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Assessment of mid-himalayan watershed development project for improving agriculture and socio-economic structure of farmers in Himachal Pradesh

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Abstract
Himachal Pradesh Mid-Himalayan Watershed Development Project has been implemented with the objectives of the improvement of the incomes of the rural farmers and conservation of Himalayan natural resources. We have worked on SD-4E micro watershed of Satluj catchment area, Himachal Pradesh. Results showed that the change in the area under vegetables crop has been found to be increased by 44.93% followed by fruits (29.66%) and cereals (6.4%). Furthermore, productivity of maize and wheat have been found to be hampered by 29.95 and 27.78 q/ha and also found higher amongst beneficiary farmers as compared to non-beneficiary farmers. However, the% change in the productivity of vegetables crops was found higher under beneficiary farms *i.e.* tomato (16.32%) and capsicum (14.86%) followed by garlic (11.77%) cabbage (10.83%), pea (10.61%), onion (10.49%), cauliflower (9.74%), beans (9.74%) and ginger (3.15%). Moreover, beneficiary farmers has significantly increased their net returns per hectare, which was highest in tomato (Rs. 4.29 lakhs) followed by garlic (Rs. 3.48 lakhs), pea (Rs. 2.27 lakhs), cauliflower (Rs. 2.08 lakhs) and capsicum (Rs. 1.89 lakhs), respectively.

Keywords: Evaluation, watershed, beneficiary, dependency ratio, literacy index, productivity

Introduction
A watershed is an area that drains to a common point and watershed development seeks to manage the hydrological relationships to optimize the use of natural resources for their conservation, enhanced productivity and poverty alleviation. For achieve this goal, it requires a coordinated management of multiple resources within a watershed, including forests, pastures, agricultural land, surface and ground water linked through hydrology. Watershed development is considered as an important component for rural development and natural resource management strategies in many countries. The watershed programme is primarily a land based programme, which is increasingly being focused on soil and water, with its main objective being to enhance agricultural productivity for socio-economic development of rural people. It has been essential in a country like India where majority of the population depends on agriculture and about 60% of total arable land (142 million hectares) is under rainfed conditions. A large portion of the rainfed areas in India is characterized by low productivity, high risk and uncertainty, low level of technological changes and vulnerability to degradation of natural resources (Joshi *et al*., 2004) [5]. In present, watershed development has become the main intervention for natural resource management. Agricultural Water Management (AWM) interventions are often a first step to increasing small holder farmers' yield levels, their incomes and household food security in many developing countries. Globally, farming systems may hold a potential to increase current yield levels by 2-4 times, and water productivity gains potentially more than double. The Governments of Himachal Pradesh has launched many watershed development projects financed by national and international donor agencies with a view to rehabilitate the degraded environment and improve the economy of the state. The Mid-Himalayan Watershed Development Project (MHWDP) happens to be one such project operational in mid-hill regions of the state since 2005.
Watersheds, especially in the developing world, are increasingly being managed for poverty

alleviation as well as for environmental conservation objectives (Tennyson and Zingari, 2005; FAO, 2006) [16]. This is a positive development since past investments in watershed management often overlooked the social and economic impacts of the technologies. In some cases, the poor even bear the costs associated with watershed management while the rich reaped the benefits (Kerr, 2002) [7]. The actual and potential linkages between land and water management and poverty are however complex and likely to be site specific and scale dependent (Swallow *et al*., 2006) [15]. The present study aims at the objectives of studying the socio-economic characteristics and agricultural productivity of sampled households in selected micro-watershed socio-economic situation.

Material and methods

Selection of study area

MHWDP was implemented on 30th September 2005 in 42 developmental blocks in Himachal Pradesh. 272 micro-watersheds over 710 Gram Panchayats were identified for the project operation in 10 districts of the state. There exist wide variations in the level of treatment given to different micro-watersheds in various parts of the state. SD-4E micro watershed of Satluj catchment area, falling under Kot panchayat of Kandaghat Tehsil in Solan district was selected purposively for the present study.

Sampling design and Sample size

Simple random sampling technique was used for the selection of beneficiary and non-beneficiary farmers. The matter regarding the utilization of created potential of water was discussed with the officer of the agriculture department and it was reported that proportion of operational sites as well as extent of water utilization was more in Kandaghat block of Solan. The sampled project beneficiaries and non-beneficiary were characterized into three farm categories marginal (<1 ha), Small (1- 2ha) and semi medium (>2ha) on the basis of total land holding. A sample of 30 project beneficiaries as well as 30 non-beneficiaries was taken from the project sites.

Data collection

Both primary as well as secondary data were collected in order to fulfil the requirements of specific objectives of the study. The primary data were collected from the sampled beneficiaries and non-beneficiaries on specifically designed and pre-tested survey schedule through personal interview method. The secondary data were collected from the office of micro-watershed in Kandaghat block and publications of other line departments engaged in the project with respect to population, literacy, land utilization, cropping pattern, irrigation, and production of crops, project interventions in farm and non-farm activities.

Analytical techniques

The collected data was analyzed by using simple tabular method. The results have been presented by working out averages and percentages. Following formulae/expression were used for estimation of different parameters:

1. Sex ratio

Sex ratio represents the number of females per thousand males and was calculated for the total sampled households with the following formula.

$$\text{Sex Ratio} = \frac{\text{Total population of females}}{\text{Total population of males}} \times 1000$$

2. Literacy Rate

Literacy is an important indicator for judging the quality of human resources; it was calculated by deducting the population below five years of age (non-school going) from the total sampled population.

$$\text{Literacy rate (\%)} = \frac{\text{Total number of literate persons}}{\text{Total population} - \text{Population below 5 years}} \times 100$$

3. Literacy Index

Literacy Index is calculated by sum of weighted value for literacy category (primary, middle, metric, senior secondary and graduate & above) to the number of persons to be literate.

$$\text{Literacy Index} = \frac{\sum \text{Wi Xi}}{\sum \text{Xi}}$$

Where:
Wi = Weights i.e. 0, 1,2,3,4 and 5 for illiterate, primary, middle, matric, senior secondary and graduate & above, respectively
Xi = Number of persons in respective category.

4. Dependency ratio

Dependency ratio is calculated by the ratio of total number of dependents in a family to the total workers.

$$\text{Dependency ratio w.r.t. total workers} = \frac{\text{No. of dependents in a family}}{\text{Total workers}}$$

5. Cropping intensity

The cropping intensity has been worked out as the ratio of gross cropped area to the net sown area, expressed in percentage.

$$\text{Cropping intensity (\%)} = \frac{\text{Gross Cropped Area}}{\text{Net sown Area}} \times 100$$

6. % change in selected parameters

The production, productivities, input use, labour use, costs and returns etc. associated with different crop enterprises were estimated both for project beneficiaries and non-beneficiaries. The impact of project interventions was analyzed by working out% change with following expression:

$$\textit{Per cent change} = \frac{X_1 - X_2}{X_2} \times 100$$

Where:
X1 = value of parameter under project beneficiaries
X2= value of parameter under non-project beneficiaries

7. Output- input ratio

It is the ratio of gross returns to the cost of cultivation.

8. Gross return

Gross return refers to the total income of the farmers earned from crop.

9. Net returns

Return obtained by subtracting the total cost from gross return.

Results and Discussion

Distribution of project beneficiaries and non-beneficiaries farmers: Appraisal of data on the farm category-wise

distribution of beneficiaries and non-beneficiaries farmers is presented in table1 showed that the beneficiary and non-beneficiary farmers were distributed with respect to marginal, small and semi medium farm category according to their size of land holding. Moreover, Out of total selected beneficiaries and non-beneficiaries farmers in each category, 15 farmers belonged to marginal category, 9 farmers to small category and 6 farmers to semi-medium category. The % distributions were found to be 50%, 30% and 20% in the marginal, small and semi- medium farm in both categories.

Table 1: Farm category-wise distribution of beneficiaries and non-beneficiaries farmers

Category	Beneficiaries		Non-beneficiaries	
	Number	Percentage	Number	Percentage
Marginal farmers (< 1.0 ha)	15	50	15	50
Small farmers (1.0 to 2.0 ha)	9	30	9	30
Semi-Medium farmers (>2.0)	6	20	6	20
Total	30	100	30	100

Demographic profile of sample households

Distribution according to the size and structure of family determines the socio-economic well-being of the households. Distribution also indicates the demographic profiles of the farmers that how many of males and females of a particular family are indulge in agricultural activities. The data in table 2 revealed that, in case of beneficiary households, the average family size was observed at 6.87 persons per household out of which 56.04% were males and 43.96% were females. The average family size of 7.43 was observed in case of non-beneficiary households, out of which 55.61% were males and rest were females. The number of females per thousand of males was 784.48 in beneficiary category which was less than the non-beneficiaries, 846.77. In case of beneficiary households, the percentage of joint and nuclear families were 43.33 and 56.67%, respectively. This was higher in case of joint family and lower in nuclear family in case of non-beneficiary as compared to beneficiary households.

The literacy rate was observed to be 92.67% in beneficiary households while in case of non-beneficiary households the overall literacy rate was recorded at 79.82% in the selected watershed which was lower than the beneficiary households. Literacy index of beneficiary farmers was calculated to 2.95, whereas in non-beneficiary farmer's literacy index was worked out to be 2.53 which were lower than the beneficiary farmers. This indicates that though the literacy rate was higher in both categories the quality of education in study area was also fairly good among beneficiary farmers compared to the non-beneficiary as indicated by the literacy index.

Table 2: Demographic profile of sample households

Particulars	Beneficiary farmers	Non-beneficiary farmers
Size of the family		
Average size of Family (No)	6.87	7.43
Number of Males (%)	56.04	55.61
Number of Females (%)	43.96	44.39
Sex Ratio	784.48	846.77
Structure of family		
Joint families (%)	43.33	56.67
Nuclear Families (%)	56.67	43.33
Educational status		
Illiterate (%)	3.93	11.66
Non School Going (%)	3.4	8.52
Literate (%)	92.67	79.82
Primary	11.64	16.59
Middle	14.07	13.9
Hr. Secondary	31.54	21.52
Sr. Secondary	26.69	16.59
Above Sr. Secondary	8.73	11.21
Literacy rate (%)	92.67	79.82
Literacy Index of the families	2.95	2.53
Occupational status (%)		
Service	12.67	18.71
Business	23.06	18.71
Agriculture	64.27	62.59
Average no. of workers	4.20	4.63
Dependency ratio *w.r.t.* total workers	0.64	0.60

In case of both beneficiary and non-beneficiary farm categories, agriculture was the main occupation of the selected household. 64.27% and 62.59% of beneficiary and non-beneficiary farmers were indulged in agriculture. Furthermore, In case of business sector the beneficiary farmers was 23.06% whereas it was 18.71% in case of non-beneficiary farmers and the overall percentage of service sector was 12.67% for beneficiary farmers and 18.71% for non-beneficiary farmers which were slightly lower than the beneficiary farmers in both sectors. In agriculture sector workers population was comparatively higher in case of beneficiary farmers which shows that the beneficiary farmers are progressive than the non-beneficiary farmers in the agriculture sector. Dependency ratio with respect to the total workers was found to be 0.64 and 0.60% in beneficiary and non-beneficiary

farmers which was found more in beneficiary farmers.

Land utilization pattern of beneficiary and non-beneficiary farms in selected micro-watershed

Land is a natural resource which can yield the maximum profits to the farmers. It is considered as the important resource in which many farm and non-farm activities can be performed. Land utilization pattern in the study area was analyzed and presented in table 3 (Fig. 1). The study revealed that average size of land holding of the beneficiary farmer was worked out to be 1.12 ha, whereas 1.16 ha on non-beneficiary farmers.

Table 3: Land utilization pattern of beneficiary and non-beneficiary farmers (hectares)

Particular	Beneficiaries	Non-beneficiaries
Cultivated land +Orchard land	0.99 (81.06)	0.84 (71.99)
Ghasnis/ Pasture land/Forest land	0.13 (11.03)	0.20 (17.45)
Fallow land	0.10 (7.91)	0.12 (10.56)
Total land holdings	1.12 (100)	1.16 (100)

*Figures in parentheses indicate percentages to total

It was observed that the cultivated land and orchard area accounted for 81.06% of total land holding in case of beneficiary farmers whereas it was 71.99% in the case of non-beneficiary farmers. Ghasni and pasture land accounted for 11.03% in case of beneficiary and 17.45% in case of non-beneficiary farmers. Constituted fallow land was 7.91 and 10.56% in case of beneficiary and non-beneficiary farmers, respectively. Both the beneficiary and non-beneficiary farmers were making the maximum use of cultivated land as it is important resource which can yield maximum profits to the farmers. The land utilization pattern prevailing in the study area has been summarized in Figure 1. The figure revealed that average size of total land holding of the beneficiary farms was 1.12 ha, whereas 1.16 ha on non-beneficiary farms.

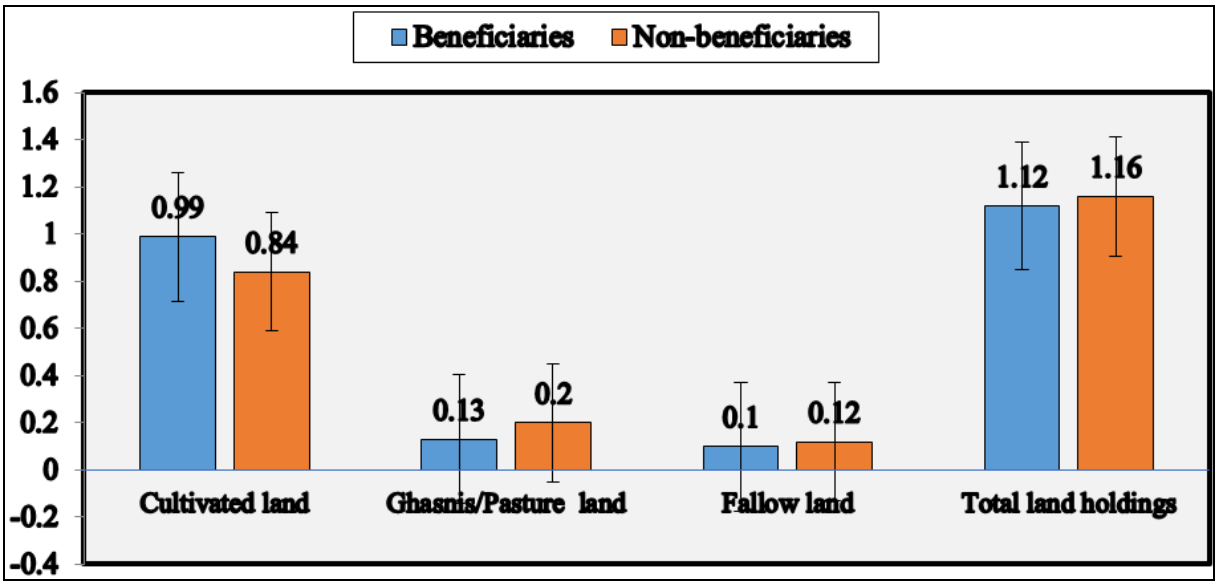

Fig 1: Land utilization pattern of sample household Change in cropping pattern of beneficiary and non-beneficiary due to MHWDP

Data illustrated in table 4 indicated the relative importance of crops in a particular region during a year with the aim to conserve soil and water, which in turn was responsible for the allocation of area to the cash crops. Both beneficiary and non-beneficiary farmers were growing similar crops but generally differing in area under various crops as availability of water was less on non-beneficiary farmers. There were maximum% change in the pea, cauliflower, cabbage and beans cultivation because the beneficiary farmers having the available water from watershed sources.

Table 4: Changes in the cropping pattern of sample cultivators (Hectares)

Particulars	Beneficiary farmers	Non-beneficiary farmers	% Change
Cereals	0.99	0.93	6.4
Vegetables	0.51	0.35	44.93
Orchards	0.15	0.12	29.66
Total	1.65	1.40	17.86
Gross cropped area	1.65	1.40	
Net sown area	0.99	0.84	
Cropping intensity	167.78	165.81	

The cropping intensity of beneficiary farmers has been found 167.78 which were slightly higher than non-beneficiary farmers 165.81, indicating shift towards high value cash crops and better use of land resources. Area under cereal crops was estimated to be 0.99 ha in case of beneficiary farmers which were slightly higher than the non-beneficiary farmers 0.93 ha. The total area under all crops in case of beneficiary farmers was 1.65 ha while it was 1.40 ha on non-beneficiary farmers. The% change shows that there was a highest change in the vegetable followed by the fruit crops and cereal crops. Total% change was found to be 17.86%, indicating the positive impact of watershed on beneficiary farmers.

Productivity of different crops grown by beneficiary and non-beneficiary in selected micro-watershed

Cereal crops

As a result of the project implementation, some additional area was bought under irrigation through various water harvesting structures and farmers could make use of irrigation water for their crop production. So, it determines that the beneficiary farmers were taking the advantages of the watershed by which their crop production and crop productivity was growing to higher side. Maize and wheat were the most important crops of *Kharif* and *Rabi* season, respectively in the micro-watersheds.

Table 5: Productivity of field crops on sample cultivators (q/ha)

Crops	Beneficiaries	Non-beneficiaries	% Change
Maize	29.95	27.78	7.82
Wheat	23.20	21.32	8.86
Pea	107.14	96.86	10.61
Garlic	95.88	85.79	11.77
Ginger	127.72	123.82	3.15
Cauliflower	120.55	109.85	9.74
Cabbage	133.65	120.6	10.83
Tomato	317.73	273.15	16.32
Beans	75.15	69.46	8.19
Capsicum	90.55	78.83	14.86
Onion	158.08	143.07	10.49
Potato	192.91	177.84	8.47

Production and productivity of crops was improved by the use of inputs like seed, fertilizer, irrigation and FYM etc. Table 5 indicated that the productivity of cereal crops was estimated to be higher in project beneficiary farmers as compared to non-beneficiary farmers. Productivity of maize was found to be 29.95 q/ha in beneficiary farmers and 27.78 q/ha in non-beneficiary farmers and the productivity of wheat was 23.20 q/ha and 21.32 q/ha in beneficiary and non-beneficiary farmers, respectively. There were 8.86 and 7.82% change in the wheat and maize for beneficiary over the non-beneficiary farmers, respectively.

Vegetable crops

Vegetable crops were grown prominently in micro-watersheds area where tomato, capsicum, ginger, garlic, pea, beans, cauliflower and cabbage were the major vegetable crops. Both beneficiary and non-beneficiary farmers were able to grow the same kind of crops but the non-beneficiary farmers were growing on less area as compared to the beneficiary farmers due to the less availability of irrigation facility. Table 5 indicated that the difference in productivity of vegetables was higher than the cereal crops. Tomato (16.32%) and capsicum (14.86%) recorded the highest change in the productivity followed by garlic (11.77%) cabbage (10.83%), pea (10.61), onion (10.49%), cauliflower (9.74%), beans (8.19%) and ginger (3.15%) on beneficiary farm compared to non-beneficiaries, implying the combined effect of project interventions. Therefore, they were using the better management practices like improved seeds, fertilizers, irrigation and plant protection. Similar results were found by Srinivasa (1988) [14], Kumar *et al*. (1999) [8] and Pathak *et al*. (2013) [10].

Economics of major crops grown by the sample households

The returns per hectare from various crops were computed and the results have been presented in Table 6. Table revealed that among the cereal crops, the highest gross returns were found to be Rs. 35 thousand from wheat followed by maize Rs. 34 thousand per ha and average cost of cultivation per hectares were Rs. 29 thousand in wheat and maize for beneficiary farmers, respectively, Whereas, gross return for non-beneficiary farmers were found to be higher in maize and lowest in wheat i.e. Rs. 32 thousand per ha with the average cost of cultivation of Rs. 26 thousand, respectively. The gross returns from the tomato were found to be highest Rs. 4.77 lakhs per ha with the average cost of cultivation of Rs. 48 thousand followed by the gross return from garlic (Rs.3.83 lakhs), pea (Rs.2.68 lakhs), ginger (Rs.2.55 lakhs) and cauliflower (Rs.2.41 lakhs) in case of the beneficiary farmers and gross return for non-beneficiary farmers were highest in tomato (Rs. 4.10 lakhs) with average cost of cultivation of Rs. 46 thousand followed by garlic, ginger and pea. The gross returns from vegetable crops were significantly higher in case of beneficiary farmers as compared to non-beneficiary farmers. Similar trend was observed by Kale (2009). Table further revealed that the net returns per hectare from different crops on beneficiary and non-beneficiary farms. Under beneficiary farms category, among the cereal crops the net returns from maize were found to be Rs. 5032 per ha and from wheat Rs. 6054 per ha and in case of non-beneficiary farmers net returns from maize Rs. 5505 per ha and from wheat Rs. 5 878 per ha were obtained. The percentage change in the net return from maize decreased by 8.59% and increased in the wheat by 3.01% in case of beneficiary over the non-beneficiary farmers.

Table 6: Impact of MHWDP on economics of major crops per ha on the sample cultivator (Rupees)

Category	Crops	Gross returns	Cost of cultivation	Net returns	Output-input Ratio
Beneficiaries	Maize	34440.20	29408.19	5032.01	1.17
	Wheat	34806.00	28751.10	6054.90	1.21
	Pea	267837.50	40556.15	227281.35	6.60
	Garlic	383536.00	35862.40	347673.60	10.69
	Ginger	255449.60	76152.25	179297.35	3.35
	Cauliflower	241094.00	33530.65	207563.35	7.19
	Cabbage	200481.00	32451.65	168029.35	6.18
	Tomato	476601.00	47514.12	429086.88	10.03
	Beans	187872.50	45907.95	141964.55	4.09
	Capsicum	226365.00	37860.43	188504.57	5.98

	Onion	189696.00	71093.05	118602.95	2.67
	Potato	96452.50	80236.35	16216.15	1.20
Non-beneficiaries	Maize	31942.40	26437.25	5505.15	1.21
	Wheat	31972.50	26094.45	5878.05	1.23
	Pea	242150.00	38210.36	203939.64	6.34
	Garlic	343160.00	33818.81	309341.19	10.15
	Ginger	247640.00	74770.88	172869.12	3.31
	Cauliflower	219700.00	30527.41	189172.59	7.20
	Cabbage	180895.50	31052.91	149842.59	5.83
	Tomato	409725.00	46130.91	363594.09	8.88
	Beans	173657.50	33336.61	140320.89	5.21
	Capsicum	197082.50	31098.91	165983.59	6.34
	Onion	171681.60	67830.21	103851.39	2.53
	Potato	88922.00	73403.58	15518.42	1.21

Net returns from vegetables crops were higher in case of beneficiary farmers as compared to non-beneficiary farmers. The overall net returns from tomato were found to be highest Rs. 4.29 lakhs per ha followed by garlic (Rs. 3.48 lakhs/ha), pea (Rs. 2. 27 lakhs/ ha), cauliflower (Rs. 2.08 lakhs/ha) and capsicum was Rs. 1.88 lakhs/ha in case of beneficiary farmers and in case of non- beneficiary farmer the overall net return from the tomato was highest followed by the garlic, pea, cauliflower, ginger and capsicum. The higher level of net returns to beneficiary farmers could be attributed by the irrigation facilities and better use of other resources. Same results were found by Sreedevi *et al.* (2004) [13]; Jat *et al.*, 2008 [4]; Rajput *et al.* 1994 [11]. The overall percentage change in the tomato were found to be highest (18.01%) followed by the onion (14.20%), capsicum (13.57%), garlic (12.39%), cabbage (12.14%) and beans (1.17%) in case of beneficiary over the non-beneficiary farmers. The average output-input ratio of maize, wheat, pea, garlic, ginger, cauliflower, cabbage, tomato, beans, capsicum, onion and potato were calculated as 1.17, 1.21, 6.60, 10.69, 3.35, 7.19, 6.18, 10.03, 4.09, 5.98, 2.67 and 1.20, respectively in beneficiary farms as compared to 1.21, 1.23, 6.34, 10.15, 3.31, 7.20, 5.83, 8.88, 5.21, 6.34, 2.53 and 1.21, respectively in non-beneficiary farms.

Conclusion

With the intervention of project there has been increase in the area under cereal and vegetables by 6.40 and 44.93% on beneficiary. The increase in productivity was found to be highest in case of tomato followed by capsicum, garlic, cabbage and pea for beneficiary farmers as compared to non-beneficiary farms. The percentage change in the net returns on the basis of economic cost in the wheat and vegetable crop was found higher as compared to non-beneficiary farmers. The major problems coming in the way of watershed development areas were the lack of knowledge regarding recommended scientific practices for crop and livestock husbandry, unfavourable climatic condition to recharge of water sources, medical facilities, and distribution system through kuhl irrigation, inadequate training, safe drinking water, and high cost of inputs. The deterioration of watershed functions has significant negative impacts, potentially leading to erosion and the depletion of soil productivity; the sedimentation of watercourses, reservoirs and coasts; increased runoff and flash flooding; reduced infiltration to groundwater; reduced water quality; and the loss of aquatic habitat and biodiversity. The main aim of watershed management is to conserve the soil, plant, and water resources of a catchment while benefiting humanity. All environmental, social, and economic concerns are combined to treat watersheds in an integrated manner. Project intervention has been positive and significant impact on raising the different field crops in the selected area. Watershed technology helped to increase the returns from dry land crop production as well as other subsidiary activities. The availability of irrigation facilities improved the cropping system and productivity on the farms, therefore, the implementation of watershed development programme needs to be continued and extended to other areas. For sustainable crop production on long term basis in rainfed areas, due priority should be given to watershed work with active participation of government machineries and beneficiaries. It was found that the farmers of watershed area utilize more amounts of inputs and consequently production was higher. Therefore, it is suggested that the lead bank of the watershed areas should emphasize on providing timely and sufficient credit in watershed area to harness the potential optimally. Policy recommendation is to implement the control measure such as: to control damaging runoff and degradation and thereby conservation of soil and water, to manage and utilize the runoff water for useful purpose, to protect, conserve and improve the land of watershed, to protect and enhance the water resource originating in the watershed, to improve and increase the production of timbers, fodder and wild life resource etc.

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