Integrated Watershed Management in the Foot Hills of the Western Himalayas

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Abstract: Shivaliks-the foot hills of Western Himalayas also known as Kandi Region is heavily populated; 68% area of it is wasteland, uncultivated and devoid of vegetal cover. Immediate attention is needed to rehabilitate the tract to provide basis needs both for the cattle and people. In order to rehabilitate the area and to check further degradation, an Integrated Watershed Management Programme with the assistance of the World Bank popularly known as "Kandi project" was under taken in 27 most critical sub-watersheds covering an area of 75,295 ha. between June 1990 to March 1999 with a total outlay of Rs. 598 million for 9 years. Holistic approach of watershed management integrating land husbandry, forestry, agriculture, horticulture, animal husbandry with people's participation was adopted. With the implementation of appropriate soil and moisture conservation technology, improved agriculture, horticulture, forestry and animal husbandry practices through participatory approach it has been possible to arrest and reverse the process of eco-degradation by reducing flooding and devastation caused by soil erosion and run off, increase the production from arable and non arable lands on sustainable basis, and raise the income, employment and standard of living of the people. Greenery has returned and the people are happy and prosperous.The main direct benefits accrued by the end of project period on account of project intervention have been computed as Rs. 732 million against the total investment of Rs. 598 million by the end of project. These immediate benefits alone have resulted in a recovery of 123% of the total expenditure.

Keywords: shivaliks, integrated watershed management, holistic approach, people's participation, impact evaluation

1 Introduction

The foothill ecosystem of north India called Shivalik is considered as one of the most degraded ecosystems of the country where land, water, vegetation and animal resources have been locked in a complex and vicious cycle of degradation. This belt covers an area of 11,709 km^2 and forms about 21% of the total area of the State with a total length of about 275 km and width varying from about 20 km to 40 km. The terrain is hilly with a narrow belt of largely undeveloped farmland in the foothills with altitudes ranging from about 250 m to 1,500 m. The tract serves as catchment area for a number of important rivers. The steep slopes, denuded vegetal cover, monsoon rains and flash floods result in continuous soil erosion ultimately leading to ecological imbalance. The climate is subtropical. The mean annual rainfall varies from 800 mm—1,200 mm, the bulk of which (80%) are received during the three monsoon months (July to September). The mean annual temperature is normally 24℃ to 27℃. The hottest month is June in which drought conditions prevail. The rock system is weak and of very fragile nature, which is readily prone to disintegration on exposure due to removal of vegetative cover. Most of the terrain is highly susceptible to landslides and excessive erosion. The soils in general are shallow, poor in humus and interbedded with pebbles and boulders. The drainage density in the Shivaliks is very high, with 7 km to 9 km of drainage channels/gullies per km^2, leading to problems of soil erosion, flooding and declining productivity, a constant threat to life, property and means of communication for the villagers in the tract. There is acute scarcity of water in the area during summer months. Even the drinking water supply becomes uncertain and people have to depend on natural springs. About 90% of the agricultural land is under dry farming and only about 10% arable land is having irrigation available. The areas are

over burdened with over-grazing, grass cutting, lopping and over cutting of trees and other forms of environmental destruction. Agriculture is almost rainfed covering 18.53% of total area out of which only 17% is under irrigation. Crop production is very much subsistence-oriented. Crop yields are low mainly due to poor soil moisture management, inadequate soil preparation and faulty cultural practices. The region is also comparatively more heavily populated (210 person/km^2) against the average population density of 93 person/km^2 of the State. Natural vegetation is sparse, degraded dry mixed deciduous forests.

2 Solution

An Integrated Watershed Development Project (Hill) popularly known as Kandi project was envisaged to treat the most ecologically fragile area of the lower Shivaliks. A study identified 106 sub watersheds that require rehabilitation. Out of these, 27 most critical sub-watersheds covering an area of 75,295 ha were taken up for the treatment with the assistance of the World Bank. The Project became operational in June, 1990 and ended in March, 1999 with a total outlay of Rs. 598 millions.

3 Project objectives

The main objective of the project was to arrest and reverse the Eco-degradation of the natural environment through the use of appropriate soil and moisture conservation technology and increase production and income from arable and non-arable lands on sustainable basis. The conservation of soil and moisture in situ would improve the production and income from agriculture crops, horticulture, fodder, fibre, fuelwood and livestock, and reduce flooding and other devastation caused by the degradation in both the project area and adjacent plains. The aim was to lay the foundation for sustainable increase in production to keep pace with the population growth and develop approaches for coordinated interactive planning and strengthening the management and use of non arable lands. This required collective thinking and joint efforts of planners and policy makers, research institutions, non-government organizations and above all the local people. A strategy integrating the Forestry, Agriculture, Horticulture, Animal Husbandry and Soil Conservation was, therefore, to be adopted.

Basically the works involved in the project were of demonstrative nature to create visual impact centres. As a policy, the works were not executed over the entire catchment but only in the representative units for demonstration purposes so that people of that watershed get sensitized to use the technology and adopt it for holistic improvement of the area. Overall emphasis was laid on creating an enabling environment for greater people's participation in the management of their natural resources.

4 Project components and methods of treatment

The IWDP (Hills) comprises of five major components for integrated development of the watersheds. The share of budget (72% of the total project expenses) for each component spent in the watershed treatment operations is given in Table 1.

Table 1 Major components with percentage share of expenditure

S. No.	Components	% share of expenditure
1	Forestry	35%
2	Drainage line treatment and water management	40%
3	Agriculture	11%
4	Horticulture	5%
5	Animal husbandry	9%

Treatments adopted under various components are summarized below.

Forestry: Afforestation, Vegetative/Shrub Barriers, and Pasture Development.

Drainage line treatment and water management: Gully Stabilization, Stream Bank Protection, Village Ponds and Tank Construction, Rehabilitation of Village Ponds, Control of Roadside Erosion and Landslides.

Agriculture: Vegetative Field Boundaries, Contour Vegetative Barriers, Terrace Repair and Vegetative Reinforcement, On-Farm Fodder Production, Rainfed Crop Demonstration, Post Harvest Technology.

Horticulture: Rainfed Horticulture.

Animal husbandry: Livestock Reduction, Breeding Centres, Supplementary Livestock Feeding-Late Pregnancy, Calf-Starter, Female Calf-Rearing, Construction and Rehabilitation of Stalls.

People's participation.

5 Project implementing agencies

The Project headquarters is located at Solan, headed by the Project Director. The four field units headed by Assistant Project Officers (APOs) are located at Nahan, Nalagarh, Una and Nurpur. The staff from concerned line departments is provided at headquarters as Subject Matter Specialists (SMS) and in the field units for implementation. A State level Steering Committee was established for overall supervision of the project under the Chairmanship of Secretary (Forests) with the Secretaries and Heads of line departments and Directors of Research, State Agriculture and Forestry Universities as members.

6 Physical and financial achievements

The activities undertaken under various components and cumulative achievements for the project period (1990—1991 to 1998—1999) are summarized in Table 2 and Table 3.

Table 2 Physical achievements under various components (1990—1991 to 1998—1999)

Items/Activities		Unit	Achievements
Agriculture and Horticulture (Arable lands)			
(1)	Contour vegetative barriers	ha	285
(2)	Terrace repair and vegetative reinforcement	ha	5,814
(3)	Vegetative field boundaries	ha	8,852
(4)	Rainfed Horticulture demonstration	ha	2,172
(5)	Rainfed Crop demonstration	ha	7,856
(6)	On Farm Fodder Cultivation	ha	3,844
(7)	Post harvest loss prevention-Grain storage bins	No.	14,278
Forestry (Non-arable lands) on Forest-, Private-, and Village Common lands.			
(1)	Vegetative shrub barriers	ha	3,399
(2)	Pasture development	ha	2,939
(3)	Silvipasture	ha	1,928
(4)	Afforestation	ha	7,604
(5)	Woodlots	ha	144
(6)	Rehabilitation of vegetation	ha	2,070
(7)	Replenish Afforestation	ha	2,593
(8)	Smokeless Chullahs	No.	5,728
Drainage Line Treatment (Soil and Water Conservation)			
Gully Stabilization			
(1)	Masonry/cement structures	No.	88
(2)	Dry stone structures	M^3	126,191
(3)	Earthen run off dams	No.	47
(4)	Brushwood check dams	km	255

Continued

Items/Activities	Unit	Achievements
	M^3	53,375
Stream Bank Protection		
(1) Crate wire structures	M^3	86,161
(2) Live hedge spurs	km	206
	M^3	90,669
Village Ponds	No.	628
Water harvesting structures	No.	72
Roadside erosion control	km	114
	M^3	5,312
	ha	28
Landslide treatment	ha	432
Animal Husbandry		
(1) Natural Breeding Centres	No.	65
(2) Livestock reduction	No.	231
(3) Supplementary feeding-late pregnancy ration.	No.	7,067
-Calf starter	No.	493
-Female calf rearing	No.	3,374
(4) Construction of feeding stalls	No.	9,542
(5) Rehabilitation of feeding stalls	No.	1,034
(6) Construction of veterinary hospitals	No.	3
(7) Construction of veterinary dispensary	No.	5
(8) Chaff Cutters	No.	3,815
People's Participation		
Constitution of Village Development Committees (VDCs)		
Nalagarh Unit	No.	30
Nahan Unit	No.	28
Una Unit	No.	19
Nurpur Unit	No.	37

Table 3 Financial achievements (1990—1991 to 1998—1999)

Year	Amount spent (Rupees)
1990—1991	7,208,000
1991—1992	18,310,000
1992—1993	30,000,000
1993—1994	50,000,000
1994—1995	73,500,000
1995—1996	107,800,000
1996—1997	103,000,000
1997—1998	101,836,000
1998—1999	106,346,000
Total	598,000,000

7 Impact evaluation

To assess the impact and success of the project and draw inferences for future use, an impact

evaluation study of the IWDP (Hills) project was conducted by an independent agency “The Institute for Development and Communication (IDC), Chandigarh”. The aim of the study was to determine whether the project objectives set in terms of expected outputs, effects and impact thereof have been met. The study did not only assess the physical and financial achievements, but also indicated the discernible changes in socio-economic parameters and analyzed implementation constraints. Evaluation also clarified the validity of the course adopted to achieve the goals.

8 Methodology

The study was conducted through the processes of familiarization with the project, reconnaissance of the area, design of the study, and observations recorded in the field. Technique of stratified random sampling was adopted with the adequate sample size for various parameters and components of the study. Local communities as well as the project field staff were intimately involved in the sampling work through PRA techniques, participatory discussions, semi-structured interviews/ questionnaires etc. The data on plantations, structures and related project activities in the non-arable lands was collected by recorded sample measurements, whereas in case of arable lands (e.g. components of agriculture, horticulture, animal husbandry, peoples participation etc.) the relevant data was collected by household surveys based on semi-structured interviews, schedules and PRA exercises in the villages.

9 Results and discussion

The non-arable untreated (control) sub-watersheds are almost totally devoid of any older or mature tree growth. This scenario is indicative of over exploitation and indiscriminate felling of trees. In afforestation the average number of plants surviving per ha of afforestation area is 1,103. This indicates the result of protection provided in the plantations. The number of plants surviving per meter length of vegetative/shrub barriers varied from about 2 to 10 in different situations. In general, the performance of shrub barriers was not very satisfactory. Mean stocking of planted and natural plants in Silvipasture was 904 and 193 plants per ha respectively resulting in total stocking of 1,097 plants per ha. This requires thinning/pollarding to create more openings for inducing and sustaining of grass growth. Mean forage yield from the afforestation as well as silvipasture/pasture plots was about 30 quintals per ha compared to only 1.9 quintals per ha in case of untreated (control) sub-watersheds. In order to sustain fodder production at reasonably higher level, the tree and shrub canopy will have to be so managed as to allow sufficient sun to reach the forest floor for optimum growth of fodder grasses.

About 89% of the gully plugs have served their purpose of arresting soil loss very well. At places the number of spurs has been found inadequate to prevent bank cutting and in the process they are getting damaged due to excessive water pressure. 72.9% of the total spurs studied were categorized under grade-A as they had no noticeable damage, breach or structural failure. At places some are breached and toppled. This was due to wrong placement of spurs. However, overall performance and the workmanship of the spurs (87%) have been good. Wire crated retaining walls and breast walls constructed at vulnerable points along roads to check roadside erosion have generally functioned very well. The vegetation planted either to control the active landslides or to reinforce the crated structures had also established satisfactorily.

Out of the multiplicity of plant species used for landslide control works, Ipomea, Vitex, Leucaena, Dendrocalamus, Vetiver, and Saccharum species have given better results. Closure of the landslide area against grazing and cutting of vegetation seemed very important in its stabilization through quicker restoration of effective vegetative cover. Ipomea hedges were damaged badly by abrasive action of boulders and pebbles moving with the floodwaters in the upper reaches but performed well in lower reaches. Water harvesting structures including percolation tanks have caught fancy of the watershed communities and proved very useful for irrigated agriculture under otherwise water scarcity conditions. Though most of the structures have done very well, the reservoirs of some of them were seen to be silting up at the faster rate due to excessive erosion in their catchment. Moreover, the water delivery system was not functioning in certain cases and the farmers were not able to utilize the water stored therein. This aspect needs immediate attention of the VDCs and the concerned government department functionaries. On the whole, about 80% of the ponds were functioning very well.

The improved vegetal cover, stream bank protection and grade stabilization has afforded protection to lands, public properties and reclaimed torrent infested land for productive purposes. A survey revealed the reclamation of 1.21 ha of productive land per km length of drainage line. The total area of the land so reclaimed in the entire project is assessed to be 623 ha with an estimated value of Rs. 155,787,000.

The mean cultivated area per family increased marginally from 4.6 acres to 4.9 acres after the project. The proportion of irrigated area per family increased from 35.2% to 47.7%. Area devoted to maize has increased from 28.7% to 38.9%. Though there was no cultivation of berseem fodder in the control and treated watersheds during pre-project period, about 15% area is now devoted to berseem cultivation after the project. Yield of wheat increased from 19.17 qtls/ha to 23.5 qtls/ha and maize from 14.17qtls/ha to 16.35 qtls/ha.

Area under fruit cultivation increased to about 18%. Total milk production per family per day increased from 3 litres to 9.3 litres for non farming families while in case of farming families this production changed from 10 litres to 15.6 litres.

There was an overall improvement in the living standard of the watershed communities as a result of the implementation of the project. Value additions, income generated and certain immediate gains resulting from the implementation of Kandi project are summarized in Table 4.

Table 4 Evaluation of the total gains of different impacts of integrated watershed development project

Items	Assessed value (Rs. in millions)
Land reclaimed from choes (torrents)	155.787
Soil saved from being washed away	212.500
Nitrogenous nutrients from leaf litter	21.416
Organic carbon/Nitrogen accumulation in soil	35.203
Fodder increment on non-arable land	14.200
Increased grain production	128.200
Increased milk production	164.600
Total	731.906

The main direct benefits accrued by the end of project period on account of project intervention have been computed as Rupees 731.906 million (Table 4) against the total investment of Rupees 598 million (Table 3). These immediate benefits alone have resulted in a recovery of 122.4% of the total expenditure. Apart from these immediate benefits and gains, the project will also yield additional high dividend in the course of maturity of forestry and horticulture plantations and also provide indirect benefits of improved hydrology of the treated sub-watersheds in the long run. Since the project has been quite viable and sustainable environmentally as well as socio-economically and has achieved its objectives, the World Bank has extended the assistance to continue it for a further period of five years with a total outlay of Rs. 1,692.7 millions in Phase II.

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