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Impact of Mid-Himalayan Watershed Development Project on its Beneficiaries in North-western Himalayas: A case of Himachal Pradesh

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ABSTRACT

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India's total farmers has 67.10 per cent marginal (below 1 ha.) followed by 17.91 per cent small (1-2 ha.). Indian agriculture thus dominated by marginal and small farmers who have very low land holdings, therefore raising productivity has been found to be the most important factor for increasing the income levels of farmers. Watershed management has been found to be influential programme for achieving this target. HP Mid-Himalayan Watershed Development Project - an integrated multisectoral Watershed Development Project has been operated in Mid Hills of Himachal Pradesh in 10 districts of the state from 2005 to 2017. The study has been carried out in the purposively selected Solan, Sirmour and Mandi districts of the state by selecting randomly a sample of 270 respondents comprising of 180 beneficiaries + 90 non-beneficiaries, in terms of 2:1 ratio for the comparison of both the categories of respondents. This study has put emphasis on land use pattern, cropping pattern, productivity, income and benefit cost ratio. Results revealed that beneficiaries have put more area under cultivation (0.56 ha) and have more irrigated land (0.36 ha) as compared to non-beneficiaries (0.20 ha) which lead to increase in cropping intensity (196.51 %) on their farms. The study recommends that positive impact to be recorded on farmers' productivity and benefit-cost ratio of important crops as of project and investigation should be intensified at the farm level for growers to benefit.

Introduction

The Indian Himalayan Region (IHR) plays a vital role in sustaining life. It is important to the 50 million people who lives on its slope, and equally but less visibly important to nearly 1.2 billion people, a fifth of the world's population who depend on its downstream river basins. Another 3 billion rely on it indirectly in terms of food and energy production. The 11 mountain and hill states

constitute almost 20.3 per cent of the total land mass of the country. Approximately 4 per cent (Census of India, 2011) of the Indian population live in the mountain states of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh, Nagaland, Manipur, Meghalaya, Mizoram and the hill district of Assam, Tripura and West Bengal. Keeping in mind the geographical aspects of the hills states where the forest cover areas are large and vast, and the

majority of the people living in these areas depend upon it for the livelihood. Forest becomes a centric focus. The protection of the livelihood comes in contrast with the conservation of forest, and how the existing forest rules and issues may aid in the development of the hill states. These are enormous prospects in the hill and mountain states for a thriving eco-tourism and mountain agriculture.

Himachal Pradesh located in North Western Himalayas of India, has a geographical area of 55,673 sq. Km with cultivated land 543365 hac (GOI, 2017). The State of Himachal Pradesh characterized by undulating, highly erodible and degrading tracts, has about 80 percent of cultivated land as rainfed (E&SD, 2017), hence the watershed approach has been found to be the most suitable approach for development of such hilly areas. The approach has been found to be holistic, multidisciplinary and integrated involving close coordination of different activities/departments. In the past, planning based on administrative units has failed to take in to account the peculiar problems, resulting from the historical process of over-exploitation of various natural resources in each locality.

Watershed management has been considered to be a process of planning, organizing and rationalizing land and other resources in command areas of a watershed to provide needed goods and services, simultaneously, conserving soil, water and other natural resources. The interrelationships among land use, soil and water, and the linkages between upstream and downstream area have been given an explicit significance in watershed management approach. Thus, watershed management has been found to focus on using resources in a productive and sustainable manner. The primary objective of watershed management projects has slows down or if

possible, reverses the man made degradation which has been mostly manifested in accelerated run-off usually with heavy sedimentations, reduced agricultural productivity and progressive removal of vegetative cover on non-arable lands. The watershed management projects internalize the externalities caused by flooding from a large number of seasonal torrents every year and there have been heavy investments on account of compensations by Central and State Governments.

The Government 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) has been operated in H.P. from 2005 to 2017, covering about 63.64 per cent to the geographical area of the state (E&SD, 2016). It has been considered essential to assess the impact as well as the distribution of such impacts among the targeted population, inhibiting the command area where project interventions have been completed during the last about 12 years. Estimation of different impacts of watershed development project has based on land use, literacy rate, cropping intensity, crop productivity, changes in household income, households' expenditure and changes in living standards. This article deals with changes in the socioeconomic parameters of selected households and impact of project interventions on land use, irrigation status, cropping pattern and productivity. It reveals that changes in benefit cost ratio of the important crops and incremental benefits on beneficiaries' farms.

Materials and Methods

HP Mid-Himalayan Watershed Development Project - an integrated multi-sectoral

Watershed Development Project has been implemented in Mid Hills zone of Himachal Pradesh with the assistance of the World Bank. The Project became operated in 10 districts of the state from 2005 to 2017 so as cover 710 Gram Panchayats of 46 Development Blocks. Purposive sampling has been adopted to select three districts namely Solan, Sirmaur and Mandi districts (Figure 1) out of 10 districts, because these three district represent 17 development blocks out of 42, comprising 40.4 per cent of the total command area and selected on the basis of varying climatic conditions which represents the overall impact of the project interventions in the total command area. Multistage stratified random sampling has been adopted to select the sample size. At the first stage, two development blocks from each district have been selected comprising 35.3 per cent of the total development blocks. At the second stage, list of gram-panchayats has been prepared and a sample of three gram-panchayats from each block has been selected. Thus, 18 Gram panchayats have been selected from the six blocks. At the third stage, a sample of 10 farmers from each gram-panchayat, thus a sample comprising of 180 farmers have been ultimately selected by adopting probability proportion method. Simultaneously, a sample of 90 non-beneficiaries have been selected from the adjacent panchayat unaffected by the project interventions. The data have collected based on personal interview of household heads through pre-tested schedule. The socio-economic parameters such as demography (Average size of family, sex ratio, dependency ratio, literacy rate and literacy index), land use pattern, cropping pattern, livestock inventory, crop productivity, total household income, net income from agricultural and non-farm activities and benefit cost ratios have been used in the study. All the information has been collected through field visits during 2016-17. Baseline

data have been collected from Agricultural census, 2005-06, Directorate of land records, Himachal Pradesh and Statistical outline of Himachal Pradesh, 2005-06, Economics and Statistical department of Himachal Pradesh.

Simple statistical tools such as averages, standard deviation and percentages have been used to arrive at the results related to the study objectives. t test has been used to study the significant difference in the crop productivity of important crops by using the following formula:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\sigma^2 \left(\frac{1}{N_1} + \frac{1}{N_2} \right)}} \sim df(N_1 + N_2 - 2)$$

$$\sigma^2 = \frac{N_1 \times \sigma_1^2 + N_2 \times \sigma_2^2}{N_1 + N_2 - 2}$$

Where,

\bar{X}_1 = Average crop productivity of beneficiaries

\bar{X}_2 = Average crop productivity of non-beneficiaries

N_1 = Number of the beneficiaries cultivated the given crop

N_2 = Number of the non-beneficiaries cultivated the given crop

σ^2 = Pooled variance

σ_1^2 = Variance of crop productivity for beneficiaries

σ_2^2 = Variance of crop productivity for non-beneficiaries

Gini concentration ratio and Lorenz curve have been used to examine the impact of the

project on household income distribution. The quantitative measure of Gini Concentration Ratio is given as follow:

$$\gamma = \frac{N-1}{N+1} - \frac{2}{N(N-1)\mu} \left(\sum_{i=1}^n P_i X_i \right)$$

Where,

γ = Gini Concentration Ratio

N = Total Number of Households

μ = Population mean's income

P_i = Income rank P of person i with income X

This effectively gives higher weight to poorer people in the income distribution helping to satisfy the transfer principle (i.e. the measured inequality should decrease, when shifting income from a higher to a lower income household given the original order of income ranks).

Assumptions of the study

There has been no demonstration effect of project interventions on non-beneficiary farms.

The study has only pertained to assess the impact of project interventions whether beneficiary and non-beneficiary farms have located under same watershed.

Results and Discussion

Description of the study area

HP Mid Himalayan Watershed Development Project (HPMHWD) has been operative in 5, 92,389 ha since 2005 and altitude ranging from 600 to 1800m, which lies between 30° 22' 40" N to 33° 12' 40" N latitude and 75° 45' 55" E to 78° 10' 15" E longitude. Soil has been found to be sandy loam to clay and have received annual rainfall of 1282.19 mm.

The command area of the project has been divided into different land uses. Maximum geographical area has been found under forests (40.40 %) followed by net sown area (31.62 %); permanent pastures and other grazing land (13.25 %) and; barren and uncultivable land (7.60 %). Per cent share of net irrigated area to net sown area has been found to be 13.45 per cent and cropping intensity of study area has been found to be 168.00 per cent. Kuhl and tanks have been major sources of irrigation covering 11.17 and 8.26 per cent of net irrigated area. Total population has been found to be 13.15 lac, out of which 24.94 and 5.70 per cent were schedule caste and schedule tribes. The project has operated in 710 panchayats and 5,592 villages covering 2,73,108 households. Literacy rate of the study area has been found to be 83.43 per cent. Total livestock population has been found to be 9,16,905 and human livestock ratio has been 1.43 as shown in Table 1.

Financial achievements of the project

Out of total expenditure done by the project, it has been found that maximum expenditure has been done for construction of water harvesting structures i.e. 25.38 per cent among different project activities as shown in Table 2. The prime objective of the project has to increase availability of water for irrigation and to achieve this object for effective implementation of the project and for enhancement of physical productivities expenditure on construction of water harvesting structures has to be doubled, which lead to further increase in farm income.

Socioeconomics

Socio-economic parameters (Table 3) indicated socio-economic status of the selected households. It has been found that average family size of beneficiaries (5.54) was more than non-beneficiaries (5.44) but

opposite results have been found in sex ratio. Non-beneficiaries (921) had higher sex ratio than beneficiaries (910) and in the baseline data it has been found to be 915. Dependency ratio has been found out to be 2.74 and 3.45 in case of non-beneficiaries and beneficiaries respectively. The literacy rate has found to be 91.67 and 89.89 per cent in case of beneficiaries and non-beneficiaries and found much improvement when compared with baseline data (74.90 %). Literacy index indicate average quality of education of the study area. These parameters have been used only to show the socio economic status of the study area; not for the comparison between beneficiaries and non-beneficiaries because it has been found that there was no such intervention under the product for increasing the literacy status and sex ratio.

Average size of land holding has been worked out to be 1.36 ha on non-beneficiary farms and 1.29 ha on beneficiary farms. The irrigated area has been found to 176.92 per cent higher on beneficiaries than non-beneficiaries, as a result, beneficiaries have put more area under cultivation (0.56 ha) leading to increase in their cropping intensity by 39.55 per cent as compared to non-beneficiaries and 175.63 per cent cropping intensity has been found in baseline data. Singh *et al.*, (2017) found that due to project interventions, cropping intensity has been increased significantly.

Change in Land use pattern

The total cultivated land under beneficiary farms has been found to be higher by 19.08 per cent as compared to non-beneficiaries (Table 4) which has been due to about 17.33 per cent lesser area under *ghasnis*/pasture and having more irrigation facility through construction of check dams and water harvesting structures on the beneficiary farms. This significant increase in cultivated

especially irrigated land has been found due to construction of village ponds, Makowal structures, Masonry dams, water harvesting structure and earthen run off dams on 16.66, 10.00, 6.67, 25.00 and 2.78 per cent of the total beneficiaries. The project high priority for roof rain harvesting, rejuvenation of village ponds, tanks and land development programme on percent farms on 11.11, 1.67, 14.44 and 4.44 per cent of total beneficiaries. More so, land put to non-agricultural use has been found to be less by 49.33 per cent on beneficiaries as compared to non-beneficiaries. Desai *et al.*, (1997) reported that project interventions helps the farmers to put more area under cultivation.

Cropping pattern of food crops

Cropping pattern in any region depends mainly on soil, altitude, micro-climate, availability of resources and management factors. The changes in the per cent share of area under different crops in the gross cropped area has revealed the extent of agricultural diversification on sampled farms. From the table 5 it has been depicted that there has been significant increase (49.09 %) in gross cropped area as compared to beneficiaries (1.06 ha) than non-beneficiaries (0.71 ha).

Per cent area under wheat and maize has decreased w.r.t. gross cropped area on beneficiaries than non-beneficiaries. But, there has been a significant increase in area under Kharif and Rabi vegetables. It has been also found that beneficiaries had shown shift from growing traditional crops like maize to high yielding crops viz. tomato (49.48 %), capsicum (64.96 %), ginger (99.93 %), pea (110.88 %) and garlic (54.94 %) due to increase in the irrigated area and providing seed of high value crops (5-10 Kg per household) by project. Ahmad *et al.*, (2011) and Kushwah *et al.*, (2016) revealed that

increased in the irrigation facility, helps the farmers to shift from traditional crops to high value crops.

Cropping pattern of fruits

Beneficiaries have about 139.67 per cent higher area to be under fruits than non-beneficiaries as shown in table 4. Apricot (30 %) and Plum (23 %) have found the major fruit crops grown by the beneficiaries (Figure 2). This has been due to different land development programme, irrigation facility, homestead horticulture and high yielding cultivars given by the project to 4.44, 50.00, 19.44 and 22.22 per cent, respectively. New crop like pomegranate has also been introduced by beneficiaries may be due to impact of HPMHWDP.

Cropping pattern of forest species

Area and number of fodder crops under beneficiaries' farms have significantly increased as compared to non-beneficiaries (Table 6). It has been found that *Bauhinia variegata*, *Leucaena leucocephala* and *Celtis australis* have been grown more by beneficiaries as compared to non-beneficiaries. This has also been due to project intervention for improving the productive potential through improvement of fodder and management practices (3.33 %), fodder augmentation demonstrations (2.78 %) and fodder conservation demonstrations (2.78 %) leading to about on an average 36.18 number of forest species higher than non-beneficiaries' farms. Semual *et al.*, (2004) also reported that increase the availability of fodder due to project interventions.

Table.1 Profile of HP mid-Himalayan watershed development project

Particulars	Project area
Altitude (m)	600-1800
Latitude and Longitude	30 ⁰ 22' 40'' N to 33 ⁰ 12' 40'' N and 75 ⁰ 45' 55'' E to 78 ⁰ 10' 15'' E
Annual Rainfall (mm)	1282.19
Soil texture	Sandy loam to clay
Total geographical area (ha)	5,92,389 (100.00)
Land Use Pattern (ha)	
1. Forests	2,39,340 (40.40)
2. Barren and Un-cultivable Land	45,049 (7.60)
3. Permanent Pastures and Other Grazing Land	78,462 (13.25)
4. Land put to Non Agriculture Land	4,037 (0.68)
5. Land under Misc. Trees Crops not included in Area Sown	8,930 (1.51)
6. Cultivable Waste Land	14,979 (2.36)
7. Other Fallow Land	4,849 (0.82)
8. Current Fallow Land	10,435 (1.76)
9. Net Sown Area	1,87,307 (31.62)
10. Area Sown more than Once	1,27,368
11. Total Cropped Area	3,14,675
Net-Irrigated area (ha)	25,199
Source wise irrigated area (ha)	
1. Kuhl (canals)	2,313
2. Tanks	2,081

3. Any other sources	20,805
Cropping intensity (%)	168.0
Total population (lac.)	13.15
Population density (person/km²)	222
Schedule caste population (lac.)	3.28
Schedule tribes population (lac.)	0.75
Number of panchayats	710
Number of villages	5592
Number of households	2,73,108
Literacy rate (%)	83.43
Livestock population (no)	9,16,905
1. Per ha cultivated area	4.89
2. Per ha grazing land	11.68
Human livestock ratio	1.43

Figures in parentheses indicate percentages to the total geographical area

Table.2 Total financial achievements of different project interventions under HP Mid Himalayan Watershed Development Project from 2005-06 to 2014-15

S. No.	Project interventions	Grand total (in Rs. cr)	Percentage
1	Institutional strengthening	84.54	23.16
2	Plantation activities	56.88	15.58
3	Soil conservation measures	39.70	10.87
4	Water harvesting structures	92.67	25.38
5	Productivity enhancement	20.51	5.62
6	Livestock development	21.82	5.98
7	Enhancing livelihood	48.99	13.42
	Total	365.10	

Table.3 Important socio-economic parameters in the study area

Sr. No.	Particulars	Unit	Non-beneficiaries	Beneficiaries	Per cent change	Base line data**
1	Average size of family	Number	5.44±1.90*	5.54±2.49	1.84	6.21
2	Sex ratio		921±221	910±275	-1.19	915
3	Dependency ratio		1:3.45±0.42	1:2.74±0.48	-20.58	1:3.56
4	Literacy rate	Per cent	89.89±16.20	91.67±12.55	1.78	74.90
5	Literacy index		2.60±1.11	2.69±0.80	3.46	2.05
6	Average size of land holding	Hac	1.34±0.52	1.29±0.46	-3.73	1.96
7	Net cultivated area	Hac	0.46±0.20	0.56±0.24	21.74	1.27
8	Irrigated area	Hac	0.14±0.04	0.36±0.15	176.92	0.28
9	Un-irrigated area	Hac	0.33±0.15	0.20±0.08	-39.39	0.99
10	Cropping intensity	Per cent	156.96±36.49	196.51±11.49	39.55	175.63

*Mean ± Standard Error, **Agricultural Census and Statistical abstract, Himachal Pradesh

Table.4 Land use pattern of selected households (*Ha.*)

Particulars	Non-beneficiaries	Beneficiaries	Per cent change
Cultivated area	0.45	0.54	19.08
	(33.80)	(41.62)	
Irrigated	0.13	0.34	156.47
	(9.97)	(26.44)	
Un-irrigated	0.32	0.20	-38.40
	(23.83)	(15.18)	
Orchard Area	0.01	0.02	139.67
	(0.66)	(1.65)	
Irrigated	0.01	0.02	
	(0.13)	(1.56)	
Un-irrigated	0.01	0.00	
	(0.53)	(0.08)	
Forest land	0.07	0.05	
	(4.89)	(3.85)	
Ghasnis/Pastures	0.68	0.56	-17.33
	(50.63)	(43.29)	
Fallow land	0.05	0.05	
	(3.43)	(4.21)	
Barran land	0.05	0.05	
	(3.53)	(3.78)	
Land put to non-agricultural use	0.04	0.02	-49.33
	(3.07)	(1.61)	
Total Area	1.34	1.29	
	(100.00)	(100.00)	
Irrigated	0.14	0.36	
	(10.10)	(28.01)	
Un-irrigated	1.20	0.93	
	(89.90)	(71.99)	

Figure in parentheses indicate percentage to total

Table.5 Cropping pattern of food crops (*Ha.*)

Particulars	Non-beneficiaries	Beneficiaries	Per cent Change
Wheat	0.14	0.18	32.05
	(19.61)	(17.37)	
Maize	0.15	0.14	-9.94
	(21.61)	(13.06)	
Other	0.00	0.05	
	(0.00)	(5.02)	
Kharif Vegetables			
Tomato	0.10	0.15	49.48
	(14.20)	(14.23)	
Capsicum	0.07	0.12	64.96
	(9.90)	(10.96)	
Ginger	0.02	0.04	99.93
	(2.72)	(3.65)	

Other	0.03 (3.83)	0.05 (4.39)	71.00
Rabi Vegetables			
Pea	0.09 (12.65)	0.19 (17.90)	110.88
Garlic	0.07 (9.61)	0.11 (9.99)	54.94
Other	0.04 (5.87)	0.04 (3.44)	
Gross cropped area	0.71 (100.00)	1.06 (100.00)	49.09

Figure under parentheses indicate percentage to gross cropped area

Table.6 Cropping pattern of forest species

Particulars	Non-beneficiaries		Beneficiaries	
	Area (ha.)	Number	Area (ha.)	Number
<i>Grewiaoptiva</i>	0.06 (37.28)	11.38	0.05 (25.17)	10.41
<i>Morus alba</i>	0.02 (12.74)	3.81	0.02 (8.96)	3.71
<i>Bauhinia variegata</i>	0.01 (8.37)	3.06	0.02 (8.79)	4.54
<i>Leucaenaleucocephala</i>	0.01 (7.95)	2.33	0.02 (8.20)	3.39
<i>Celtisaustralis</i>	0.04 (27.58)	4.05	0.07 (35.97)	7.44
Other	0.01 (6.08)	2.26	0.03 (12.93)	6.68
Total	0.16 (100.00)	26.90	0.21 (100.00)	36.18

Figure under parentheses indicate percentage to total

Table.7 Per cent change of crop productivity and its significance between beneficiaries and non-beneficiaries

S.No.	Crops	Per cent Change	t value
1	Wheat	13.64	8.68*
2	Maize	30.08	26.23*
3	Tomato	11.72	24.22*
4	Capsicum	11.39	13.67*
5	Ginger	12.15	6.89*
6	Beans	10.27	14.27*
7	Pea	13.19	12.89*
8	Garlic	7.97	12.11*
9	Cauliflower	7.26	5.20*

*p value <0.01

Table.8 Incremental benefits to farmers from the project (*Rupees*)

Sr. No.	Particulars	Non-beneficiaries	Beneficiaries	Per cent change
1	Net income from agricultural activities	112708	179862	59.58
2	Net income from non-agricultural activities	118545	124131	4.71
3	B/C ratio of important crops			
	i. Tomato	1.72	1.90	11.03
	ii. Capsicum	1.69	1.81	6.84
	iii. Ginger	1.95	2.06	5.32
	iv. Beans	1.70	1.82	6.93
	v. Pea	1.68	1.70	0.84
	vi. Garlic	1.57	1.63	3.74
	vii. Cauliflower	1.49	1.54	3.94

Fig.1 Location map of the study area

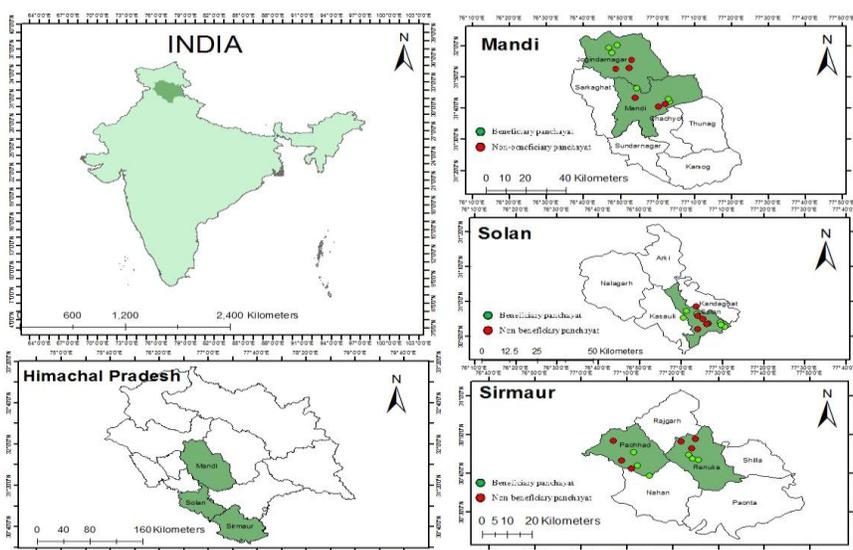


Fig.2 Cropping pattern of fruit crops

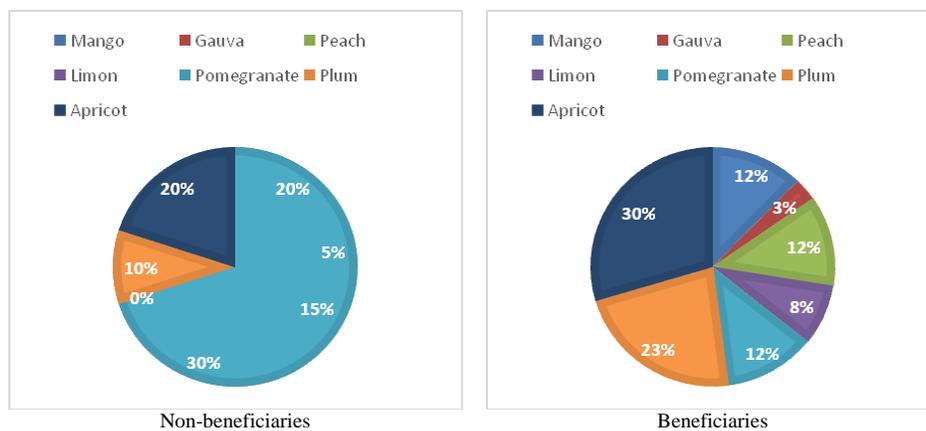


Fig.3 Livestock inventory of beneficiaries and non-beneficiaries

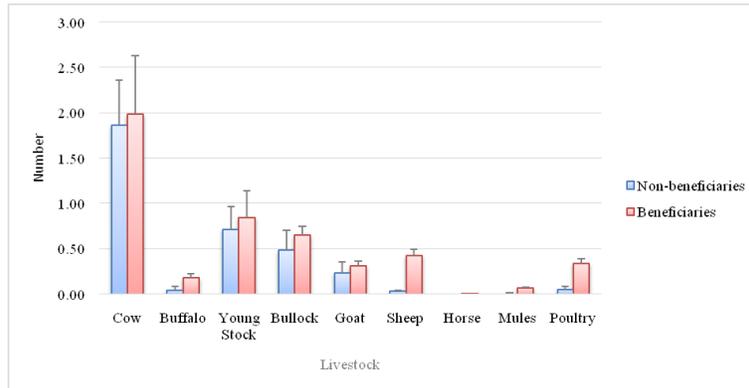


Fig.4 Crop productivity of major crops

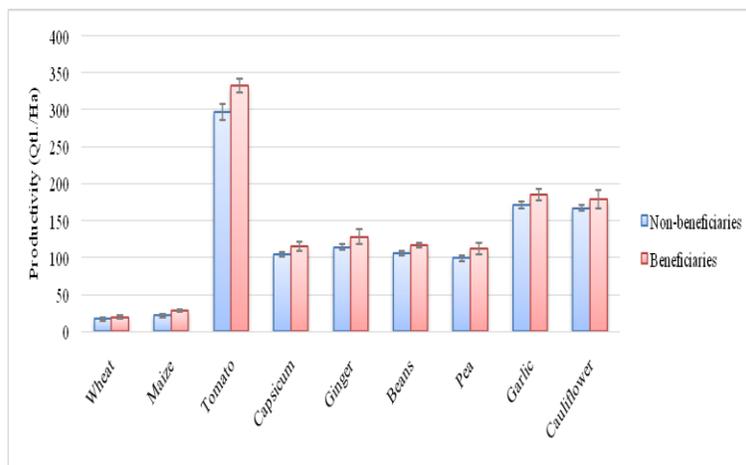


Fig.5 Composition of Household income of beneficiaries and non-beneficiaries

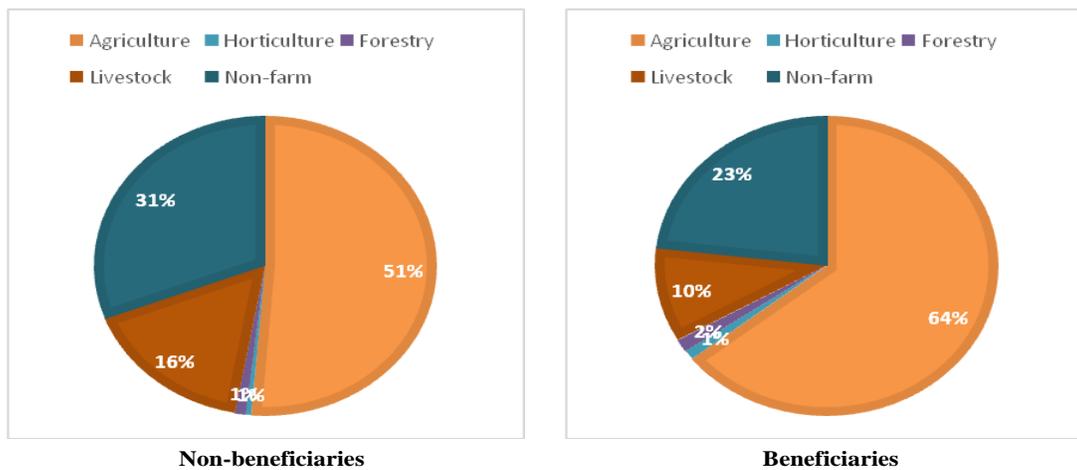
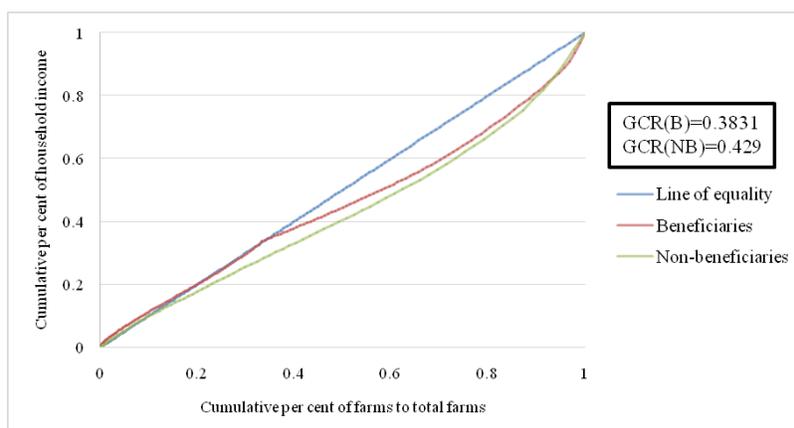


Fig.6 Lorenz curve on income distribution among beneficiaries (B) and non-beneficiaries (NB)

Livestock status

Livestock rearing has been considered to be an integral part of farming system in hilly states. They have been found not only direct providers of milk, meat, wool and manures but also main source of energy for ploughing and transport. In economic terms, they have been found to be a good supplementary source of income for the farmers through enhancement of physical productivity of crops by the use of farmyard manure. Figure 3 depicts that there has been a significant increase in livestock population on beneficiaries (4.82) as compared to non-beneficiaries (3.43). This has been due to different livestock improvement programmes like, manger construction (30.56 %); chaff cutter (33.33 %), goatry (5.56 %) and poultry (5.56 %); seed (55.56), implements (50.00 %) and technology for on farm fodder cultivation (2.78 %); crop residue treatment (2.78 %) and different health cover and breeding viz. artificial insemination (5.56 %), organize veterinary camps (3.33 %), support to veterinary institutions and national breeding centre (3.33 %). These activities of project has led to reduction in open grazing, increased fodder production, increase milk production and less dependence on community land for fodder. Indirectly, providing assistance for construction of vermi

compost pit (22.22 %) and *khadi* (3.89 %) had boost the beneficiaries for raring more livestock and especially sheep.

Productivity issue

The impact of HPMHWDP has been studied in terms of crops' productivity. It had been revealed from that maximum yield level had been found in tomato (298 and 333 q/ha) followed by garlic (171 and 185 q/ha), cauliflower (167 and 179 q ha), ginger (115 and 129 q/ha), beans (106 and 117 q ha), capsicum (104 and 116 q/ha), pea (100 and 113 q /ha), maize (22 and 29 q/ha) and wheat (17 and 20 q/ha), respectively for non-beneficiaries and beneficiaries (Figure 4). Major crops like tomato, garlic, cauliflower, ginger, beans, capsicum, pea, maize and wheat have shown 11.72, 7.97, 7.26, 12.15, 10.27, 11.39, 13.19, 30.08 and 13.64 per cent, respectively, enhance in the physical productivity levels of beneficiary farms as compared to non-beneficiary farms. The changes in crop productivity levels have been found to be statistically significant at one per cent level of significance (p value <0.01) on beneficiaries as compared to non-beneficiaries (Table 7). The respondents have observed these changes have been found due to creation of water resources, soil conservation structures, assistance for vermi

composting, distribution of farm implements and high yielding crops. Jat *et al.*, (2008) and Kushwah *et al.*, (2016) also found that productivity of different crops had increased due to watershed development project interventions.

Changes in share of farm and off-farm income to the total household income

To access the impact of the project on farm income, income from various sources has been calculated in terms of percent share of farm and off-farm income to the total household income. A perusal of Figure 5 indicated that annual household income has been found to be increased by 39.39 per cent from Rs. 536737 to Rs. 385068 of beneficiaries compared to non-beneficiaries.

This increase in total farm income has been attributed cumulatively to increased irrigation facility, providing different employment opportunity, different dairy development programs and providing support through non-farm activities like knitting (26.67 %), swing (6.67 %), *khadi* (3.89 %), cutting and tailoring (3.33 %) and coal making through pine needles (2.78 %). It has also been found that agriculture having maximum contribution to total household income i.e. 64.00 per cent followed by non-farm activities (23.00 %), livestock (10.00 %), forestry (2.00 %) and horticulture (1.00 %). Similar trends had been found in case of non-beneficiaries.

Incremental benefits

A perusal of table 8 indicated that net income from agricultural activities has been calculated Rs. 179862 and Rs. 112708, for beneficiaries and non-beneficiaries, respectively. Beneficiaries' net income from agricultural and non-agricultural activities has been found 59.58 and 4.74 per cent more than non-beneficiaries, respectively. Per cent

change in the B/C ratio of beneficiaries as compared to non-beneficiaries for important crops viz. tomato, capsicum, ginger, pea, garlic and cauliflower has been found 11.03, 6.84, 5.32, 6.93, 0.84, 3.74 and 3.94 per cent, respectively. This has been due to increase the crop productivity through better irrigation facility, decrease in cost of production by availability of seed/planting material, assistance for vermi composting and farm implements.

Pattern of income distribution

The Lorenz curve for beneficiaries and non-beneficiaries has been drawn and shown in figure 6. The Lorenz curve of beneficiaries has been found to be lie above that of non-beneficiaries and the total household income of beneficiaries has been found higher than that of non-beneficiaries. The Gini Concentration Ratio has lower value (0.3831) for beneficiaries as compared to non-beneficiaries (0.4296), indicating that the income has been found more evenly distributed for beneficiaries indicates better off status of beneficiaries than non-beneficiaries, i.e. the gap between the rich and poor has been brought down. Lobo (1990), Deshpande and Reddy (1993), Singh *et al.*, (1993), Kumar and Singh (2002) and Singh and Prakash (2010) revealed that watershed development projects helps to decrease the income inequality.

In conclusion the above facts clearly indicate that overall interventions of the project in the command area have positive and effective changes on land use system favourably through olericulture and with little attention to development of cereals and fruit crops. With availability of irrigation facility, farm implements, high plant yielding varieties, vermi compost and bio-fertilizers for beneficiaries has resulted positive effect on net sown area, gross cropped area,

productivity and availability of nutrients. Livestock improvement programmes have increased the livestock status due to increase in fodder availability, veterinary training and other activities. Self-employment schemes such as knitting, swing, *khadi*, carpentry, goatry and poultry etc. have also lead to an increase in income of the beneficiaries significantly.

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