher and they generally tend to take the risks.

The average yield of all the crops in Lateri block except soybean is lower than the state average. It is pertinent to note that Madhya Pradesh is the largest soybean growing state in India where more than 5 million ha produce about 4 million t of soybean with a production of 750–1062 kg ha^{-1}, which amply supports the project objective of studying sustainability of agriculture in the rainfed tropics.

On-farm Participatory Trials

Methodology

Detailed soil survey and soil analysis was carried out. Geohydrological study of soil losses and water runoff are being recorded to monitor the effect of water and soil conservation work carried out in the watershed. Automatic weather station is commissioned to record the microclimatic data. Participatory approach was adopted in water and soil conservation activity by motivating and mobilizing people's participation in watershed development. Medium and small farmers, who were willing to participate in the on-farm participatory trials (OFPTs), were selected. The plot size was 0.15 to 0.25 ha. All the farmers involved in the trials were given training on the recommended practices and record keeping.

Government partnership

The Government of Madhya Pradesh has supported the management of natural resources through the watershed development programs under the Rajiv Gandhi Watershed mission. The major activities carried out under this mission were water harvesting, soil conservation, improving vegetative cover, and empowering community with emphasis on weaker section of the society.

Study on existing farming system

The information was gathered by using the following tools to understand the existing agricultural system including soil, crop husbandry, and socioeconomic aspects of the families:

- Baseline survey: socioeconomic survey; and crop production data
- Group discussions
- Transect walk and PRA
- Secondary data collection

Constraints analysis

In the soybean-based farming system in Lalatora watershed area, the following important constraints were identified jointly with farmers:

- Soybean cultivation has low productivity ranging from 900 to 1200 kg ha^{-1}.

- Soils were deficient in boron (B) and sulfur (S).
- Waterlogged conditions prevailed many a times if not continuously in the growing season.
- Risk of erratic rainfall and insufficient moisture in the soils.
- Market fluctuation affected the price realization by farmers.

Selection of interventions

The following interventions were selected to improve productivity of soybean and chickpea to suit local conditions and resources:

- Evaluation of best-bet options for soybean-based systems.
- Evaluation of response to micronutrients (B as borax at 10 kg ha^{-1}, S as gypsum at 200 kg ha^{-1}, and combination of both).
- Broad-bed and furrow (BBF) system (1 m broad-bed and 30 cm wide furrow) was formed with tractor-drawn implement.
- Introduction of improved seeds of soybean (JS 335) and chickpea (ICCV 2, ICCV 10, and ICCC 37) varieties.
- Seed treatment with *Rhizobium* (or phosphate-solubilizing microorganisms) culture to enhance nutrition and thiram for disease control.
- Use of nuclear polyhedrosis virus (NPV) for controlling *Helicoverpa* (pod borer) attack on chickpea.
- Water and soil conservation measures.

On-farm trials: The approach

The approach of farmer-managed trials was adopted. The trials were basically managed by farmers with technical advice provided by scientists and non-governmental organization (NGO) staff for planning, conducting, and monitoring the trials. This approach was advantageous as scientists received feedback and accordingly user-friendly interventions were devised. There was no change in other agronomic practices, which are generally adopted by the farmers. The guiding principles adopted for on-farm trials (OFTs) were:

- Farmers were provided scientific information about the constraints and possible solutions for increasing productivity.
- Farmers were involved from the beginning and the OFTs were planned in partnership with the farmers.
- Inputs for OFTs were provided at subsidized rates initially.
- Trained NGO staff collected records of inputs and outputs for OFTs along with neighboring non-trial farmers as controls.
- Farmers evaluated the OFTs in their own way.
- In 1998 rabi season, one on-farm trial was conducted with chickpea variety ICCC 37 for evaluation by farmers and seed multiplication.
- In 1999 kharif, OFTs were conducted on soybean JS 335 along with best-bet options put together by scientists from Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Central Research Institute for Dryland Agriculture (CRIDA), and Indian Institute of Soil Science (IISS). A multi-pronged integrated pest management (IPM) strategy was also adopted using physical method (plowing in summer), chemical method, and biological method (use of pheromone traps).
- In 1999/2000 rabi season, one trial was conducted on chickpea using 3 varieties (ICCV 2, ICCC 10, ICCC 37), combined with seed treatment and reduced tillage.
- In 2000 kharif, OFTs were conducted on soybean using improved variety JS 335, BBF, micronutrient amendments (B and S), and nutrient budgeting.
- In 2000/01 rabi season residual effects of B and S amendments on wheat and chickpea yields were evaluated. Nutrient budgeting trials for soybean-based systems were continued.
- In 2001 kharif the following OFTs were conducted on soybean:
  - Cultivation on fallow land using short-duration soybean variety Samrat.
  - Micronutrient trials using B and S.
  - Landform trials comparing BBF.
  - Mixed cropping with maize.
  - Introduction of new crops (pigeonpea, groundnut, and maize).

Performance of On-farm Participatory Trials

During 1998/99 rabi season interactions with farmers at Lalatora revealed that most farmers were using traditional chickpea variety Katila. They were very keen to evaluate improved chickpea varieties developed by ICRISAT. Five farmers volunteered to evaluate ICCC 37 and breeders' seed of ICCC 37 was provided to these farmers. The farmers had agreed to return double the quantity of seeds provided as their contribution for building seed bank at Lalatora. On an average, farmers harvested 20% more grain yield of ICCC 37 with maximum yield of 1680 kg ha^{-1} as against the yield of 950 kg ha^{-1} from the traditional variety (Table 4). The farmers were happy with the bold shiny seed and high yield. During 1999/2000 rabi season more farmers came forward to evaluate improved chickpea varieties and also reduced tillage for chickpea crop production.

Use of improved chickpea varieties ICCV 10, ICCV 2, and ICCV 37 resulted in higher yields (957 to 1471 kg ha^{-1}) over the local variety (923 kg ha^{-1}). The variety ICCV 10 was found more promising than other varieties evaluated. The combinations of improved variety with seed treatment and reduced tillage exhibited better production than improved variety alone (Table 4). Profitability of improved practices over traditional practices was higher by Rs 6421 ha^{-1}. Improved variety with seed treatment yielded 59% higher yield than the local variety. The gross profit was also significantly higher.

Breeders' seeds were provided initially to the farmers for evaluating the performance of chickpea varieties. The farmers were helped in roguing the odd plants in the chickpea fields under evaluation. Four women self-help groups (SHGs) consisting of 40 members purchased seeds and with the help of BAIF staff stored treated seeds in government godowns until planting of the next rabi crop. Through this mode, the four SHGs sold 1200 kg of quality seeds in the village and earned the profits. In addition, individual farmers used their own seeds of improved varieties and also provided on cost to farmers of nearby watersheds.

Evaluation of Best-bet Option

During 1999 rainy season, the scientists from JNKVV, CRIDA, and ICRISAT put together a best-bet combination option for soybean-based systems. This

Table 4. Performance of farmer participatory evaluation of chickpea varieties at Lalatora[1].

Variety	No. of farmers	Area covered (ha)	Yield (kg ha^{-1})	Increase (%) over control
1998				
ICCC 37	5	1.8	Av. 1150 Max. 1680	
1999				
ICCV 10	14	3.75	Av. 1471 Max. 2500	59
ICCV 2	5	1.25	Av. 1280 Max. 1600	38
ICCC 37	25	6.25	Av. 957 Max. 1700	4
Control (traditional farms)	14	4	Av. 923	

1. Interventions included improved variety, seed treatment, non-nodulating seed, and reduced tillage; no intervention in control.

option consisted of use of improved variety of soybean (JS 335), seed treatment with thiram along with *Rhizobium* and phosphate solubilizing microorganisms, application of diammonium phosphate (DAP) at 50 kg ha^{-1}, and IPM. In the first year, 27 farmers evaluated this option for soybean covering 40 ha (Table 5). Average increase in soybean yield was 34% above the baseline/control plot yield of 950 kg ha^{-1}. The range of soybean yields with best-bet option varied from 0.81 to 1.06 t ha^{-1}. Detailed analysis of benefit-cost ratio for the farmers who evaluated this option was worked out and the net profit was Rs 5575 ha^{-1} (Vadivelu et al. 2001).

Response to micronutrient amendments

In 1999 season, soil samples from Lalatora were collected and analyzed. The analysis revealed that these soils were deficient in B and S. These results were shared with the farmers and the implications were explained. Remedial measures were also suggested. During 2000 rainy season 13 farmers came forward to evaluate effects of B, S, and B+S amendments (10 kg borax = 1 kg B ha^{-1}, 200 kg gypsum = 30 kg S ha^{-1}, and 1 kg B + 30 kg S ha^{-1}). The farmers evaluated these treatments in strips, monitored the plant growth during the season, and harvested separately.

The results showed that B, S, and B+S treatments significantly increased soybean yields (1710 to 1780 kg ha^{-1}) and the yields were 34–39% higher than the best-bet option treatment (Table 5), which served as control treatment without B, S, and B+S amendments. Farmers found these trials educative and they were happy to harvest increased yields of soybean, which also resulted in increased income.

During the postrainy season these plots were maintained and six farmers planted wheat following normal practices to evaluate the residual benefits of B, S, and B+S amendments. Residual benefits of B and S amendments for soybean in kharif season increased wheat yields by 30 to 39% over the untreated control plot yields. Total systems productivity increased by 63 to 73% due to single dose of 1 kg B and 30 kg S application. The economic analysis of these trials showed that farmers' net incomes increased by Rs 8190 to 8850 ha^{-1} due to B and S amendments, respectively.

The economic analysis of the OFT in 2001 showed that intervention of combined application of B and S gave maximum benefit amounting to Rs 26454, followed by only B (Rs 26609) and S application (Rs 25955). All these three interventions proved to be beneficial to the farmers with 1.8 benefit-cost ratio as compared to control with traditional practices (1.3) and gave almost 49% higher benefits to the farmers. These amendments not only increased the incomes, but also improved the water-use efficiency through increased productivity. The farmers were impressed with these results. Besides Lalatora farmers, other

Table 5. Performance of soybean variety in on-farm trials at Lalatora.

Variety	No. of farmers	Area covered (ha)	Yield (kg ha^{-1})	Interventions	Increase (%) over control farm
1999					
JS 335	27	40.5	1275	Improved seed; seed treatment and application of DAP	34
Control (traditional)	14	6	950	No intervention	
2000					
JS 335	13	6	1730	Boron application	35
JS 335	13	6	1710	Sulfur application	34
JS 335	13	6	1780	Micronutrients	39
JS 335	6	3	1500	Broad-bed and furrow	17
Control (JS 335)	13	6	1280	Best-bet option	

farmers from the neighboring watersheds of Anandpur, Lateri, Khairkhali, and Mahauti also indented in advance their B and S requirements with the BAIF staff.

During 2001 kharif season, 12 farmers further continued evaluation of B and S amendments on the same plots. The results revealed that the response to B and S amendments was 10 to 16%, which was almost half that of the response observed in 2000 kharif season. The probable reasons for the reduced benefits due to B and S amendments could be: (i) occurrence of 45 days drought (dry spell) during reproductive stage of soybean, (ii) application of B and S after sowing of the crop due to continued rains in the beginning of season, and (iii) improved availability of B and S from the previous amendments.

Evaluation of broad-bed and furrow landform treatment

Three farmers evaluated BBF landform for soybean production and observed 17% increase in soybean yields over their normal practice. Considering the fact that the black soils of this region are prone to waterlogging, BBF technology was suggested for evaluation. The BBF practice proved better (1500 kg ha^{-1}) than the traditional cultivation practices of the farmers (Table 5), which involved planting on flat surface. There was initial resistance to BBF due to signs of low and slow germination as a result of poor sowing practices. This lacuna has been rectified with provision of modified seed drills for BBF operations and adequate field training to the farmers. With further improvements in planting on BBF, during 2001 kharif season, 11 farmers evaluated BBF landform treatment. During the drought season also, BBF increased soybean yields by 16% over and above the yields of best-bet option. However, farmers feel and perceive that they lose some land in furrows and more crop lines could be sown in the field. Availability of equipment for BBF preparations and planting are perceived as constraints by the farmers.

Technology Exchange

Ultimate success of any technology depends on its acceptance by the farmers. If the technology is not economically viable, socially acceptable, and not user-friendly, it would be rejected by the farmers. This was ascertained by the feedback received from the farmers. Based on the encouraging demand-driven experience, extension of technology dissemination was initiated by organizing:

- field days, field exposure visits, and scientist visits;
- increasing awareness through enhanced interactions with extension officials;
- promoting seed banks to ensure timely seed supply through SHGs (4 SHGs procured and supplied 1.2 t seeds to 12 farmers, in addition to project supply and farmers' own seeds);
- field demonstrations;
- providing literature about improved options;
- linkages with other agencies (*swayam sidha*, market access); and
- government organization, NGO, and farmer visits.

These activities have proved to be very effective in dissemination of the technologies. The impact is clearly seen by increased demand for improved varieties in large numbers from non-operational project areas. Another interesting feature was attracting financial support from the Government of Madhya Pradesh for undertaking physical structures for water conservation.

Adoption and Farmers' Perceptions on Interventions

Adoption status and farmers' opinion on various interventions carried out during the project are reported in Table 6. The most important constraint of waterlogging in the rainy season requires adequate drainage systems. Eighty-one per cent of the respondents categorize the adoption as 'partial'. Most of the innovations that were identified as non-adoption are either due to lack of technical knowledge or the expensive nature of the operation. One hypothesis is that the problem lies more in the nature of the perceived higher cost, which the farmer is not willing to invest. This calls for a properly designed program which will provide sufficient subsidy with reasonable contribution from the farmers. Farmer interest in the interventions is given below:

- All farmers appreciated:
  - Introduction of new crop variety;
  - Seed treatment;
  - Use of biofertilizer.

Table 6. Adoption of soil and water conservation (SWC) measures.

	Adoption status[1]			Causes for non-adoption[1]			
SWC measures	Not adopted	Partly adopted	Fully adopted	Ignorance	Technical constraints	Very expensive	Inconvenient
Land leveling	2.08	91.67	6.25	NR[2]	45.37	46.15	8.48
Waterway	9.38	81.24	9.38	NR	45.37	54.63	NR
Farm pond	34.49	51.72	13.79	NR	47.12	52.88	NR

1. Data indicate respondents (%).
2. NR = No reply.

- Most farmers appreciated:
  - Mixed cropping;
  - Micronutrient application.
- The practice of reduced tillage was appreciated by less than half of the participating farmers.
- BBF landform was appreciated by least number of farmers.

Summary and Conclusion

The major constraint in the watershed area is low cropping intensity, as majority of the dryland is left fallow during the rainy season. Waterlogging and soil erosion are the other constraints. Lack of initiative by the farmers is due to their perception that higher costs are involved in undertaking these investments and they expect the Government to take a lead role. The yields of most of the crops are lower than the state average, except soybean. In general the yields are less than 1 t ha^{-1}; however, there is huge variation in the yields over years. The education level is poor particularly in the women's group. The infrastructural facilities in terms of electricity, roads, and telecommunications are also poor.

Farmers were happy to evaluate improved options, which increased their farm incomes. Along with the improved crops/varieties, farmers appreciated much the technologies to harvest rainwater through farm ponds, best-bet options, amendments with selected nutrients, use of NPV, and the concepts of village-based seed banks and vermicomposting.

All the participating farmers opined that the introduction of improved varieties of chickpea and the improved practices have given higher yields than local practices and local variety and they were satisfied with the interventions. All the interventions suggested in the project were user-friendly, except BBF in which the availability of implement and skill to use were the constraints encountered by the farmers. Availability of the improved variety, quality seeds, and credit were other constraints faced by farmers. Work load and its distribution should be analyzed further as some practices may involve more women participation or vice versa.

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