Central Soil and Water Conservation Research and Training Institute (CSWCRTI)

L.1. Participatory Watershed Management

A case study from Antisar, Gujarat

Background

The Antisar watershed is spread over 812 Ha out of which 736 Ha is owned by private farmers and 76 Ha belongs to Antisar Panchayat and is used as common land. The watershed was characterized by soil erosion varying from 'sheet' and 'rill' erosion in agriculture fields to 'gully' erosion in the community wastelands devoid of vegetation. Runoff was as high as 33 per cent of the total rainfall; leaving little moisture for crop and vegetation growth. Further, the fertility of the soil was very low leading to poor yield of crops. The Valsad, Research Centre of the CSWCRTI initiated a watershed development project in Antisar under the IWDP scheme of the government of India.

Objectives and processes

The project objectives included conservation of soil and water, introduction of high yielding varieties and silvi-pasture development. The principle of participation of the local community in planning and implementation stages was followed in the Project. The various interventions taken up in the Project included; land levelling, bunding and smoothening of field slope, agro-horticulture, agro-forestry and crop demonstration on private farmers' field, and silvi-pasture development on community lands. Besides, construction and rejuvenation of check dams, artificial recharging of open and tube wells was taken up on both private as well as community lands. Awareness about soil and water conservation measures was generated through exposure visits. Regular meetings were held with the people of the watershed.

Photo 1 . Watershed association meeting in progress at Antisar

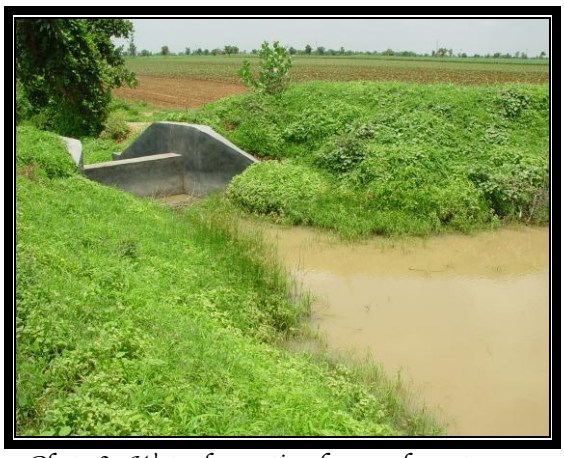

Photo 2 . Water harvesting for supplementary irrigation

Results and impact

As a result of the various interventions in the project, substantial impact was visible in the watershed. The land improvement index (LII) increased by 10.99 per cent (weighted area basis) for those lands brought under land leveling activity. Crop fertilization index increased from 0.42 to 0.73 (Figure 1). The crop diversification index (CDI) which had declined due to drought, subsequently increased. The cultivated land utilization index (CLUI) also showed increasing trend. Induced Watershed Eco-Index also increased. Overall, total cropped area increased from 586.05 Ha to 613.12 Ha despite four consecutive drought years. 1663 Ha-cm groundwater was harvested for crops including supplemental irrigation of 646 Ha-cm even in the drought year of 2002.

Fig. 1. Annual change in Cultivated land utilization index (CLUI), crop diversification index (CDI), crop fertilization index (CFI) and Induced Watershed Eco-Index (IWEI) for Antisar Watershed

The production of different grasses in the watershed ranged from 405 Kg/Ha to 1250 Kg/Ha as against nil in the beginning of the Project.

The on-farm investment by farmers increased by 3.24 per cent showing increased confidence in farming. The spending on consumer durables (0.24 per cent) in the face of four consecutive drought years reflects the improved economic status of the families in Antisar. The project was economically viable considering tangible and intangible benefits, the net present worth ranging between Rs. 5404/Ha (10 % discount rate) and Rs. 3993/Ha (15% discount rate) with benefits cost ratios being 1.61 and 1.57. The project was able to pay back all the costs in five years.

Photo 3 . Horti-silviculture in community land

Photo 4 . Rabi crop from recharged water

The corpus (Rs. 4.0 lakh) generated by local beneficiaries through contributions enabled the watershed functionaries to take up the maintenance of assets created during the project. The major work of village pond deepening undertaken by the watershed committee after the exit of Project Implementing Agency is testimony of their capabilities. These indicate that specialized personnel of various social groups are capable of running the project activities on their own.

L.2.Technology of Rainwater Harvesting and Recycling Through Renovation of Ponds

A Case Study from Johranpur, Chandigarh

Background

Majority of area in low lying Shivalik hills, covering 3.1 million Ha in north-western states of India is rainfed. Water stress during crop growth stages has been the most limiting factor affecting crop productivity in these areas.

Harvesting of rainwater during period of excess rainfall and its recycling during deficit period in kharif and/ rabi season could solve the problem to a great extent. The technology of rainwater harvesting and recycling varies with physiographic conditions. Rainwater management in moderately sloping agricultural watersheds would essentially revolve around reviving the ancient technology of ponds and tanks that have become ineffective either due to silting up or defunct catchments.

The Central Soil and Water Conservation Research and Training Institute (CSWCRTI), Research Centre, Chandigarh demonstrated the effectiveness of this technology in improving the productivity of lands in the shivalik hills. The demonstration is done on watershed basis and involves active participation of the local communities.

Processes and key activities

Rainwater harvesting and recycling in the watershed involved diverting the runoff rainwater from agricultural fields to the renovated ponds and recycling the harvested water back to the fields. The process enhances crop productivity by providing supplemental irrigation and checking soil erosion through safe disposal of runoff. This model of rainwater harvesting and recycling for agricultural watershed envisages first and foremost the creation of water storage capacity, in the range of one to two Ha-m, either by renovating the existing ponds or digging new ones. This is followed by construction of a network of drainage channels across slope to induce run off in the range of 20-30 per cent of rainfall and diverting the run off to ponds. Finally 50 per cent utilization of harvested rainwater for supplemental irrigations to crops is to be ensured. Thus, each hectare of land which produces 20-30 cm of runoff can get back 10-15 cm through 2-3 supplemental irrigations of 5 cm depths.

Encouraging results

Two supplemental irrigations to existing crops in the watershed brought about an increase in yield in the range of 186 to 289 per cent. It also made the introduction of new crops like tomato, ginger, legume and oilseed possible. It converted deficit of 58 and 61 per cent in supply of green and dry fodder, respectively to a surplus of 10 and 48 per cent.The overall net agricultural income per hectare per year was raised by 3.3 times from Rs. 7,448 to Rs. 24,590. All this resulted in higher share of agriculture to total income (73 per cent), employment per hectare (64 per cent) and per capita income (88 per cent).

Safe disposal of runoff through a series of newly constructed drainage channels caused marked reduction in soil and nutrient losses from the watershed. The area weighed degradation index of the watershed reduced from 2.11 to 1.29. This improved the availability of nitrogen, phosphorus and potassium in the soils of the watershed. The project implemented at a cost of Rs. 9.21 lakhs and having a life span of 20 years, had a benefit-cost ratio of 2.38. The payback period for the project was seven years with an internal rate of return of 28.6 per cent.

Encouraged with the success of Johranpur watershed, the Research Centre replicated it with greater success in Mandhala and Mansa Devi watersheds in Himachal Pradesh and Haryana respectively. The respective State Agricultural Universities have also shown the utility of watershed approach at ChurgalKhanna in Jammu and Kashmir and Mahadeva in Uttar Pradesh.

It is possible to extend the technology to more than 50 per cent area of Shivaliks (1.5 m Ha) having slope less than 15 per cent in the states of Himachal Pradesh, Punjab, Haryana, Jammu and Kashmir and Uttarakhand and also to entire dry and wet, sub-humid rainfed region of the country.

L.3. Integrated Land and Rainwater Management for Sustainable Production in Shivalik Foothills

(A Case Study from Solan , Himachal Pradesh)

Background

Mandhala located in the Shivalik foothills is characterized by undulating topography, poor soil fertility exacerbated due to soil erosion and lack of irrigation facilities. The small agriculture holdings on steep slopes witness frequent crop failures or very low yields as cultivation goes on year after year without proper conservation measures. Farmers stick to age old practices sometimes not aware of improved technology and at most others not in a position to invest on land improvement/development measures on their own. The cycle of inadequate inputs on degraded land resulting in poor productivity continues as farmers feel compelled to maintain revenue rights by cultivating land.

Integrated land and rainwater management for sustainable production in Shivalik foothills in Mandhala watershed in Solan district was initiated as a response to the need of the inhabitants and requirements of rainfed area after a basic resource survey. Aimed at an overall development of the village, the project spread across 425 Ha covering 151 farm families. Operational during the period 2002-2006, the project followed a participatory approach.

Processes and key activities

Improvement and development of land was undertaken to reduce erosion and to increase absorption of the incident rainwater into the soil profile leading to improvement of soil moisture conditions in the watershed. The possibilities of rainwater harvesting, storage and its recycling to provide irrigation potential were explored to increase productivity. Different water harvesting structures were developed to harvest the rainwater and recycle it for productive use. A pond with submergence area of 0.4 Ha with a catchment area of 4.32 Ha was developed in the village. De-siltation of pond and increasing the height of embankment increased its capacity from 0.7 Ha-m to 2.0 Ha-m. The pond is being effectively utilized for supplemental irrigation to about 10 Ha of land, which used to be under rainfed farming in the past. A check dam was constructed as a multipurpose structure to check erosion, retain water and also has a provision to divert the water to main pond in case of low rainfall in the region. A tank with a capacity of 22,000 liters was constructed to harvest the seepage flow (sub-surface flow) at a farmer's field. The sub-surface flow is perennial in nature and can meet the irrigation requirement of terraces with an area of two to three acres.

Besides improved water management practices, appropriate technology for wasteland development, increased production, and crop diversification was disseminated and demonstrated to enhance economy of farming community on a sustainable basis. Capacity building of farmers through training and exposure visits was undertaken. They were familiarized with composting techniques to improve soil fertility and were provided with Soil Health Cards. Fisheries development for multipurpose use of harvested water, establishment of *aonla* orchard by modified in situ budding technique and agro-forestry, bamboo plantation were some of the other activities undertaken.

Water use efficiency was greatly emphasized. A water users' society was also set up. After completing all the aspects of water resource development for upper Mandhala (i.e. excavation of pond, setting up of pump, overhead tank, pipelines, outlets) the scheme was handed over to the water user society. The society handles the operation of diesel pump, distribution of water, management of water accounts, etc.

Encouraging results

Performance of the water resource development structures has been good with all the structures fulfilling their objectives. Seepage losses have also been minimized by supplying the water through underground pipe lines. In case of one of the water harvesting structure, ten hectare of land was brought under supplemental irrigation. Per unit cost of storing water in renovated water harvesting structure was found to be Rs. 28.50 per cubic meter. However, return of Rs. 38.20 per cubic meter was obtained by utilizing the harvested water for irrigation to the crops in three years. The amount spent on storage of water in surface pond and even sub surface storage can be recouped in 4-5 years as the yields increase.

Crop yields have improved considerably on account of supplemental irrigation with the harvested rainwater. A total of 261 per cent yield increase in case of wheat and 218 per cent in maize was accounted for in just three years of the project period. Crop yields of the farmer in the irrigated area (by water harvesting structure) have gone 3-4 times the original yields. Employment generation has been 7270 man-days during the project period.

The Mandhala watershed presents a successful example of model watershed management in the Shivalik region. The overall development of village Mandhala has been widely acknowledged and appreciated. The technology of storing surface and subsurface water is economically feasible and appropriate and can be replicated elsewhere in the hilly tract of the Shivalik.

L.4. Watershed Management in Eastern Ghats

A Case Study from Koraput , Orissa

Problem Statement

The Eastern Ghats are discontinuous range of mountains, hills and plateaus on the east coast of India which occupy an area of 19.76 million Ha spread over the states of Orissa, Chhatisgarh, Andhra Pradesh, Tamil Nadu and Karnataka. The tribal dominant Koraput district located in the eastern ghat region of Orissa is characterized by low literacy, lack of awareness and backwardness. There is a large proportion of marginal farmers and landless people, land holdings are highly fragmented and there is a high reliance on common pool resources.

The Kokriguda watershed is located in Semiliguda block of Koraput district over an area of 317.5 Ha. The annual normal rainfall recorded in the region is 1521.8 mm which is generally received during 82 rainy days. The major problems identified in the watershed includes flooding in monsoon and acute water scarcity during summer, land degradation, poor fertility and productivity, lack of fuel wood and fodder availability, crop damage by wild animals, unemployment, distress migration in lean season, and illiteracy.

Improving the management of water was identified as a key issue and watershed development as a key approach for development of the area. A project was initiated for rehabilitation of wastelands and improvement of productivity of land, control of soil erosion, checking degradation of vegetation; to improve socio-economic conditions of tribal farmers; to refine available technologies for soil conservation and degraded land management and demonstrate them to people and developmental agencies/NGOs for its wider adoption in the region.

Processes

To identify the most suitable interventions a participatory rural appraisal (PRA) exercise and different surveys for effective watershed planning i.e LCC survey, vegetation survey, and land use survey along with determination of hydrological characteristics of the watershed were conduced. Thereafter, the identified interventions were implemented with full participation and in collaboration with the communities.

The implementation approach included both land and non-land based interventions; partnerships and convergence with different agencies; augmenting basic livelihood amenities; organizing and empowering communities; for development of sustainable livelihood and natural resources.

Interventions

Community Organization

To establish good rapport and trust with the villagers the Project undertook ‘Entry Point Activities’ (EPA) which included; human and animal health camps, distribution mosquito nets, provision for electricity and drinking water facilities, construction of biogas plants, community centre and community bathing place, repair of roads, and newspaper subscription. To improve the knowledge and skills of the community on alternate livelihoods, trainings and exposure visits on vegetable cultivation, nursery raising, improved crop production practices, grafting, honey bee cultivation, mushroom cultivation and vegetable processing were arranged for different groups of villagers.

The Project formed Self-help groups in the watershed and many of the livelihood activities were taken up by the women in these groups.

Ecology restoration, development of wastelands and productivity enhancement

The hillocks degraded as a result of shifting cultivation practiced by local community, were restored through various horti-silvi model supplemented with various *in situ* moisture conservation measures. Arable lands were developed through various soil and water conservation measures like land shaping, bunding, terracing, hedgerows and vegetative barriers. Gullies were plugged using loose boulder check dams (LBCDs), sunken ponds, and brushwood check dams. An underground pipeline irrigation system (with a conveyance efficiency of 95 per cent) was developed to tap the perennial stream, which helped farmers diversify in to remunerative vegetables and field crops. Agronomical interventions included introduction and promotion of cash crops like vegetables, improved crop varieties, double cropping, introducing high yielding varieties (HYVs), inter cropping, insect pest control measures and improved crop nutrition.

Results and Impact

The Water resource development actions resulted in generation of an additional storage capacity of 1.212 Ha.m of water. Imposition of physical and vegetative barriers and covers in the hills and sloping uplands reduced the *Jhola* flows by 17.9 per cent. The runoff reduced from 36.77per cent to 12.38 per cent and the stream perenniality increased by 3.84 per cent. The average water table rose by 0.325m. Soil loss from watershed also reduced from 38.2 t/Ha/yr to 6.6 t/Ha/yr. Through laying of an under ground PVC pipeline system of 1248m and 150mm dia, the conveyance efficiency increased from 23 per cent to 95 per cent.

The survival of different fruit trees like mango, guava, cashew etc. planted on non-arable lands was more than 80 per cent after 3-4 years of planting, mainly due to provision of various *in situ* moisture conservation measures. Among the forest trees like *gambhar*, *Acacia auriculioformis, Acacia mangium, Simaruba,* Cassia, the survival rate was more than 60 per cent. The interventions on arable lands increased the crop diversification index (CDI) from 0.68 to 0.98; cultivated land utilization index (CLUI) from 0.21 to 0.41; index of crop productivity from 0.33 to 0.48; crop fertility index from 0.13 to 0.44; cropping intensity 78 per cent to 120 per cent.

The percentage of organic carbon increased from 0.32 in the pre-project period to 0.51 in the post-project period. Similar increases in fertility and available nutrient status including N, P and K had also been observed in the watershed.

The improved water availability, reduced soil erosion, improved productivity of land and alternate livelihood skills resulted in doubling the annual per capita income of the villagers from Rs 12,155 to Rs 24,982. Out of the total 7278 person days of employment generated, 75 per cent have gone to the village youth. The benefit-cost ratio (BCR) of the whole project was found to be 1.7, while the BCR for interventions on arable land is 1.65 and for non-arable land it is 1.89.

The project work was highly appreciated by various organizations, line departments and NGOs and was awarded the prestigious “Vasanta Rao Naik Award for Dry Land Agriculture” for the year 2002 by Indian Council of Agricultural Research, New Delhi.

Replicability and dissemination

The state government recognized the watershed as a “model watershed” considering the outstanding work done by the CSWCRTI Research Centre. Several state govt officials, WDT members, farmers, trainees and NGOs from other areas have visited this watershed time to time during and after the project period. Sixteen exposure visits had been conducted to Kokriguda watershed during the project period. The work done in the watershed has been replicated by the Soil Conservation Department of State Govt. of Orissa and different NGOs in other watersheds.

L.5. Participatory Watershed Management for Sustainable Development

A Case Study from Patiala, Punjab

Background

The Shivalik foothills, forming part of outer Himalayas, are spread over the states of Jammu and Kashmir, Punjab, Haryana and Uttaranchal covering degraded area of about 41, 78,000 Ha. The low hills are considered to be one of the eight most degraded and highly fragile agro-eco systems of the country. The problem is so serious that in highly grazed Shivaliks, often 4-6 cm top soil disappears with one heavy shower. The degradation of the large chunks of land is basically attributed to the increasing biotic pressure in absence of appropriate management practices to augment and conserve precious land and water resources.

The CSWCRTI took up a representative watershed of 550 Ha area in the village Aganpur-Bhagwasi, district Patiala, (Punjab) for demonstrating participatory watershed development approaches. The project was taken up in the year, 1997-98 funded by Department of Land Resources, Ministry of Rural Development, Govt. of India, New Delhi.

The major problems identified in the watershed were lack of availability of water, steep sloping lands having severe erosion problems with poor moisture retention capacity, widening of *choes*/ *nalas* engulfing agriculture land, poor vegetation cover, very low productivity and fragmented land holdings.

Processes and key activities

The project was implemented with people's participation for which committees viz Watershed Association (WA), Watershed Committee (WC) and Watershed Development Teams (WDTs) were formed. The Project formed three self-help groups (SHGs) and five user groups (UGs) to facilitate the participation of weaker sections of society and landless families in the watershed. The activities carried out for development of the watershed included land levelling, terracing, gully plugs, water disposal structures, contour and graded bunds, agro-forestry/afforestation, horticulture plantation, crop improvement and supporting SHGs.

Contour bunds were built in an area of 22.5 Ha on higher slopes. Gabion check dams and masonry structures were constructed to check soil erosion in the watershed. These structures were further strengthened by bio-remedial measures like planting of *Saccharummunja, Ipomea cornea* and *Dendrocalamusstrictus* all of which have good soil holding capabilities. Under dry land horticulture, farmers were encouraged and helped to plant fruit trees like *aonla*, guava, lemon, *kinnow* and *karonda*.

Encouraging results

Land levelling, contour bunds and terracing helped in reducing theslope of land that earlier ranged between 0.54 and 3.8 per cent to between 0.1 to 0.8 per cent. The LLI increased from a low of 0.1 – 0.74 to as high as close to perfect value of one. The yield of wheat increased by 20 per cent, while that of lentil, mustard and *taramira* increased by 29.9, 20.2 and 8.4 per cent respectively.

Various conservation measures helped to control erosion of top soil. The runoff from treated watershed reduced to 24 per cent as compared to 48 per cent before treatment. Similarly, the soil loss reduced from 12.6 tonnes per Ha to 2.8 tonnes per Ha after watershed treatment.

The 45 water disposal structures, provided to safeguard the flow of runoff, proved very effective and the silt retained behind these structures ranged from 5.5 to 66.2 tonnes per Ha depending on the site and type of structure. About 35 Ha land was protected by providing these structures.

Gabion check dams and masonry structures protected 35 Ha of severely eroded land. These structures helped retain 12.3 to21.3 tonnes of soil per Ha per year. Contour bunds also proved to be a very effective measure against erosion. The improved moisture regime and favourable growth conditions created by the contour bunds enhanced the survival rate and growth of fodder grasses, fruits and forest plants. The positive effect of these activities was also seen on severely eroded lands downstream which could also be saved.

About 5.1 Ha of alkaline soil was treated with gypsum which reduced its pH from 10.2 to 8.6 that in turn allowed paddy cultivation for the first time giving a yield 31quintal per Ha. Dissemination of improved crop production technology through crop demonstrations increased the yield of most crops like wheat (82 per cent), black gram (80 per cent), and lentil (56 per cent). Application of 100:40: 20 kg/Ha of NPK respectively with 25 kg/Ha Zinc increased the maize crop yield by 174 per cent over farmers practice.

Different indicators calculated for impact analysis of watershed revealed that crop diversification Index increased from 0.545 to 0.756, cultivated land utilization index from 0.168 to 0.323, crop fertilizer index from 0.450 to 0.642, crop productivity index from 0.49 to 0.68 and eco- index increased by 0.115 points over the pre-project period. Vegetative barriers like *Saccharummunja, Ipomea cornea, Ddendrocalamusstrictus, Vetiveriazizanioides, Pennisetumperpureum* and *Eulaliopsisbinata* planted on field bunds near mechanical structures and along the gullies proved very effective for erosion control and provided much needed fodder besides protecting the land. Poplar planted on farmers' field under agro-forestry activity helped in enhancing their income. The project aimed at developing a model watershed. It has generated sufficient data, information and technology which can be useful to other developmental agencies, departments, researchers working in Shivalik foothill region. The results obtained under this watershed were replicated in other watershed developed by this centre.