Integrating Resource Conservation through Watershed Management in Uttaranchal Himalayas —Issues in Land Use Planning

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Abstract: The Indian Himalayas occupy an area of 53.7 Mha that constitutes 16.4% of the total geographical area (329 Mha) of the country. The region supports a large human population which draws heavily for various products from nearby forested areas and from degraded community forest areas for fodder, fire wood, timber, non-wood forest produce etc. Agriculture is primarily rainfed and water harvesting mechanisms occur in limited situations.

Scientific land use and watershed development is an integral part of the strategy to develop rainfed agriculture which has tremendous potential in the Himalayas. Since hill agriculture is primarily rainfed, increasing crop productivity along with sustainable development and natural resource conservation are the major objectives of these programs.

Evaluation of watersheds that were implemented through the National Watershed Development Project for Rainfed areas (NWDPRA) was carried out in two Central Himalayan watersheds, by purposive sampling with single stage stratification. Data were analyzed using partial budgeting techniques.

In both the locations crop diversification has taken place with new cash crops like peas, ginger, colocasia etc, which have been introduced through watershed interventions. The area under traditional crops like coarse millets has decreased. The irrigated area in Khootgad increased by 236% largely due to the construction of small water harvesting structures for storing surface runoff, while in Mohnagad the relative figure was 100%. Farmers in both the watershed have switched over to the cultivation of improved crop varieties although the use of chemical fertilizers is low and farmers continue to use organic manure for sustaining crop yields. Adoption of *in-situ* moisture conservation techniques coupled with increased crop production in both the watersheds has resulted in significant increase in crop yields, which range from 21% in potato at Mohnagad to 126% in case of wheat at Khootgad. The total agricultural production from the watershed increased by 41% in Khootgad and 135% in case of Mohnagad, the contribution being cereal crops in the former and cash crops in the latter. Fodder cultivation which was not practiced earlier became an important activity later on leading to sufficient fodder availability in the watersheds.

Family income analysis reveals that agricultural sector is the dominant source contributing more than 50% in both the watersheds. Further the income distribution pattern reveals that agricultural income is more equitably distributed than off-farm income, indicating that watershed development has helped in reducing income disparity. However the distribution of benefits from the watershed program is highly dependent on watershed accessibility to various infrastructural facilities, extent of consolidated land holdings, homogeneity of social structure and farmers perception about the programme and number of innovative farmers.

Watershed management in the Himalayan region has a vast potential to achieve self sufficiency, nutritional security, economic well being of small farmers along with environmental security. To realize the potential benefits to the extent possible many constraints expressed by planners, implementors and farmers need to be mitigated through technological advancements, increased accessibility and harmonizing existing policies.

Keywords: himalayas, watersheds, productivity, conservation, income, land use planning

1 Introduction

The Indian Himalayas occupy an area of 53.7 mha that constitutes 16.4 per cent of India's geographic area of 329 mha and supports nearly 300 million humans. The area of the newly formed hill state of Uttaranchal (28°43'45" to 31°08'10" N and 77°35'05" to 81°02'25" E) is 51,125 km^2 which supports a population of 8,479,562 humans (Census 2001), spread over two administrative divisions of Garhwal and Kumaon covering 13 districts. The forest area is 67% making it one of the most densely forested states in India. Rural communities in Uttaranchal draw almost all their sustenance from forests that provide fodder, fire wood, herbs and all inputs for agriculture and horticulture.

In Uttaranchal, only 13.62% is the net cultivated area. Agriculture is characterised by poor crop yields, tiny and scattered holdings, low cropping intensity, lack of irrigation, absence of HYV's and negligible use of chemicals and pesticides. Nearly 70% of the holdings are < 1 ha and cover only 24% of the cultivated area. Mixed cropping practiced in traditional subsistence hill farming helps in maintaining the large crop diversity which reduces risk of environmental unpredictability. Crop rotation, use of cattle dung and forest litter as sources of manure help to maintain soil fertility. Traditional varieties and races of paddy (rice) and minor millets (foxtail and finger millets) are the major summer crops while wheat, barley are important winter crops. Nearly 41% of the summer crop is devoted to paddy and 56% of the winter crop goes to wheat. High erosion rates from both arable and non-arable areas due to improper land and water management practices are issues of concern. Hazard mitigation and self sustainable village development through watershed approaches have been found to be most appropriate (Dhyani *et al*., 1997) for the Himalayan region.

This paper is based on the evaluation of two microwatershed management programs, implemented during 1993—1997 by the State soil conservation department under the National Watershed Development Project for Rainfed Areas (NWDPRA) in the middle Himalayas, so as to determine the efficiency of the programme and identify issues for efficient land use planning in the hill state.

2 Study sites

Two watersheds were extensively surveyed for this study. The Khootgad watershed (Almora district) represents the subtropical to temperate agro-ecological region of Kumaon. The geographical area of the watershed is 776.53 ha, with arable land being 61.13%. The watershed supports a population of 2,596 individuals. The watershed drains into the Kosi river whose water is used extensively for irrigation drinking and generation of hydro-electric power. The average annual rainfall in the area is 1,162 mm.

The Mohnagad watershed (Dehradun district) represents the temperate hill region of Garhwal. It is predominantly a non agricultural watershed since 78.41% of the watershed area of 1,839.2 ha is non-arable. The watershed has a thin population density majority of whom are tribals (Table 1). Both the watersheds followed primitive farming practices, poor crop yields and had practically no resource conservation mechanisms for ensuring sustained livelihood.

Table 1 General information about the watersheds surveyed

Attribute	Khootgad	Mohnagad
District	Almora	Dehradun
Region represented	Kumaon	Garhwal
River catchment	Kosi	Yamuna
Average annual rainfall (mm)	1,162	896
Agroclimatic situation	Subtropical to temperate	Temperate
Area of watershed	776.53	1,839.20
Arable land area (ha)	474.75	396.60
Reserve forest area (ha)	50.55	41.08
Civil *soyam* forest area (ha)	101.81	1,308.15
Pasture land (ha)	79.90	—
Barren land (ha)	69.50	93.26
Total human population	2,596	1,670

3 Methodology

Primary data were collected from sixty watershed farmers in each watershed on various aspects using pretested structured schedules. PRA techniques were also employed to gather information on project accomplishments and invite suggestions from farmers. Primary data was also collected from all the project functionaries and feed back was obtained with regard to administrative and policy issues. Secondary data was collected from project office. Partial budgeting techniques were employed for analysis of data. Diversification index was determined as per Shiyani and Pandya (1998).

4 Results

4.1 Sustainability of programme activities

Natural resource conservation, enhancement of crop productivity, development of horticulture and pastureland were the major objectives of the watershed programme. To achieve them several activities were undertaken in these two watersheds during 1993—1997 (Table 2).

Table 2 Works executed during the watershed project phase and their present status

Activity	Khootgad		Mohnagad	
	Work done during project	Present status 2000—2001	Work done during project	Present status 2000—2001
In Arable land				
Vegetative filter strips (m)	300	450*	6,400	2,160
Contour vegetative Hedge (ha)	82.5	60.0	773	165
Gully control (ha)	80.90	120.5*	—	—
Contour cultivation (ha)	350.0	180.0	—	—
Naula rejuvenation (no's)	4	5*	12	8
Dryland horticulture (no's)	13,955	21,378*	12,000	1,000
Compost pits (no's)	104	150*	—	—
Kitchen garden (no's)	233	400*	—	—
Crop demonstration (no's)	400	70 % of area is under HYV'S	300	50% of area is under HYV's
Irrigation tanks (no's)	—	—	25	7
In Non arable land				
Live stone fencing (m)	4,048	2,720	2,230	400
Vegetative contour hedge (ha)	128	70	12	6
Gully control (ha)	80.80	102.50*	—	—
Grass seeding (ha)	53.0	120.50*	350	420*
Live check dam (no's)	63	80.0*	422	165
Brush wood check dam (no's)	10	35	60	150
Afforestation (no's)	52,000	60% survival	153,000	8,000
Dugout ponds (no's)	22	27*	61	25
Loose boulder checkdam (no's)	286	265	723	380
Gabion structures (no's)	55	50	64	52
Retaining wall (no's)	7	4		
Dugout sunken structure (no's)	—	—	75	5

* indicate the activities which are being continued by farmers on their own initiative after project withdrawal; HYV's – High yielding varieties

The status of these activities after four years of project withdrawal reveals that in arable land treatment by contour vegetative barriers and contour cultivation were not favoured by farmers due to practical difficulties in field operations. Demonstration of improved crop varieties in general and that of cash crops, in particular, were popular activities in which farmers showed keen interest. Both the watersheds have suitable weather conditions in which off-season vegetables can be grown and sold at remunerative prices in nearby cities, fetching immediate profitable returns to cultivators.

It is interesting to note that the number of watershed activities executed in Khootgad watershed on arable land were more than those executed in Mohnagad watershed, although both the projects were executed by the same department. This difference may be attributed to keen interest showed by farmers of Khootgad in arable land improvement and their prior exposure to improved farming practices by an NGO in the watershed area. Vegetative filter strips as resource conservation treatment continued in Khootgad watershed, while they were discontinued in Mohnagad watershed. Further, vegetative filter strips are being adopted by those farmers who have consolidated their land holdings.

Among the various treatments carried out in non-arable land, grass sodding and brushwood check dam are being continued by farmers in both the watersheds since they are easy to adopt. Gabion structures constructed to control gully erosion while being effective, were not extended by the farmers due to their cost of construction and their location in common access areas.

Protection of community pasture land and afforested areas through stone wall fencing was observed to be ineffective in both the watersheds. Field investigations revealed that while survival rate of planted seedlings was above 60%, their growth was stunted due to continued disturbances by open access grazing being allowed for domesticated animals. However, cultivation of fodder grasses was widely prevalent in Khootgad watershed, with areas like terrace risers, terrace shoulders etc., being used for their cultivation and fodder availability increased by nearly 135% (from various sources) in the watershed.

Water harvesting structures and gully control measures led to the rejuvenation of dried springs (*naulas)* and dugout ponds were favoured in Khootgad, while such structures were not effective in Mohnagad. This may be attributed to two important factors – Khootgad has serious water scarcity throughout the year and secondly the location of water harvesting structures were identified by the farmers during the execution phase. Both these factors led to effective community efforts in water harvesting and recycling.

4.2 Impact of the watershed programme

The biophysical and socio-economic impact of these two watersheds management programmes is presented in Table 3. In Khootgad, the area under cultivation got reduced by 9.6% which was desirable since most of the arable land is not suitable for the cultivation of annual crops. In Mohnagad the area remained unchanged. Irrigated area increased by 263.3% and 114.6% in Khootgad and Mohnagad, respectively. Significant increase was observed in the area under cash crops in both the watersheds. Cash crops like vegetables, specially off-season vegetables, can be ideally grown in the hills, and since both the watersheds are well connected by all-weather road, movement of farm produce to large towns was not a constraint. It was observed that all arable land in the vicinity of one kilometer from road was being used for raising vegetables and other cash crops.

Cropping intensity increased by 51.5% in Mohnagad as compared to 19.6% increase in irrigated area in absolute terms. The area under improved pea and potato varieties was more in Mohnagad in the pre project period, whereas Khootgad was a traditional crop growing area. But after successful crop demonstration activities in Khootgad, the arable area began to be used for growing improved cash and food crop varieties. In contrast, farmers were disinclined to go in for improved crop varieties in Mohnagad probably due to the absence of an appropriate technology package for the watershed. Moreover, the presence of a central crop improvement and extension institute in Khootgad definitely had a significant impact on the adoption rate, which was lacking in case of Mohnagad. The average productivity of arable land increased by 28% and 93.2% in Khootgad and Mohnagad watershed, respectively, which can be attributed to large area under improved varieties and higher cropping intensity. This was also reflected in the availability of fodder in the watershed.

Table 3 Bio-physical and socio-economic impact of watershed management program

Indicator	Khootgad		Mohnagad	
	BP	AP	BP	AP
1. Arable land (ha)	474.75	436.78 (–9.6)	396.6	396.6
a. Irrigated area (ha)	11.0	37.0 (236.3)	53.4	114.5 (114.4)
b. Area under cash crops (ha)	9.0	101.2 (1,024.4)	133.5	217.5 (62.9)
c. Area under horticulture (ha)	32.0	38.0 (18.7)	12.0	41.0 (241.7)
d. Cropping Intensity	166.7	199.5 (19.6)	151.9	203.4 (51.5)
e. Average productivity of arable land (q/ha)	10.3	13.24 (28.5)	24.06	46.5 (93.2)
f. Area under improved varieties (ha)	7	70 (63)	15	45(30)
g. Average fodder productivity (q/ha)	16.5	18.4(1.9)	17.9	24.2(6.3)
h. Cultivated fodder production	—	4,350	NIL	NIL
2. Non-arable land				
a. Pasture land (ha)	79.9	99.9(25)	—	176.8
b. Canopy cover (%)	25.0	37.3(12.3)	20.0	22.0(10.0)
c. Green fodder production (g)	65.0	120.5(85.3)	55.0	109.6(98.2)
3. Diversification index	0.71	0.85	0.86	0.89
4. Socio-economic aspects				
a. Total human population	2,596	2,572(–1.1)	1,670	2,725(63.2)
b. Marketable surplus generated				
(i) Cereals (metric tons)	272	380 (39.7)	1,425.8	2,584.9 (81.3)
(ii) Pulses	–37	+141.8 (178.8)	0	–994.6 (–104.8)
(iii) Oilseeds	–19.8	+272.6 (292.4)	–485.5	-41.04 (–90.1)
(iv) Vegetables	–110.9	+597.6 (708.5)	44.73	19,266.2(183.3)
(v) Milk	124.8	+270.0 (116.0)	6,801.8	168.2 (132)
			72.5	
c. Average family income at constant price (*Rs*/hr)	14,213	27,849 (95.9)	21,410	51,288 (139.5)
(i) Contribution of farm income %	35.5	42.0	42.6	60.4
(ii) Contribution of labor within watershed	22.0	28.5	—	3.5
(iii) Contribution of off farm income	44.5	39.5	37.4	36.1

Figures in paranthesis indicate per cent increase over the before project period

Livestock rearing is an integral part of hill agriculture and non-arable lands serve as common area for open access grazing, as a result of which they are usually in a degraded state. The area under pasture increased significantly in both the watersheds, due to grass seeding and stall feeding of animals. The canopy cover and green fodder availability throughout a year, increased and led to positive changes in milk production in both the watersheds.

Total human population in Khootgad declined by just 1.1% due to out migration of farmers to nearby towns, whereas in Mohnagad the human population increased by nearly 63.2%.

It was observed that consequent to the implementation of the watershed program, a sizeable quantity of marketable surplus of all items is produced in Khootgad, while Mohnagad remained deficient in case of pulses and oilseeds. This is not only due to the large population in Mohnagad but also the low diversification rate. Average annual family income, at constant prices, increased by 96% and 140% in Khootgad and Mohnagad, respectively. Since a larger area is under cash crops (Table 3), contribution of income from watershed resources, therefore, increased by 13% and 21.3% in case of Khootgad and Mohnagad respectively.

4.3 Issues in land use planning

Many approaches of watershed development have been tried out, all in the pursuit of a elusive replicable participatory approach which can give sustainable results. Analysis of data of this study reveals that an integrated watershed approach is the key to achieve food and environmental security through resource conservation. Watershed development will fail to meet productivity equity and sustainability objectives unless project beneficiaries are fully engaged and careful attention is paid to social organization. Success depends on consensus among users (Farrington *et al*., 1999) for which priority needs of the farmers are harmonized with the technical programme, since farmers are more interested in short term benefits. Thus watershed programmes need to be 'demand driven' and not 'target driven' as is usually the case.

Participatory monitoring and in built flexibility for midway corrections in the program will help in confidence building and increase resource use efficiency. Information sharing and mutual negotiation for collective decision making regarding management of common property resources (CPR's) is essential for ensuring sustainability. Frequent exposure visits and need based training of watershed groups, specially women, through social equity is desirable to manage the assets created. Effective vertical and horizontal coordination among various line departments and non-governmental organization is necessary to ensure smooth implementation.

Finally, policy decisions need to be taken up at the government level for implementing land consolidation, improving accessibility and marketing of agricultural surplus. Earlier have reveled that soil conservation and water harvesting measures are effective and replicable if land holdings are consolidated, mostly by mutual consent among farmer groups. Natural resource conservation in fragile areas and increased agricultural productivity can be achieved through proper land use planning, using 'people power' supported by crucial policy decisions that will have far reaching positive impacts.

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