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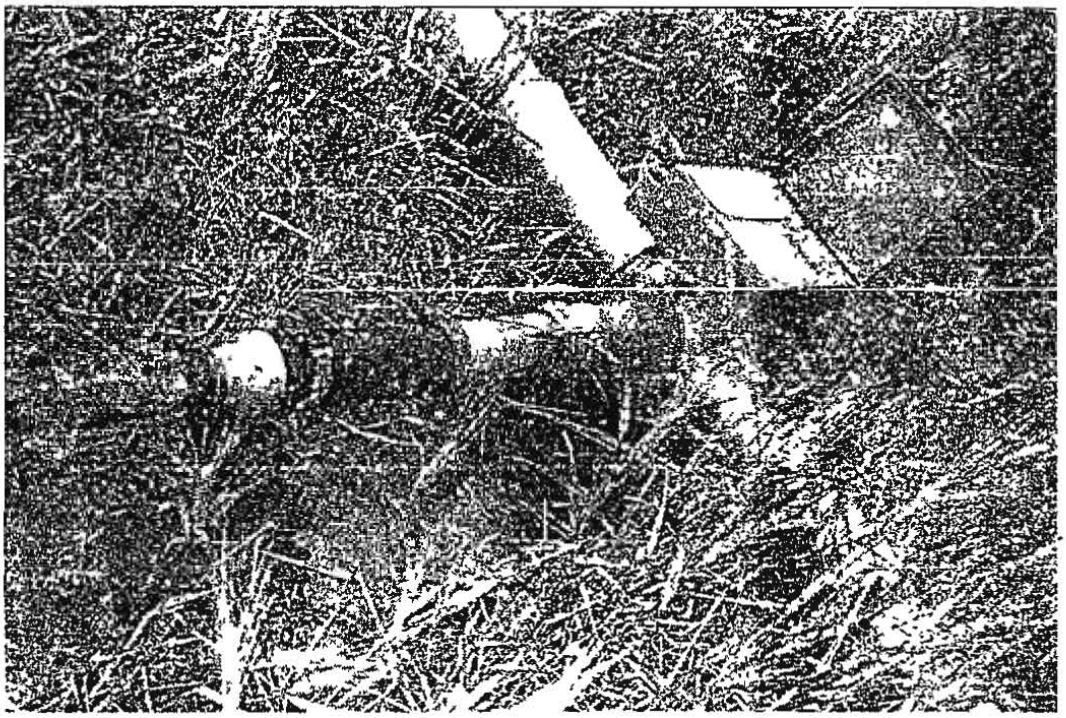

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A Consortium Approach for Sustainable Watershed Management for Increasing Productivity of Rainfed Systems: Potential and Challenges

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Abstract: *Rainfed agriculture in India covers nearly 65% of net sown area and there is enormous potential for enhancing productivity by one to two folds. An innovative model with a consortium of institutions for watershed management for increasing productivity of rainfed systems holistically through technical backstopping is developed and evaluated at Adarsha watershed, Kothapally in Ranga Reddy district of Andhra Pradesh, India. The approach of building new partnerships through consortium, participatory and convergence mode has yielded successful results at on-farm watersheds in India and Southeast Asia. The benefits reaped from this consortium approach model at Kothapally are being scaled up in three districts of Andhra Pradesh under the Andhra Pradesh Rural Livelihoods Programme (APRLP), three districts of Madhya Pradesh and Rajasthan, and Northeastern Thailand, North Vietnam and Southern China with support from APRLP-DFID, Sir Dorabji Tata Trust, India and Asian Development Bank (ADB), Philippines. This consortium approach provided 'win-win' solution for sustaining productivity, enhanced rural employment opportunities and improve the livelihoods of rural people while protecting the environment, which are the major challenges in the rainfed areas. However the challenge is on how to scale-up this consortium model to larger areas on sustainable basis. ICRISAT's successful watershed management programs reveal that further scaling-up may be done through capacity building initiatives. The lessons learnt from the consortium approach for watershed management can help re-engineer suitable roadmaps for maximizing returns to investment. Further we need to focus on issues such as community interest for participation, institutions to continue activity for maintenance after the project activity ceases, maintaining the link between the watersheds and supporting institutions for technical backstopping, appropriate policies for groundwater use and common property resources and innovative ways to develop common wastelands, micro-enterprises and village-based seed banks. With changing policies and economies, market links for products, value added products for rural areas, infrastructure and suitable ways to meet the challenges for the target areas also need to be addressed.*

Background

Agriculture is the key occupation and backbone of rural economies in the dry regions. The state of natural resources in the rainfed areas on which agriculture is dependent show a grim picture, generally characterized by high variable and low rainfall, fragile environments and poor natural resource base (low-productivity soils), water limitation, high poverty where people encounter disproportionate uncertainties in agriculture, with income levels meagre and uncertain. The natural resources in rainfed areas are facing serious threats of deterioration due to unrelenting human pressures, inappropriate management practices and utilization incompatible with its capacity.

In developing countries up to 70% of the population depends directly or indirectly on agriculture, and 560 million poor people live in the semi-arid tropics (Wani et al 2003). Their plight is

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the management of soil and water, which eventually leads to the development of other resources People's participation is critical for sustainable development and management of watersheds.

Success story of Adarsha watershed, Kothapally – Real-world on-farm watershed

Farmer-participatory integrated watershed management: A case study

In the consortium model, watersheds are used as entry points for converging livelihood related activities based on natural resource use. This helps watershed development to be explicitly linked with rural livelihoods and address the equity issues for landless families, women and youth in the villages. In the process, policy interventions are identified at the micro and macro levels. It also identifies issues on micro-practices, macro-policies, convergence and information and management systems. Watershed activities link micro-credit and revolving loan programs with resource poor farmers. Quantitative and qualitative indicators are used for impact assessment.

To improve the rural livelihoods through watershed approach ICRISAT has adopted Adarsha watershed, an example which is a more holistic vision that brings the concept of sustainability and eco-regionality and looks at achieving results through increased productivity and profitability of complex farming systems at the smallholder level. The Adarsha watershed at Kothapally village in Ranga Reddy district, Andhra Pradesh, India encompasses the new model tools and technologies for harnessing and managing natural resources on a watershed scale without undermining the natural resources.

The Adarsha watershed is a participatory system with a multi-disciplinary and multi-institutional approach, a process involving people to create a self-supporting system essential for sustainability. In the consortium approach, ICRISAT, Drought Prone Area Project (DPAP) officials, M. Venkat Rangaiah Foundation (MVF) an NGO, Central Research Institute for Dryland Agriculture (CRIDA) and farmers jointly selected Kothapally watershed for participatory on-farm integrated watershed management. The process began with the management of soil and water, which eventually lead to the development of other resources. Human resource development and large-scale community participation as improving the livelihoods being people centered, access to productive resources, empowering women, building on local knowledge and traditions and involvement of local villagers contributed to the success story of Adarsha watershed (Wani et al., 2002b).

Soil and water conservation measures

An insight into the watershed area of the village recognized a need for community-based water harvesting structures for efficient water storage and water conservation. As on December 2003, one gabion structure, 37 sunken pits in the gullies for increasing recharge of groundwater, 14 checkdams, 39 dry wells regenerated and 97 gully control structures were completed.

Increased productivity

In this watershed farmers evaluated improved crop management practices (INM, IPM and soil and water management) along with researchers. Farmers obtained high maize yield ranging from 2.2 to 2.5 times with improved technologies as compared to the yields of sole maize (1.5 t ha^{-1}) in 1998 (Table 1). In case of intercropped maize with pigeonpea, improved practices resulted in four fold increased maize yield (2.7 t ha^{-1}) compared with farmers' practices where the yields

further compounded by acute degradation of soil and water resources. It is estimated that by 2025 most of the developing countries will be facing severe water scarcity (Rockstrom *et al.* 2003, Spencer and Ryan, 2001). So far increased agricultural output was achieved mainly by bringing more land under cultivation (current average productivity in rainfed areas in SAT is 800-1000 kg ha^{-1}). The limits of geographic expansion were reached many years ago in densely populated parts of India, China, Java, Egypt, and Western Europe. The total area of land used for agriculture rose from 4.55 billion hectares in 1966 to 4.93 billion in 1996. Further agricultural research will become even more crucial in the 21st century than in the last century as we seek to grow more food on the same amount of land and water without causing ecological damage. Hence we need to look for "win-win" solutions that can improve both agricultural output and environmental conditions, and explore tradeoffs involved.

What is Needed?

In the Indian context for *e.g.*, as a major share (about 65 %) of agricultural land is rainfed, watershed programs can be considered as a key to meet the emerging and complex challenges of rainfed areas, such as deplorable high poverty, huge unemployment and acute degradation of natural resources. However, the conventional watershed development programs had a skewed approach of only reaping benefits from soil and water conservation unequitably. To address the issue of increasing rainfed productivity in dry regions, the new integrated watershed management model through consortium approach has provided multiple benefits across geographical regions, sizes, types and extent of people's participation as a vehicle of development to alleviate poverty by raising farm productivity and generating employment opportunities in marginal and fragile environments.

Innovative Participatory Consortium Approach Watershed Model

Based on the lessons learnt over the years, ICRISAT in partnership with NARSs have developed an innovative farmer participatory consortium model for management of watersheds (Wani et al., 2002a). The successful consortium model of on-farm benchmark watersheds in India, Thailand, and Vietnam was initiated in 1999 with technical backstopping by ICRISAT and national agricultural research systems (NARS). Five on-farm and three on-station watersheds covering varying agro-ecological, socioeconomic and technological situations were selected in India, Thailand, and Vietnam. This consortium approach adopted by ICRISAT comprising several institutions for technical backstopping of the on-farm with expertise from different international, national, government and non-government organizations (NGOs), private sector and farmers is utilized to advise and guide the community on the system/approach under operation. The largest benefits the consortium partners derive are establishment of the links and partnerships to exchange the knowledge and technologies amongst themselves, share the benefits by avoiding the duplication of work and by harnessing strength of other partners.

In order to address the farm productivity and dependent rural livelihood issues, the strategy of this participatory consortium model is to take the on-station research results to real-world on-farms watersheds through research for fine-tuning the technologies. Further scaling up and scaling-out the potential technologies for greater impact, which aims to create a self-supporting system essential for sustainability and development in the dry regions. The process begins with

watersheds were selected for development and critical monitoring as the sites for undertaking action research. An innovative model with a consortium of institutions, as opposed to single institution approach, for technical backstopping was initiated (Fig. 1) for project implementation (Wani *et al.* 2003b). All the partners have worked in partnership with another institution to manage the watershed sustainably.

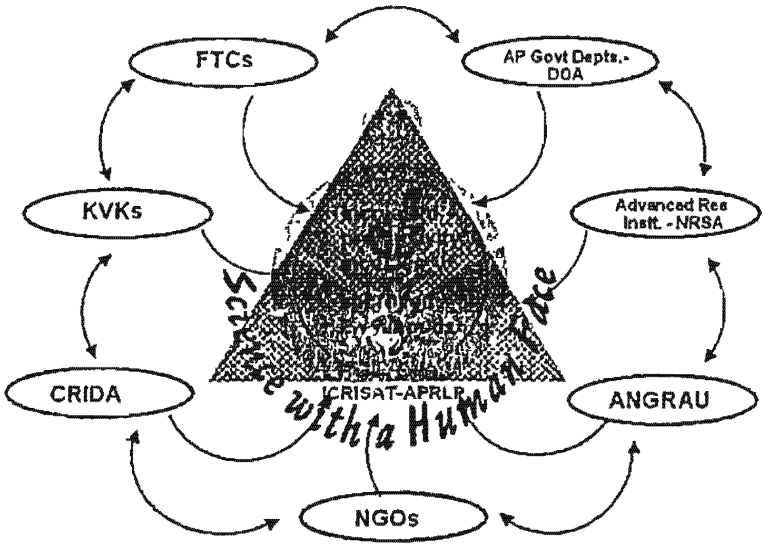

Figure 1. Farmer participatory ICRISAT-APRLP consortium for integrated watershed development.

A successful partnership based on strong commitment from state and local agencies, community leaders and people is desirable. It was recognized that to shift the community participation from contractual to consultative and collegiate mode, tangible private economic benefits to individuals are must. Such tangible benefits to individuals could come from *in-situ* rainwater conservation and translating through increased farm productivity by adopting IGNRM approach. Adopting the principle that "users pay" provided no subsidies for investments on individual's farms for technologies, inputs and conservation measures. Once the individuals could realize the benefits of soil and water conservation they came forward to participate in community activities in the watershed through various organized groups.

To achieve the goal of improving rural livelihoods and sustainable utilization of existing resources, the roadmap chosen is through convergence of activities in the watersheds such as agriculture, horticulture, livestock, fisheries, poultry and small enterprises that bring value addition to rural produce. The overall objective of the whole approach being poverty reduction, the new integrated watershed management model fits into the framework as a tool to assist in sustainable rural livelihoods.

The nucleus watersheds are serving as the sites of learning where farmers are conducting the experiments with improved soil, water, crop nutrient, and pest management options with the technical support from the consortium partners. The farmers from nucleus watersheds are slowly

were 0.7 t ha^{-1}. In case of sorghum the improved practices adopted increased yields by three-folds within one year. Yield of intercropped pigeonpea with improved management practices increased by five times in 2000 (Wani *et al.* 2002b).

Table 1. Average yields with improved technologies in Adarsha watershed, 1999–2002.

		Yield (kg ha^{-1})			
Crop	1998 baseline data	1999	2000	2001	2002
Sole maize	1500	3250	3750	3300	3480
Intercrop maize	-	2700	2790	2800	3083
(Farmers' practice)		700	1600	1600	1800
Intercrop pigeonpea	190	640	940	800	720
(Farmers' practice)	-	200	180	-	-
Sole sorghum	1070	3050	3170	2600	2425
Intercrop sorghum	-	1770	1940	2200	-

The impact of integrated watershed management interventions on poverty and livelihoods of rural communities clearly showed that average net returns per hectare for dryland cereals doubled and pulses was 45% higher even with irrigation, while the net returns on rainfed cereal crops have more than doubled. Adoption of the improved varieties not only increased crop yields, but also enhanced the economic profitability of other soil and water conservation investments, which may otherwise be economically not attractive to farmers. Average household income from crop production activities within and outside the watershed was 15400 and 12700 rupees respectively. The average per capita income was Rs. 3400 in Adarsha watershed and Rs. 1900 outside the watershed. This shows a significant impact of watershed intervention activities (initiated in 1999) towards poverty reduction in Kothapally watershed through increased incomes for the poor from crop production activities. The average income from agricultural wages and non-farm activities were 17700 and 14300 rupees within and outside the watershed, respectively. The increased availability of water (and hence supplementary irrigation) and better employment opportunities in watershed development related activities have contributed to diversification of income opportunities and reduced vulnerability to drought and other shocks (Wani *et al* 2003c).

Scaling-up and Scaling-out

These micro-level studies have been critically reviewed and analysed for upscaling the conclusions to stipulate the macro-level picture of the watershed benefits and people's participation.

Based on the success of the participatory consortium watershed management model at Kothapally; three districts of the Andhra Pradesh Rural Livelihoods Programme (APRLP) three districts of Madhya Pradesh and Rajasthan, Northeastern Thailand, North Vietnam and Southern China with support from APRLP-DFID, Sir Dorabji Tata Trust, India and Asian Development Bank (ADB), Philippines have selected this model for scaling up the benefits in nucleus and satellite watersheds. In the target ecosystems project implementing agencies (PIAs) were selected based on their strengths and knowledge base available in the system. Nucleus

Farmer participatory evaluation on B and S nutrient amendments studies in farmers' fields at Guna district, Madhya Pradesh showed that S application @30 kg ha^{-1} increased yields of soybean by 34% over the recommended N and P doses alone and with B and S application yield increase ranged from 22 to 53 % over control. Higher grain yields (48% over control with B+S application) of chickpea were recorded over control with residual effect of B, S and B+S application treatments (Table 2).

Table 2. Residual effect of B, S and B+S nutrient amendments applied to soybean on grain and straw yield of chickpea in watershed of Guna district, Madhya Pradesh, India during post rainy season 2002-2003

Treatment	Yield (t ha^{-1})		Percent increase over control	
	Grain	Straw	Grain	Straw
Boron (@0.5 kg B ha^{-1})	1.61	1.66	54	10
Sulphur (@ 30 kg S ha^{-1})	1.76	1.92	68	27
Boron + sulphur (@ same as above)	1.55	1.79	48	18
Control (farmer's practice)	1.05	1.51	-	-

In addition farmers from the nucleus watersheds evaluated improved land management, crop management and pest and disease management options and observed increased yields (46 to 158%) as compared to their normal practices. In order to explore alternate sources of livelihoods number of options such as nursery raising, vermicomposting, village-based seed banks, and *Dhal* making were identified and evaluated.

Increased rainwater use efficiency

Efficient utilisation of rainwater for increasing productivity and incomes plays an important role in dry regions. In Lalatora watershed (Vidisha, Madhya Pradesh) during 2001 the average rainwater use efficiency (RUE) for soybean grain yield was 1.6 kg mm^{-1} of rainwater under farmer's practice while it was 2.0 kg mm^{-1} rainwater (25% higher productivity for rainfed systems in Madhya Pradesh) where micronutrients were applied. In watersheds of Kurnool, Mahabubnagar and Nalgonda districts of Andhra Pradesh, the average RUE for grain yield in maize was 5.2 kg vs 9.2 kg mm^{-1}; in sorghum was 1.7 vs 3.7 kg mm^{-1} with micronutrient amended plots as against non amended control plots in the farmers' fields.

Village-based seed banks

One of the critical issues for increasing crop productivity is availability of good quality seeds to the farmers. The approach adopted was empowering farmers and self-help group (SHG) members to operate village-based seed banks. In order to build the stocks of seeds of improved crop varieties in the watershed villages, activities on continued strengthening of village-based seed banks by pumping in more quantities of breeders' seeds of different crops was taken up. As

empowered to become the trainers for satellite watersheds in the district. The PIAs implement the nucleus watersheds are empowered and developed as master PIAs to train other PI implementing watersheds in the locations.

The process

ICRISAT took up this challenge of converging various agencies at watershed level by putti together a consortium of organizations – national and state agricultural research institutio government departments, Krishi Vignan Kendras (KVKs), non-governmental organizatio (NGOs), farmers' organizations, and women's self-help groups (SHGs) — for effective delive at watershed level. The basic characteristic of an effective consortium is the common vision the project goal. The team building exercise started with the core team in the first round a spiralled up further to include the entire network of consortium partners in the fourth round. T workshops adopted the principles of openness and complementarity to get the best out of t strengths of consortium partners.

Baseline information and analysis

The detailed PRA and stratified household surveys for the nucleus watersheds, soil informatio along with historical rainfall and minimum and maximum temperature data enabled us t calculate the length of the growing period (LGP) and helped us to understand the constraints fo increasing productivity from the farmers' perspective. The LGP in the watersheds varied from 6 to 180 days and this critical information is assisting us in diversifying the existing systems t improve the productivity. The stratified household surveys provide baseline information fo monitor progress and impact of various interventions made in the watersheds.

Knowledge-based entry point

To move away from the subsidy and direct lurement through entry point activity we adopted knowledge-based novel entry point activity for building the rapport with the farmers in th watersheds. Based on the primary constraint analysis thru PRA and baseline characterization soil fertility was selected as an important constraint for increasing productivity. This knowledge based approach to make farmers aware about the health of their soil facilitated farmer participatory evaluation of nutrient amendments for the selected crops. Farmers were very much excited to know the results of their soil analysis and more so when the scientists at their doorstep explained it's implications to them.

Demand-driven interventions and participatory evaluations

Through PRA and subsequent discussions with the farmers demand driven interventions for increasing the productivity were identified. Through the regular discussions in ten nucleus watersheds under the APRLP about 1550 farmers came forward to evaluate improved crop and land management options on no subsidy basis. Fifteen farmers in each watershed representing different landholdings evaluated the responses to boron (B) and sulphur (S) amendments under their practices with green gram, maize, sorghum, pigeon pea, chickpea, castor, and groundnut. Similarly successful demand driven interventions and participatory evaluation for increasing productivity can be seen in ADB-ICRISAT and TATA-ICRISAT-ICAR watershed projects.

watershed PIAs and farmers serve as trainers to the rest of the watersheds in a given agro-ecosystem for rapid extension of technologies.

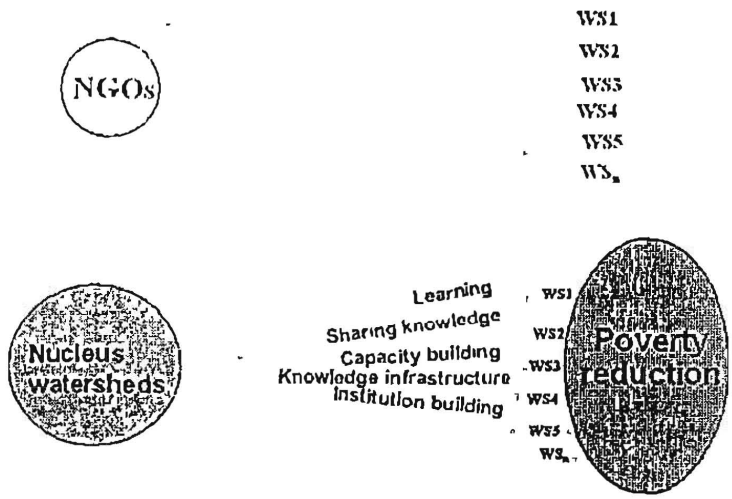

Figure 2. Knowledge transfer within the institution and the region

Mass capacity building efforts

Farmers' days, field days and farmer awareness programs are important activities for effective dissemination of on-station and on-farm technologies to a wide range of farmers in the watersheds. Specialized training courses/programs on participatory watershed management, tropicultor training, use and maintenance of hydrological equipment, seed treatment and *Rhizobium* inoculation methods, integrated pest and disease management, training project personnel on socio-economic survey methods in community watersheds, information and communication technology, action learning for community mobilization, income generating options and improving livelihoods like training of SHGs, women, youth and landless households in vermicompost preparation, *dhal* mill for milling pigeon pea are a part of this consortium model. Preparation of training materials, information brochures, bulletins, pamphlets on various watershed-based technologies such as tropicultor usage and efficiency, *Gliricidia* micronutrients and vermicomposting, in English and regional languages and their distribution in all the nucleus watersheds. Website for the APRLP-DFID-ICRISAT project, TATA-ICRISAT-ICAR and ADB-ICRISAT projects are launched with selected datasets to be put on the website and the site is updated as and when new information is added.

ICT-enabled farmer-centered learning systems for knowledge exchange

Modern information and communication technologies (ICTs) adapted are one of intelligent intermediation for facilitation of flows of information and knowledge to masses for upscaling the benefits. In the watersheds community centers managed by the PIAs are functioning as a Rural Information Hub (RIH) connecting participating villages (or groups of villages, as the case may be) and also with other internet connected web sites. Each RIH center has a PC and a suitable connectivity device (e.g. modem or VSAT technology). It is operated or managed by rural group (women or youth SHGs). To site a case, taking advantage of the established connectivity with Adarsha Society in Addakal, Mahabubnagar district a 'distance learning program was launched by ICRISAT.

purity of seeds play a very critical part in building the village-based seed banks; this issue addressed under the technical guidance of the consortium partners where the SHGs buy back seeds of varieties (not the hybrids) produced by the farmers. During the first season farmers provided with a choice to evaluate seeds of improved varieties and hybrids of the crops of choice on cost basis. Based on the performance of seeds of improved varieties of crops farmers adopted the practice of retaining the seeds for next year planting and also for selling. example, under the APRLP-ICRISAT- ICAR project, during 2003 season, two village-ba seed banks at Karivemula and Devanakonda became operational in Kurnool district that h already procured 10 tonnes of seeds of ICGS 11 and ICGS 76 of groundnut crop. In Nalgo district 4.5 tonnes of greengram (MGG 295) and one tonne of pearl millet (ICMV 221) w procured by the village seed banks of the district. During 2003 in ADB-Tata funded projects M.P. and Rajasthan seed banks for chickpea, sorghum and pigeonpea are operational.

Rehabilitation of common grazing lands and participatory bio-diversity management
Rehabilitating common grazing lands is one of the important activities under watersh management. As a case is the Tata-ICRISAT-ICAR project activity in Gokulpura village Thana watershed, Bundi district, Rajasthan where the terrain (90 ha of open grazing land) undulating and lands are highly degraded (little fodder and grasses that grew there were longer palatable to the cattle) due to high grazing pressure by cattle in this hot semi arid ar The Villagers through panchayat, resolved to erect stone wall (physical fencing) around the ha grazing lands and not to allow (social fencing) any cattle for grazing in that area. Thus t area was fortified with physical and social fencing. Once this was achieved villagers plan useful grasses, saplings all around the area. The degradation was so severe that the mortality the saplings was very high. Then came the idea of putting up stone bench terraces, cont trenches and silt trap pits for *in-situ* moisture conservation. This resulted in excellent soil moisture conservation and aided establishment of vegetation. Since after that the activity number of species of useful grasses and fodder has gone up many folds. Besides the flora ev the fauna has been rehabilitated in this area. Nilgais, a species of wild cow (blue bulls have ma this area a safe heaven for them and their young ones), rabbits, hares, jackals, foxes, mongoos and a host of bird species are found in this area, an impact of their community participatory a collective action.

A biodiversity assessment was undertaken recently with the community participating actively enumerating and listing the uses of the various herbs, shrubs and grasses that have be rehabilitated in this area. Some of the herbs, shrubs and grasses found rehabilitated in the pla are *Dhaman* (*Cenchrus setigerus*) grass, the native *Khejri (Prosopis cineraria)* species, B (*Zizyphus mauritiana*), Neem (*Azadirachta indica*), Dhallar (*Dichrostachys cinerea*), Shisha (*Dalbergia sissoo*), Subabul (*Leucaena leucocephala),* Khejada (*Acacia leucopholia*) etc.

Capacity building for empowerment of rural community and other stakeholders

Empowerment of stakeholders through capacity building is very critical in participatory integrate watershed management. In this model emphasis is on capacity building of all the stakeholders facilitate the scaling-up of the benefits from the nucleus and satellite watersheds in the targ districts. The strategy adopted in this module for scaling-up is depicted in Figure 2. The nucle

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Conclusions and Way Forward

The innovative participatory consortium approach in integrated watershed management is to increase rainfed productivity whilst protecting the fragile environment, promote inclusiv through participatory and convergence approach and create diversified opportunities improving rural livelihoods. The benefits through consortium approach were assessed join farmers and consortium partners in terms of efficiency, employment and sustainability nucleus watersheds. The well being of the rural poor needs our help on fostering their fai equitable access to productive resources. The analysis showed that the benefits of the wate program were more in the poor income regions as compared to higher income regions. Fa are fully involved in the on-farm trials and are confidently sharing their results and me adopted with other farmers from neighbouring villages; thus helping in scaling-up ben Successful watershed management programs reveal that further scaling-up may be don capacity building through farmers' days, training programs, and information and communic technology programs. The rationale behind adopting this approach has been that apart f conservation and efficient natural resource use benefits, it helps in cross learning by dr wide range of experiences from different sectors, further innovation and broad basing them large-scale use. The emphasis on empowerment of community, gender equity, and knowl based bottom-up approach and through convergence proved beneficial and farmers could d and manage their natural resources for increasing productivity and improving livelihoods successful results in different watersheds where consortium approach has been applied, re that participatory consortium approach for integrated watershed management is the way for to sustain the limiting resource base and enhance the productivity thereby alleviating poverty improving the livelihoods. This approach enables to have "win-win" solutions for sustaining productivity and it attempts to bring about desirable changes in a more holistic and system way including problem of rural poverty and protecting the natural resources.

However, the challenge is on how to scale-up this consortium model to larger areas increasing rainfed productivity on sustainable basis. This holistic approach of integr watershed management needs to be scaled-up through technical backstopping and capa building by increasing awareness amongst the stakeholders. We need to keep in mind through watershed programs we are working towards increasing the supply side of natu resources such as water, which is finite and limited. There is an urgent need to work on reduc the demand side for sustainable water management strategies. Appropriate policy institutional support for tapping potential benefits from watershed programs and its on-site off-site impacts need to be studied. With ever changing policies and economies, market links products, value addition products for rural areas, infrastructure and suitable ways to meet challenges for the target areas need to be addressed. Focus on issues such as commun participation; innovative ways to rehabilitate and manage common wastelands; institutions continue activity for maintenance after the project activity ceases; maintaining the link betwe the watershed and supporting institution for technical backstopping; building partnerships maximize externalities; equity issues and appropriate policies for groundwater use and comm property resources; balance demand and supply of water; choice of crops and administered pr policy for dryland crops; value addition to rural produce and promoting pathways for mar links for products would go a long way to increase productivity on sustainable basis.