Knowledge-based Entry Point and Innovative Up scaling Strategy for Watershed Development Projects

Sreenath Dixit*, **Suhas P. Wani, T. J. Rego, and G. Pardhasardhi**

* Central Research Institute for Dryland Agriculture, Hyderabad, A.P - 500 059.
International Crops Research Institute for the Semi-Arid Tropics, Patancheru, A.P

ABSTRACT : International Crops Research for the Semi-Arid Tropics (ICRISAT) led the consortium of research and development institutions that implemented the Andhra Pradesh Rural Livelihoods Project in the state. The project employed innovative entry point activities (EPA) to ensure sustained farmer participation throughout the project period and thereafter. This paper deals with soil nutrient analysis as an entry point activity. It discusses the process involved in the novel EPA and details the strategies adopted to upscale the methodology to other watershed development projects. It also presents how knowledge based EPA can contribute to productivity enhancement complementing outputs of watershed development activities and suggests a model for upscaling productivity enhancement strategies.

One of the major challenges facing farmers in the semitarid tropics (SAT) throughout the world is management of their lands to produce food economically and without degrading natural resources on which agricultural production is based particularly soil and water resources. Farming in the SAT is complex, diverse, risk prone and cultivation is largely rainfed with many areas experiencing problems associated with variable rainfall, land degradation and poor soils. Land degradation in the semi-arid tropics of India affects over 166 million ha which accounts for 50% of the total geographical area of the country (Sehgal and Abrol 1992). Erosion by water is the single most important factor affecting an area of 86.9 million ha and run-off water removes fine silt and clay particles rich in plant nutrients and organic carbon leaving behind impoverished soils.

The SAT is faced with an arduous task of development of environmentally sustainable farming practices, which are profitable to small farmers and could be implemented with these farmers' constrained resources. An added concern in Asia is the need to increase food production to keep pace with population growth. Large percentage of available land is marginal in nature and much of the land holdings are managed by small farmers who experience severe economic constraints. The efficient use of incident rainfall is the key to maximizing agricultural production in the semi-arid tropics. Large increases in production (up to 5 times) are possible using optimum management practices and productivity on farmers' fields could be doubled in Asia and quadrupled in Africa using available technologies as reported by Wani *et al.* (2003) and Rockstrom *et al.* (2007).

Earlier, research and development work in the SAT emphasized on increasing the availability of water for crops besides reducing soil erosion through implementation of various soil and water conservation structures within the watersheds. This structure-driven watershed developmental work neither provided a positive impact on the productivity nor encouraged the farmers to participate in development and management of watersheds and maintain these structures when the implementing agency withdrew the support mainly because only a few resourceful farmers benefited from the programme (Wani *et al.,* 2003a). ICRISAT (Patancheru, India) in collaboration with the national agricultural research system (NARS), non-government organizations (NGOs), government departments and farmers developed a consortium model for development of sustainable watersheds, wherein emphasis was shifted from mere conservation of soil and water to increasing use efficiency of conserved resources such as water and soil through enhanced crop productivity and incomes, in partnership with farmers (Wani *et al.,* 2003b).

In this approach, lack of appropriate soil, water and nutrient management practices at farm level were identified as the most important constraint for increasing crop productivity. To address this constraint, community-based soil and water conservation interventions were taken up in a farmer- participatory-mode. Also *in-situ* rainwater conservation measures at farm-level and productivity enhancement interventions were implemented to complement each other.

Over the years, researchers and development functionaries have learned many lessons on ways to involve communities and help them to manage natural resources such as soil and rainwater for productive farming leading to sustainable rural livelihoods. One of the major learning was that unless tangible benefit was evident to the community, people's participation could not be ensured (Olson, 1971, Wani *et al.,* 2003, Sreedevi *et al.,* 2004). In order to secure community participation it was necessary to show tangible impact of improved natural resource management through interventions in productivity enhancement. Participatory on-farm watershed projects spend considerable time and resources to evolve ways and means to show desirable and tangible benefits, and ensure people's participation.

A project funded by Asian Development Bank developed and evaluated an innovative farmer participatory on-farm watershed management model in Kothapally, Andhra Pradesh (AP). A strong backstopping provided to non-government organizations and farmers by the consortium of several research, development and extension organizations involving researchers, civil society, state government and by policy-makers led to success in NRM interventions in Kothapally (Wani *et al,* 2003). Building on this experience, the consortium led by ICRISAT supported the Andhra Pradesh Rural Livelihood Program (APRLP), which was implemented by Government of AP, with financial support from DFID, U.K. In order to achieve effective convergence at watershed-level, a consortium of organizations - national and state agricultural research institutions, government development departments, non-governmental organizations and women's self help groups - were put together. This methodology was based on principles of collective learning, knowledge-sharing and systems thinking which used a variety of methods and processes where appropriate activities including action-learning, participatory on-farm research and on-station research for promoting sustainable rural livelihoods were conducted.

Entry point activity

Introducing watershed development program to the community has always been an important activity. This is done through what are called 'entry point activities' (EPA) in the parlance of watershed literature. EPA is basically meant for gaining a foothold in the community and in the process, earning the goodwill of villagers before embarking on activities planned under the watershed development project. It involves building rapport with the community, strengthening and sustaining it through out the program and thereafter. In reality it involves a lot of time and resources of the project staff and could determine the success or failure of the programme. A carefully laid out EPA could address the community's aspiration and capitalize on it by ensuring larger peoples' participation in the activities. Considerable debate has taken place on the ways and means of executing an entry point activity that has a lasting impression on the project.

Entry-point-activity is envisaged to build a rapport between the project implementing agency (PIA) and the rural people before initiating watershed programs. Usually, entry point intervention/activity is identified through PRA. Government of India (GOI)'s Watershed Guidelines also provide for entry point activity with specific budgetary allocation of Rs. 80,000/- (US$ 1860) (GOI, 1994). However, in case of innovative farmer participatory model for watershed management led by ICRISAT a principle of 'no subsidy' approach for interventions on private farmlands was adopted.

Certain goodwill gestures such as creating drinking water facility and sanitation to the community, conducting health awareness camps, construction of community halls or bus shelters, promotion of kitchen gardens, etc. were carried out as entry-point-activities. Support to group income-generating activities such as fish farming in village tanks and providing power threshers with community contribution were some other rapport-building measures practiced by the implementing agencies (Fernandes, 2000).

In Unna, Himachal Pradesh for instance, thirty classrooms in government schools, eleven community centers and seven village paths were constructed as rapport building measures. Renovations of *Mahila Mandal Bhawan* (building for women's forum), community center, government primary school and *panchayat ghar* (office building for local self government) were also taken up as EPA.

Other types of EPA in watershed development program in Pakistan were construction of a *bundh* (embankment), repairing of roads, construction of small culverts, supply of school furniture, chemical control of ipomoea (a weed) in a river and construction of culvert and gate.

Over the years much time and resource have been spent on testing various types of EPA. The FAO has observed that in most cases, EPAs served community needs only for a brief period and did not provide enough incentives for motivating people to participate in long-term conservation activities that provide no tangible benefit in the short run (www.fao.org). Based on critical analysis of various watershed projects in India, it was observed that a major reason for low impact of projects was the lack of equity of the resultant benefits to the stakeholders (Wani *et al.,* 2002, 2003). Further, low community level participation was because of the *'top-down'* approach adopted in most projects and lack of tangible economic benefits through project interventions for a large number of small and marginal farmers and the landless who form a significant part of stakeholder community. Adoption of top-down, target-driven approach by the implementing agencies followed subsidy approach to enlist stakeholder involvement. Such involvement turned out to be contractual and stakeholders never took active interest, which compromised the project sustainability (Wani *et al.,* 2005). On the contrary, such approaches were misconstrued by the community as indication of surplus financial resources with the project to support interventions and that the community members need not participate with their share of labour or capital. This tendency could prove detrimental to the project outcome, as success of watershed projects largely depend on the perceived stake by the community.

ICRISAT with its rich experience in natural resource management (NRM) research in rainfed areas of Asia and Africa along with a multitude of ADB funded projects particularly in Asian SAT, viz., Kothapally in Andhra Pradesh and Lalatora in Madhya Pradesh in India besides Thanh Ha and Huongdao in Vietnam, Tad Fa and Wang Chai in Thailand and Xiaoxingcun and Lucheba watersheds in China have been enormous sources of learning to draw from.

Taking cue from this pool of knowledge a strategy was drawn to formulate knowledge-based entry point activity in the APRLP-ICRISAT Project for scaling-out the consortium approach for initiating integrated watershed management for improving rural livelihood.

Identification of entry-point-activity (EPA)

While considering the options for EPA for the project area, the consortium felt the necessity to address a fundamental bottleneck for enhancing agricultural productivity. It was felt that the technology to address the problem must be scale-neutral. Additionally, the following points were also set out for consideration:

- EPA should be knowledge-based and not involve cash resource, directly.
- It should address the issue of low productivity with a high degree of success (>80-90%)
- It should have ample scope for participatory research and development (PR&D)
- It should result in measurable and tangible economic benefit by way of enhanced productivity
- It must be simple and enable participatory evaluation
- Most importantly, it should be applicable for a majority of farmers

Considering all these points and based on the outcome of PRA, poor soil health was identified as the dominant issue to be addressed through EPA.

Methodology

The APRLP-ICRISAT Project was initiated in 2002 with the selection of three 'nucleus micro-watersheds' each in Nalgonda, Mahabubnagar and Kurnool districts in the southern state of Andhra Pradesh, India. During 2003, project activity was extended to four more watersheds around each of the nucleus watershed. These were known as 'satellite watersheds' where the impacts observed in the nucleus watersheds, were scaled-up.

Once soil health was identified as an issue to be addressed as knowledge-based EPA, a simple and cost-effective method was designed for sampling soils in the micro-watershed. This was necessitated, as it was impossible to collect soil samples from each farm owing to a large number of farmers. The need was to design a sampling method that brought to light the problems associated with a majority of farm holdings in a watershed. Farmers' meet was convened in each nucleus watershed to explain the intent of soil sampling and the method involved. During meetings, cooperation of the farmer was sought for identifying different fertility/soil quality locations that were uniform. Discussions corroborated the fact that soil quality in general varied on a toposequence with good quality soils at lower toposequence position. Another important factor causing variation in soil quality was differential inputs by individual farmers.

Both these points were factored in while deciding the sampling procedure. Micro-watersheds were divided on a map in three toposequences. Farm size was considered as a surrogate variable for socioeconomic status of the farmer that could affect the quantity of inputs in the field. For each toposequence a specified number of farms were identified based on farm size and were grouped into small (< 2 ha), medium (>2 to <5 ha) and large (>5 ha) farm holding. Based on the proportion of small, medium and large farm holding on each toposequence, stratified random sampling approach was adopted to identify five sampling locations on each toposequence. Number of samples depended on the proportion of small, medium and large farm holding. Once the number of samples for a particular category was decided, farmers were requested to identify the fields and assist in soil sampling.

Farmers were trained in collecting representative soil samples from the selected fields. During ensuing discussions it was indicated to the farmers that soil samples were being collected to represent a certain category of farms on a toposequence and that the soil test results were not merely applicable for the respective farms from where soils were sampled. Five samples (from up to 15 cm depth) were collected from each sampling location and pooled together by mixing the collected samples. Samples were divided into four quarters. Each quarter of soil sample was mixed well and one composite sample of one kg was prepared by collecting mixed soil sample from each quarter. The number of soil samples varied from 15 to 20% of the total number of farm holdings within the selected watershed depending on the size of the micro watershed.

Soil Analysis and Dissemination of Results

Soil samples from the 10 nucleus watersheds were analyzed for biological, physical and chemical parameters by following standard analytical procedures as described by Rego *et al.,* (2005) and Wani *et al.,* (2003).

The results were compiled along with nutrient uptake data for one or two major cropping systems and the same were used for discussions during the meetings convened for dissemination of soil test results. A simple approach of nutrient budgeting was adopted using the balance-sheet approach. Field sample charts were prepared for each toposequence highlighting soil nutrients both available and used.

The concept of critical limits for each nutrient was discussed with farmers with the help of those who had collected the soil samples. The lead farmers identified earlier to sample their respective fields, explained the process of soil sampling. In the meetings it was reiterated that the samples collected were merely representative, randomly selected and not specific to any particular farm, but was indicative of nutrient deficiency in general in the toposequence. *Gram Sabha*s (village meeting) proved very effective for discussing the results of soil analysis.

Once the results of soil analysis were shared with the farmers, they were engaged in a discussion to work out participations research trials for evaluating crop response to deficient micronutrients. Farmers who were willing to volunteer and offer their farms to undertake trials were also identified in the *Gram Sabha*. The project team assured them of necessary guidance, technical support and availability of inputs on payment basis. Some farmers also volunteered to evaluate improved cultivars of dominant crops based on yield potential, seed samples and available information about pests and disease resistance of new cultivars along with trials on responses to deficient micronutrients.

Field PR&D trails

Based on the *Gram Sabha* discussions, the lead farmers started preparing for experimentation. They were instructed to maintain records for all farm operations, inputs as well as crop observations on a regular basis. Farmers who needed help for record-keeping were facilitated with expertise drawn from fellow farmers in the village, project staff or school children. Internalization of these experiments in *Gram Sabha* and subsequent discussion in family served to promote awareness at large in the project villages. The on-farm participation trials involved laying out simple experiments by following improved practice evolved collectively by farmers and the project staff in comparison with farmers' practice. Trials were laid out in various combinations, for instance, with specific micronutrients or all deficient nutrients separately or in combinations depending on the farmers' choice. A minimum plot size of 1000 m^2 was maintained for each treatment. Individual farms served as replications for statistical analysis of the results, as achieving control over replicated trails under prevailing conditions at farmers' fields would be difficult.

Field days were conducted in villages during early grain-filling stage when villagers would visit and evaluate all field trials. Lead farmer would explain the aspects of experiment underway in their respective farms. Visiting farmers would collectively evaluate different treatments, discuss various crop growth parameters and compared the treatments besides providing good suggestions thus facilitating cross learning.

Crop production data was gathered by harvesting plots measuring 6 m^2 in three randomly selected spots for each treatment. Farmers were also encouraged to harvest crops treatment-wise, thresh separately and share the data on the grain and husk yields with researchers.

Up-scaling strategy

ICRISAT adopted a strategy to upscale the productivity enhancement benefits from nucleus watersheds to satellite watershed under the APRLP-ICRISAT project. Four satellite watersheds were selected around each nucleus watershed during the second year of the project. During the *Gram Sabha* in one of the selected satellite watershed villages, farmers from other satellite watersheds were sensitized by the farmers from nucleus watersheds. Lead farmers of the nucleus watershed were trained to serve as trainers for farmers from satellite watersheds while project staff supported the lead farmers. Four to five lead farmers from the nucleus watershed facilitated the entry of the project in their village and sensitize the farming community on the issue of soil nutrient deficiency. They narrated the complete process of PR&D starting with problem diagnosis, designing of trials, evaluation of trials and the learnings. They also appraised their fellow farmers about their experience in building personal capacity to serve as resource persons and satisfaction in being recognized by their peers.

Results and Discussion

During the PRA in all the nine nucleus watersheds it was observed that farmers were aware of land degradation in their fields. Duscussious such as the need to add more and more fertilizers for maintaining crop yields over the years were repeated during the meetings. Farmers easily understood the concept of nutrient budgeting but expressed lack of information about soil quality of their fields. The participations approach ensured farmers' involovement in soil sampling process in all the nucleus watersheds. Farmers appreciated the enormity of the task of sampling individual farms and accepted the method of representative sampling for diagnosing soil nutrient deficiencies at a macro- hr level.

Result of soil analysis across nine nucleus watersheds in three districts of Andhra Pradesh is presented in Table 1. The results were tabulated and presented in local language along with necessary details for interpretation and disseminated to farmers during group meetings. Results showed that in all the nine nucleus watersheds, 81 to 99% of soil samples were found to be critically deficient in zinc, boron and sulfur in addition to nitrogen deficiency in all soils.

Farmers in nucleus watersheds were concerned to learn about deficiencies in soils in their area and glad to know that corrections were possible with application of required nutrients. During the first year (2002), 15 farmers volunteered from each nucleus watershed for participating in on-farm trials with crop of their choice. Two treatments, i.e, farmer's nutrient input practice and application of micronutrients at the rate of 30 kg S ha^{-1}, 0.5 kg B ha^{-1} and 10 kg Zn ha^{-1} in addition to farmers' nutrient inputs, were tried during the first year. In all, 150 on-farm trails were laid out in 3 districts using different crops like mungbean (9), maize (22), groundnut (19), pigeonpea (43) and castor (8). A few trials, however, had to be abandoned due to drought incidence. Impressive responses in grain yield to applied B+Zn+S in all predominant crops such as maize, groundnut, mungbean, pigeonpea, and castor was recorded (Table 2). Farmers not only achieved increased grain yield, but also realized economic benefit through a nominal additional investment of Rs. 1750/- (US$39) per ha on nutrients.

The study demonstrates that a carefully thought out EPA generates enough interest among the community to

Table 1. Soil nutrient analysis in APRLP nucleus watersheds - Mean data

Watershed Name	District	No.of Farmers	Sulphur mg kg^{-1}	Zinc mg kg^{-1}	Boron mg kg^{-1}	Organic Carbon %	Extr. P mg kg^{-1}	Total N mg kg^{-1}	Extr. K mg kg^{-1}	Extr. Ca mg kg^{-1}	Extr. Mg mg kg^{-1}	Extr. Cu mg kg^{-1}	Extr. Fe mg kg^{-1}	Extr. Mn mg kg^{-1}
Tirumalapuram	Nalgonda	20	3.7 (100)	0.55 (85)	0.29 (100)	0.33 (90)	5.1 (75)	388 (100)	125 (0)	1394 (40)	193 (0)	0.85 (0)	11.5 (0)	17.8 (0)
Nemikal	Nalgonda	11	5.9 (82)	0.44 (82)	0.34 (82)	0.48 (82)	6.1 (55)	455 (100)	181 (0)	2319 (0)	416 (0)	1.02 (0)	12.6 (0)	18.2 (0)
Kacharam	Nalgonda	13	4.0 (100)	0.27 (100)	0.28 (100)	0.30 (100)	8.0 (31)	362 (100)	137 (0)	2539 (8)	237 (0)	0.83 (0)	14.6 (0)	13.1 (0)
Sripuram	Mahaboobnagar	15	3.6 (0)	0.23 (100)	0.18 (93)	0.28 (100)	8.0 (47)	310 (100)	105 (0)	558 (87)	187 (0)	0.62 (33)	23.4 (0)	22.7 (0)
Malleboinpally	Mahaboobnagar	13	5.7 (85)	0.71 (46)	0.36 (77)	0.36 (85)	13.2 (46)	415 (100)	118 (15)	1083 (46)	399 (8)	1.27 (15)	30.1 (0)	21.3 (0)
Mentepally	Mahaboobnagar	14	5.7 (86)	0.36 (79)	0.23 (100)	0.28 (100)	11.5 (43)	318 (100)	98 (0)	723 (71)	189 (0)	0.58 (50)	15.7 (0)	15.9 (0)
Karivemula	Kurnool	11	3.2 (100)	0.44 (82)	0.27 (100)	0.42 (82)	9.8 (27)	512 (81)	143 (0)	1985 (50)	263 (0)	0.83 (0)	6.9 (0)	11.1 (0)
Devanakonda	Kurnool	15	3.7 (93)	0.13 (100)	0.28 (100)	0.23 (100)	8.6 (33)	302 (100)	101 (6)	2003 (18)	313 (0)	0.76 (6)	7.6 (0)	7.7 (0)
Nandavaram	Kurnool	9	7.5 (67)	0.39 (89)	0.63 (44)	0.47 (67)	5.7 (67)	496 (89)	223 (0)	7256 (0)	715 (0)	0.72 (0)	5.0 (0)	8.0 (0)

induce them to participate in watershed development projects for their benefit. It also shows how EPA can lead to a meaningful engagement with the farming community and strengthen the up- scaling process. Replenishment of soils with micronutrients helped individual farmers realize tangible economic benefits thus ensuring people's participation in an NRM project. (Fig 1)

The study confirms earlier findings by Olson 1971, Wani *et al.* 2003, Sreedevi *et al.* 2004 on people's participation and highlights how an upscaling strategy could be built-in keeping the interest of individual farmers as the focal point. The lead farmers continued application of micronutrients and participated actively in community watershed project. They spent their time as resource farmers during the upscaling process.

Lead farmers as trainers for up-scaling strategy

During 2003, when all the 10 nucleus and 40 satellite watersheds were operational, these watersheds supported the up-scaling (Fig 1) of the productivity enhancement practices to 10 different micro-watersheds that were being implemented by the Project Implementing Agency (PIA) under another program. This indicates that the concept of knowledge-based EPA in itself is up-scalable and that the process can easily be internalized by PIAs. In this manner, the ICRISAT-APRLP nucleus watersheds served as sites of learning for their own satellite watersheds besides other watersheds.

The PIA of the nucleus watersheds and the lead farmers served as trainers for others in the satellite and other watersheds. Lead farmers were equipped with knowledge on total yield, nutrient uptake data and consequent economic returns (Table 3).

During the year (2003), farmers preferred to evaluate responses to individual micronutrients particularly in nucleus watersheds. Three farmer volunteers in each watershed evaluated B, Zn and S individually and B+Zn+S with and without optimum N and P. These treatments were superimposed over farmers' nutrient inputs. Due to increased number of treatments, plot sizes were reduced under individual treatments so as to be accommodated within an area of 2000 m^2. Combined application of micronutrients at optimum N+P level resulted in highest response and the additive response to each deficient element was observed at this level. Inadequate supply of N & P as observed in case of farmer's practice, could not exploit the full potential of application of B, Zn and S. Increase in crop yield varied from 37 to 88% under farmers' practice in case of different crops. However, under optimum N and P levels the response for applied micronutrients varied from 55 to 122% in different crops (Table 4).

The strategy of adopting knowledge-based EPA and up-scaling from nucleus to satellite watersheds was applied in similar community watershed projects supported by the ADB in Thailand, Vietnam, China and India. In India

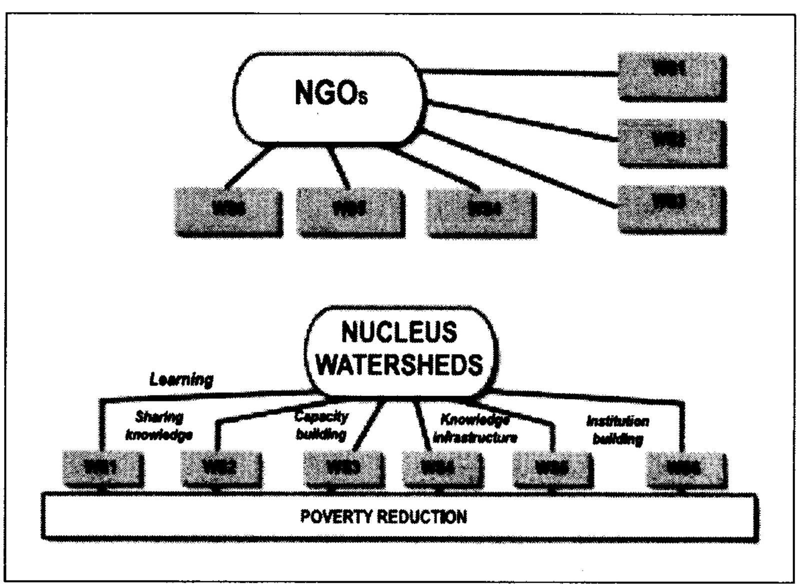

Fig1. The Scaling-up strategy.

Table 2. Crop response to micronutrients in watersheds in Andhra Pradesh, India, 2002-03.

Watershed	Crop	Grain yield (t ha^{-1})		Yield increase
		Control	Treated	over control (%)
Mahabubnagar				
Sripuram	Maize	2.38	4.37	84
	Pigeonpea[1]	0.24	0.42	75
Malleboinpally	Maize	2.98	4.57	53
Mentepally	Maize	1.20	1.74	45
Nalgonda				
Tirumalapuram	Castor	0.43	0.64	49
	Pigeonpea[1]	0.41	0.46	12
Nemikal	Mungbean	0.84	1.10	31
	Pigeonpea[1]	0.35	0.66	89
Kurnool				
Karivemula	Groundnut	1.44	1.96	36
	Pigeonpea[1]	0.13	0.33	154
Devanakonda	Groundnut	0.94	1.24	32
	Pigeonpea[1]	0.23	0.50	117
Nandavaram	Castor	0.86	1.29	50
	Pigeonpea[1]	1.63	2.64	62

1. Represents intercrop.

Table 3. Mean yield and uptake of nutrients by crops grown in APRLP watersheds, Andhra Pradesh, India, in 2002.

Crop	Stover yield (t ha^{-1})		Grain yield (t ha^{-1})		Total nutrients removed (g ha^{-1})					
					Control			Treated		
	Control	Treated	Control	Treated	S	B	Zn	S	B	Zn
Mungbean	0.73	1.00	0.77	1.11	2325	20	46	4009	30	68
Maize	3.46	4.29	2.73	4.56	4536	16	112	7014	19	192
Groundnut	1.99	2.49	0.70	0.94	4355	40	50	6418	52	81
Pigeonpea	1.31	2.10	0.54	0.87	1619	22	27	2649	36	45
Castor	0.82	1.19	0.59	0.89	2216	18	40	3550	26	62

Table 4. Crop response to micronutrients in watersheds in Andhra Pradesh, India, 2003-04.

District	Crop	No. of farmers	Grain yield[1] (t ha^{-1})				
			Control	Control + MN		Control + MN + NP	
Mahabubnagar	Maize	14	3.34	4.58	(37)	5.17	(55)
	Sorghum	6	0.90	1.46	(62)	1.97	(119)
	Castor	8	0.94	1.38	(48)	1.65	(77)
	Pigeonpea	3	0.86	1.48	(71)	1.88	(118)
Nalgonda	Maize	10	2.01	3.60	(80)	4.46	(122)
	Mungbean	6	0.91	1.39	(54)	1.54	(70)
	Castor	9	0.48	0.76	(59)	0.78	(64)
	Groundnut (pod)	7	0.62	0.93	(49)	1.14	(84)
	Pigeonpea	5	0.65	1.21	(88)	1.22	(90)
Kurnool	Groundnut (pod)	23	0.90	1.32	(47)	1.59	(77)
	pigeonpea	4	0.70	1.06	(50)	1.20	(70)

MN = micronutrients; NP = optimum nitrogen and phosphorus.

Figures in parenthesis indicate percentage increase over control.

such initiatives were supported by Sir Dorabji Tata Trust in Madhya Pradesh and Rajasthan and World Bank in Sujala watershed program implemented in Karnataka. Some of the other knowledge-based EPA tried under different programmes were introduction of pest/disease tolerant cultivars, setting up of village seed banks, and regeneration of common grazing lands.

Conclusion

The lessons learnt from the implementation of this project are that knowledge-based EPA could be a powerful tool to capture the interest of larger community and that the same could be capitalized to build a sound strategy for up-scaling the project gains from one region to other regions. This strategy could address the issue of poor replicabiltiy of successful watershed projects to a large extent. Another point of learning was the willingness of farmers to share costs provided the benefits accrue were significant and tangible. Knowledge-based EPA technique was found to be far superior than the traditional subsidy or cash-based EPA for securing initial stage community participation. Further, lead farmers and PIAs served as agents of transformation and contributed significantly to the up-scaling process. Communication strategies such as juxtaposing the 'enabled' farmers with the others during field days, *Gram Sabhas* and dissemination meetings, proved very effective. Exposure to media and discussions with policy-makers provided a forum to the farmers for voicing their views. The farmers felt empowered with their newfound recognition among surrounding villages. This approach of enabling the SAT farmers though self-reliance could provide a fillip to the non-conventional extension approaches that strive to discourage cash or subsidy-based approaches.

Acknowledgement

We gratefully acknowledge the efforts of consortium partners (NGOs, CBOs, Farmers, SAUs, Government line departments and NARSs) who contributed significantly in evaluating this approach. We sincerely acknowledge financial support from them, ADB, SDTT, APRLP-DFID and Sujala-World Bank, which enabled full scale evaluation at this approach for up-scaling the benefits.

References

Fernandes A.P., 2000. Equity in watershed management: The MYRADA experience in social and institutional issues in watershed management in India . New Delhi, India: OIKOS; and Philippines: IIRR.

Government of India, 1994. Guidelines for watershed development. New Delhi, India: Department of Land Resources, Ministry of Rural Development, Government of India.

Olson, M., 1971. The logic of collective action: public goods and theory of groups (revised edition). New York, USA: Schocken Books

Rego, T.J., S.P. Wani, K.L Sahrawat,. and G. Pardhasaradhy, 2005. Macro-benefits from boron, zinc and sulfur application in Indian SAT: A step for Grey to Green Revolution in agriculture. Global Theme on Agroecosystems Report no. 16. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 24 pp.

Rockström, J., N. Hatibu, T. Y. Oweis and S. P. Wani, 2007. Managing Water in Rainfed Agriculture In: Water for Food, Water for Life. David Molden, (Ed.) Earthscan, London and International Water Management Institute, Colombo.

Sehgal, J. and I.P. Abrol, 1992. Land Degradation Status: India, Desertification Control Bulletin No. 21. UNEP, Nairobi.

Sreedevi T.K., B. Shiferaw and S.P. Wani, 2004. Adarsha watershed in Kothapally: Understanding the drivers of higher impact. Global Theme on Agroecosystems Report no. 10. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 24 pp.

Wani S.P., P.Pathak H. M. Tam, A. Ramakrishna, P. Singh and T. K. Sreedevi, 2002. Integrated Watershed Management for Minimizing Land degradation and Sustaining Productivity in Asia, In: Integrated land management in the dry areas (Zafar Adeel ed), Proceedings of Joint UNU-CAS International Workshop Beijing, China, Jingu-mae 5-53-70, Shibuya-ku, Tokyo-1508925, united nations University.. Pp 207-230

Wani S.P., H. P. Singh, T. K. Sreedevi, P. Pathak, T. J. Rego, B. Shiferaw, and S. R. Iyer, 2003. Farmer-participatory integrated watershed management: Adarsha Watershed, Kothapally India. An innovative and upscalable approach.- AQ case Study. In: R.R. Harwood and A.H. Kassam, Editors, Research Towards Integrated Natural Resources Management: Examples of Research Problems, Approaches and Partnerships in Action in the CGIAR, Interim Science Council, Consultative Group on International Agricultural Research, Washington, DC, USA (2003) pp. 123–148. "

Wani, S.P., P. Pathak, R. C. Sachan, and S. Pande, 2003a. Improved management of Vertisols in the semi-arid tropics for increased productivity and soil carbon sequestration. Soil Use and Management 19, 217–222.

Wani, S.P., A. R. Maglinao, A. Ramakrishna, and T. J. Rego, 2003b. Integrated watershed management for land and water conservation and sustainable agricultural production in Asia: Proceedings of the ADB-ICRISAT-IWMI Project Review and Planning Meeting, 10-14 December 2001, Hanoi, Vietnam. International Crops Research Institute for the Semi-Arid Tropics, Patancheru, India, 268 pp.

Wani, S.P., and Y. S. Ramakrishna, 2005. Sustainable Management of Rainwater Through Integrated Watershed Approach for Improved Rural Livelihoods. In "Watershed Management Challenges: Improved Productivity, Resources and Livelihoods" (eds. Bharat R. Sharma, J.S. Samra, C.A. Scott and Suhas P. Wani). IWMI, Sri Lanka . pp. 39-60.

Wani S.P. and T, K. Sreedevi, 2007. Strategy for Rehabilitation of Degraded Lands and Improved Livelihoods through Biodiesel Plantations. Paper submitted in 4th International Biofuels Conference held during 1-2 February 2007 at New Delhi

World Bank and FAO, (2001). Global Farming System Study, Challenges and Priorities to 2030, Rome. www.fao.org