

IMPACT OF WATERSHED DEVELOPMENT PROGRAMME ON CROP DIVERSIFICATION: A STUDY OF HIMACHAL PRADESH

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Introduction

Agricultural development is the process of mobilizing a vast quantity of already existing resources and raising their productivity. If this process lead to an increase in total agricultural production, it is termed as agricultural growth. The technological changes are taking place in agriculture which results in crop diversification. Technological changes are the important forces which alert the structure of agricultural production process. Due to technological changes capital and labour became more productive when applied to agriculture. Agriculture is modernized by using improved seeds, fertilizers, as well as by undertaking plant protection measures i.e. by using insecticides and pesticides. An assessment of risk in farming system is the criteria for evaluating sustainability of agriculture. The crop diversification by growing many crops is practiced in the rainfed land to reduce the risk factor of crop failure due to drought and less rain. The shift in the area and changes in cropping pattern can lead to crop diversification. Crop diversification in terms of reducing the risk of rainfed farmers is also very vital to a country like India in general and the state of Himachal Pradesh in particular where two third of the farmers are resource poor.

Need and Importance of the Present Study

A very few attempts have been made by the Government agencies and individual scholars to work out the impact of watershed development programme on crop diversification in the country as whole. But so far no such, comprehensive empirical study on the impact of watershed development programme on crop diversification in Himachal Pradesh has been conducted neither by any Government agency nor by any individual researcher. This study will also prove helpful to the academicians and research scholars to understand the role and importance of watershed development projects in hill agriculture.

Objectives and Methodology

In this study an attempt has been made to work out the impact of watershed development programme on land use pattern, cropping pattern, cropping intensity, irrigation intensity and crop diversification. The present study has

been carried out during agricultural year 2014-15. A multistage random sampling technique has been adopted in order to select a representative sample of households. At the first stage all districts have been arranged in an ascending order on the basis of the number of watershed in each district. After this one tribal district i.e. Kinnaur and two non-tribal districts viz., Mandi and Shimla have been selected randomly. At the second stage all the blocks in the selected districts have been arranged according to their watershed numbers in an ascending order on the basis of treated area and one block has been selected randomly from each selected district i.e., Kalpa block in Kinnuar district, Dharmpur block in Mandi district and Mashobara block in Shimla district. At the third stage all the watersheds have been arranged according to their treated area in an ascending order and then we have selected one watershed randomly in each selected block i.e., Pangl Watershed in Kalpa block, Sajao-Piplu Watershed in Dharmpur block and Sheepur Nala Watershed in Mashobara block. After this a sample of 250 beneficiaries and 120 non-beneficiaries' farmers from all the selected watersheds has been selected randomly in proportion to the total number of households falling in each land holdings category. Further, the selected farmers have been divided into three categories according to their size of holdings, i.e. marginal farmers having less than 1 hectare, small farmers having 1-2 hectares and medium farmers having 2-10 hectares. In the present study among the beneficiary households 125 farmers fall under the marginal holding, 75 on the small holding and 50 farmers fall on the medium size of holding group. Whereas among the non-beneficiary households 50 farmers fall in the category of marginal holding, 40 farmers on the small holding and 30 farmers fall on the medium size of holding group. It is important to mention here that there is no large size of holding in this study.

The magnitude of crop diversification among the sample household has been worked out with Help of Herfindhal Index.

$$\text{Herfindhal Index} = \sum_{i=1}^n p_i^2$$

Where P_i = is the proportion of area under i th crop and

$$P_i = \frac{A_i}{\sum_{i=1}^n A_i}$$

In which

A_i = actual area under i th crop.

$I = 1, 2, 3, \dots, n$ (Number of crops)

n = total number of crops.

The index is defined as sum of the squares of all 'n' proportions and is a measure of concentration. For increasing diversification, H is decreasing and vice-versa. It is bounded by '0' (complete diversification) and 1 (complete specialization). Herfindhal index is an inverse measure of crop diversification. It assumes that very large alternative of production choices are available. Taking the case of crops, Herfindhal Index assumes that there exist a very large number of crops, which can be grown by the farmers. If the total area was equally shared among the large number of crops alternatives then the share of each crop would be near to zero. Therefore, this index uses deviations between actual shares of each crop against equal share of all possible alternatives given by zero. To work out the impact of watershed development programme the percentage change has been worked out with the help of following formula

$$\text{Percentage Change} = \frac{X_1 - X_2}{X_2} \times 100$$

X_1 = Value of parameter under project beneficiaries

X_2 = Value of parameter under non-project beneficiaries

Results and Discussions

1. Land Use Pattern among the Sample Households

The land use pattern of any economy determines the nature and magnitude of employment, income and thereby the levels of living of the people. The land use pattern of any region is determined by its physical, economic and institutional frame-work. Thus, the existing land use pattern in the different areas of the State has been evolved as a result of the action and inter-action of various factors, such as the physical characteristics of land, the institutional framework, the structure of other sources available, e.g., capital and labour, and the location of the region in relation to other aspects of economic development such as, those relating to transport and communication, as well as to industry, trade and commerce.

1.1 Land Use Pattern among the Beneficiary Sample Households

Land is very important source of livelihood in the hill areas. The detail of land use pattern among the beneficiary sample households has been presented in table 1. It is clear from the table that on the marginal, small and

medium size of holdings, cultivated area has been worked out 76.06, 75.35 and 66.95 Per cent respectively. Among all the holdings together the average cultivated area per household came out 71.43 per cent. The cultivated land has been divided into net area sown, current fallow, and other fallow land. On the marginal, small and medium size of holding, average per household, percentage of net area sown, has been worked out 76.05, 73.94 and 64.99 per cent respectively, whereas among all the holdings together this percentage came out 70.07. No current fallow land has been found on the marginal size of holding group. Among the small and medium size of holdings group it has been worked out 1.41 and 1.96 per cent. Among all the holdings together this percentage came out 1.36 per cent. Under the category of other fallow land no area has been found on any holding group.

The percentage of uncultivated area to the total area has been worked out 23.94, 24.65 and 33.05 per cent on the marginal, small and medium size of holdings respectively whereas, among all the holdings together it came out 28.57 per cent per household. The uncultivated land has been divided into area not available for cultivation, cultivable waste land, permanent pasture and other grazing land, area exclusively under miscellaneous tree and tree crops and grass land interspersed with tree respectively. On the marginal, small and medium size of holding groups 4.22, 5.63 and 7.28 per cent area fall under area not available for cultivation respectively. Among all the holdings together it came out 6.12 per cent area per household.

Table: 1 Land Use Pattern among the Beneficiary Sample Households
(Area in hectares)

Particulars	Size of Holdings			
	Marginal Holdings	Small Holdings	Medium Holdings	All Holdings
1. Cultivated Land	0.54 (76.05)	1.07 (75.35)	2.39 (66.95)	1.05 (71.43)
Net area sown*	0.54 (76.05)	1.05 (73.94)	2.32 (64.99)	1.03 (70.07)
Current Fallow	0.00	0.02 (1.41)	0.07 (1.96)	0.02 (1.36)
Other Fallow	0.00	0.00	0.00	0.00
2. Uncultivated Land	0.17 (23.94)	0.35 (24.65)	1.18 (33.05)	0.42 (28.57)
Area not available for Cultivation	0.03 (4.22)	0.08 (5.63)	0.26 (7.28)	0.09 (6.12)
Cultivable Waste Land	0.04 (5.63)	0.07 (4.93)	0.25 (7.00)	0.09 (6.12)
Permanent Pasture and Grazing Land	0.07 (9.86)	0.13 (9.15)	0.44 (12.32)	0.16 (10.88)

Area Exclusively Under Miscellaneous Tree and Tree Crop	0.02 (2.82)	0.04 (2.82)	0.12 (3.36)	0.04 (2.72)
Grass Land Interspersed with Tree	0.01 (1.41)	0.03 (2.11)	0.11 (3.08)	0.04 (2.72)
Grand Total (1+2)	0.71 (100.00)	1.42 (100.00)	3.57 (100.00)	1.47 (100.00)

Note: Figures in parentheses denote percentages to the column total.

**Includes area under fields and horticulture crops*

The percentage of area under cultivable waste land has been worked out 5.63, 4.93 and 7.00 per cent on the marginal, small and medium size of holdings group respectively. Among all the holdings together per household average cultivable waste land has been worked out 6.12 per cent. The percentage of area under permanent pasture and grazing land has been worked out 9.86, 9.15 and 12.32 per cent on the marginal, small and medium size of holdings respectively. Among all, the holdings together this type of land area per household has been worked out 10.88 per cent. The percentage of area under miscellaneous trees and tree crops has been worked out 2.82, 2.82 and 3.36 per cent on the marginal, small and medium size of holdings group respectively, whereas among all the holding groups together this percentage has been worked out 2.72 per cent per household. The percentage of area under grass land interspersed with trees has been worked out 1.41, 2.11 and 3.08 per cent on the marginal, small and medium size of holdings group respectively, whereas among all the holding groups together it has been worked out 2.72 per cent per household to the total area of all the concerned holding groups. This table further indicates that cultivated land shows a decreasing tendency with an increase in the size of holdings whereas contrary to it the uncultivated land shows an increasing tendency with an increase in the size of holding.

1.2 Land Use Pattern among the Non-Beneficiary Sample households

The detail of land use among the non-beneficiary sample households pattern has been presented in Table 2. It is clear from Table that on the marginal, small and medium size of holdings, cultivated area has been worked out 73.91, 72.86 and 63.13 Per cent respectively. Among all the holdings together the average cultivated area per household came out 67.81 per cent. The cultivated land has been divided into net area sown, current fallow, and other fallow land. On the marginal, small and medium size of holding, average per household, percentage of net area sown, has been worked out 73.91, 72.14 and 59.69 per cent respectively, whereas among all the holdings together this percentage came out 65.75. No current fallow land has been found on the marginal size of holding group. Among the small and medium

size of holdings group it has been worked out 0.71 and 3.44 per cent. Among all the holdings together this percentage came out 2.05 per cent. Under the category of other fallow land no area has been found on any holding group. The percentage of uncultivated area to the total area has been worked out 26.09, 27.14 and 36.87 per cent on the marginal, small and medium size of holdings respectively whereas, among all the holdings together it came out 32.19 per cent per household.

Table: 2 Land Use Pattern among the Non-Beneficiary Sample Households
(Area in hectares)

Particulars	Size of Holdings			
	Marginal Holdings	Small Holdings	Medium Holdings	All Holdings
1. Cultivated Land	0.34 (73.91)	1.02 (72.86)	2.02 (63.13)	0.99 (67.81)
Net area sown*	0.34 (73.91)	1.01 (72.14)	1.91 (59.69)	0.96 (65.75)
Current Fallow	0.00	0.01 (0.71)	0.11 (3.44)	0.03 (2.05)
Other Fallow	0.00	0.00	0.00	0.00
2. Uncultivated Land	0.12 (26.09)	0.38 (27.14)	1.18 (36.87)	0.47 (32.19)
Area not available for Cultivation	0.02 (4.35)	0.06 (4.28)	0.25 (7.81)	0.09 (6.16)
Cultivable Waste Land	0.06 (13.04)	0.12 (8.57)	0.39 (12.19)	0.09 (6.16)
Permanent Pasture and Grazing Land	0.02 (4.35)	0.13 (9.28)	0.28 (8.75)	0.12 (8.22)
Area Exclusively Under Miscellaneous Tree and Tree Crop	0.01 (2.17)	0.04 (2.86)	0.14 (4.37)	0.05 (3.42)
Grass Land Interspersed with Tree	0.01 (2.17)	0.03 (2.14)	0.12 (3.75)	0.04 (2.74)
Grand Total (1+2)	0.46 (100.00)	1.40 (100.00)	3.20 (100.00)	1.46 (100.00)

Note: Figures in parentheses denote percentages to the column total.

*Includes area under fields and horticulture crops.

The uncultivated land has been divided into area not available for cultivation, cultivable waste land, permanent pasture and other grazing land, area exclusively under miscellaneous tree and tree crops and grass land interspersed with tree respectively. On the marginal, small and medium size of holding groups 4.35, 4.28 and 7.81 per cent area fall under area not available for cultivation respectively. Among all the holdings together it came out 6.16 per cent area per household. The percentage of area under cultivable waste land has been worked out 13.04, 8.57 and 12.19 per cent on the marginal, small and medium size of holdings group respectively. Among

all the holdings together per household average cultivable waste land has been worked out 6.16 per cent. The percentage of area under permanent pasture and grazing land has been worked out 4.35, 9.28 and 8.75 per cent on the marginal, small and medium size of holdings respectively. Among all, the holdings together this type of land area per household has been worked out 8.22 per cent. The percentage of area under miscellaneous trees and tree crops has been worked out 2.17, 2.86 and 4.37 per cent on the marginal, small and medium size of holdings group respectively, whereas among all the holding groups together this percentage has been worked out 3.42 per cent per household. The percentage of area under grass land interspersed with trees has been worked out 2.17, 2.14 and 3.75 per cent on the marginal, small and medium size of holdings group respectively, whereas among all the holding groups together it has been worked out 2.74 per cent per household to the total area of all the concerned holding groups. This Table further indicates that cultivated land shows a decreasing tendency with an increase in the size of holdings whereas contrary to it the uncultivated land shows an increasing tendency with an increase in the size of holding.

1.3 Percentage Change in Land Use Pattern among the Beneficiary Sample Households In-comparison to Non-Beneficiary Sample Households

Table: 3 Percentage Change in Land Use Pattern among the Beneficiary Sample Households Incomparison to Non-Beneficiary Sample Households

Particulars	Beneficiary Households		Non-Beneficiary Households		Percentage Change	
	Cultivated Land	Uncultivated Land	Cultivated Land	Uncultivated Land	Cultivated Land	Uncultivated Land
Marginal Holdings	76.05	23.94	73.91	26.09	2.90	-8.24
Small Holdings	75.35	24.65	72.86	27.14	3.42	-9.17
Medium Holdings	66.95	33.05	63.13	36.87	6.05	-10.36
All Holdings	71.43	28.57	67.81	32.19	5.34	-11.25

The percentage change in land use pattern has been worked out in Table 3. This Table shows that the percentage change in cultivated land has been worked out 2.90, 3.42 and 6.05 more on the marginal, small and medium size of holdings of the beneficiary sample households in comparison to non-beneficiary sample households. On all the holdings together this value came out 5.34 more among the beneficiary sample households in comparison to non-beneficiary sample households.

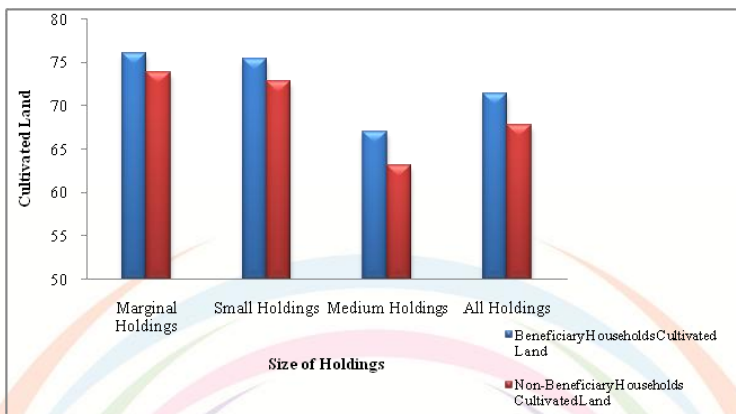


Figure: 1
Cultivated Land among the Beneficiary and Non-Beneficiary Sample Households

The percentage change in uncultivated land has been worked out -8.24, -9.17, and -10.36 less among the marginal, small and medium size of holdings of the beneficiary sample households in comparison to non-beneficiary. On all the holdings together this percentage change came out -11.25 less among the beneficiary sample households in comparison to non-beneficiary sample households. It is clear from the Table 6.3 that among the beneficiary households the percentage change in cultivated land shows an increasing tendency with an increase in the size of holdings, but contrary to it the percentage change in uncultivated land shows a decreasing tendency with an increase in the size of holdings.

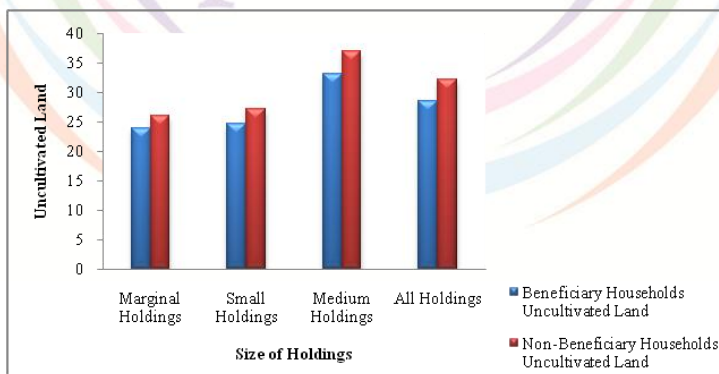


Figure: 2
Uncultivated Land among the Beneficiary and Non-Beneficiary Sample Households

It is also evident from the Figure 1 and 2. This tendency occurs due to the watershed activities such as soil conservation, land development works, rain harvesting structures on beneficiary farms.

2. Cropping Pattern among the Sample Households

The cropping pattern shows the proportion of area under different crops at a particular period of time. A change in the cropping pattern means a change in the proportion of area under different crops. The cropping system goes throughout the year, provided water is available. A wide range of factors, viz., nature of soil, climatic conditions, size of holdings, availability of various inputs like irrigation, fertilizers, manures and pesticides and processing facilities, comparative economics of alternative crops, etc., have a bearing on the individual farmer's decision to grow a particular crop. These decisions can be influenced and modified to a considerable extent through deliberate policy measures aimed at including changes in physical, economic and institutional environments of agriculture, or offering various incentives by way of input supplies, processing and marketing facilities. It means that these are factors which affect the cropping pattern or the farmer's decision to grow a particular crop.

2.1 Cropping Pattern among the Beneficiary Sample Households

Table: 4 Cropping Pattern among the Beneficiary Sample Households

(Area in Hectares, Per Household)

Particulars	Size of Holdings			
	Marginal Holdings	Small Holdings	Medium Holdings	All Holdings
I. Cereals				
Maize	0.20 (20.41)	0.18 (11.25)	0.15 (4.29)	0.18 (10.78)
Paddy	0.02 (2.04)	0.03 (1.88)	0.06 (1.71)	0.03 (1.80)
Wheat	0.15 (15.31)	0.20 (12.50)	0.20 (5.71)	0.18 (10.78)
Sub-total	0.37 (37.76)	0.41 (25.62)	0.41 (11.71)	0.39 (23.35)
II. Pulses				
	0.03 (3.06)	0.05 (3.13)	0.19 (5.43)	0.07 (4.19)
III. Vegetables				
Arbi	0.05 (5.10)	0.10 (6.25)	0.34 (9.71)	0.12 (7.19)
French Bean	0.17 (17.35)	0.30 (18.75)	0.68 (19.43)	0.31 (18.56)
Cauliflower	0.10 (10.20)	0.18 (11.25)	0.44 (12.57)	0.19 (11.38)
Peas	0.08 (8.16)	0.16 (10.00)	0.39 (11.14)	0.17 (10.18)

Potato	0.14 (14.29)	0.24 (15.00)	0.55 (15.71)	0.25 (14.97)
6. Sub-total	0.54 (55.10)	0.98 (61.25)	2.40 (68.57)	1.04 (62.28)
7. Total Field Crops	0.94 (95.92)	1.44 (90.00)	3.00 (85.71)	1.50 (89.82)
IV. Horticultural Crops				
Apple & Others	0.04 (4.08)	0.16 (10.00)	0.50 (14.29)	0.17 (10.18)
Gross Cropped Area	0.98 (100.00)	1.60 (100.00)	3.50 (100.00)	1.67 (100.00)

Note: Figures in parentheses denote percentages to the column total.

Cropping pattern among the beneficiary sample households of the sample households has been presented in Table 4. This table shows that the percentage of area under Cereals crops (i.e., maize, paddy, and wheat) has been worked out 37.76, 25.62 and 11.71 on the marginal, small and medium size of holdings respectively, whereas among all the holdings together this percentage came out 23.35 per cent. The percentage of area under pulses has been worked out 3.06, 3.13 and 5.43 on the marginal, small and medium size of holdings respectively, whereas among all the holdings together this percentage came out 4.19 per cent. The percentage of area under vegetables has been worked out 55.10, 61.25 and 68.57 on the marginal, small and medium size of holdings respectively, whereas among all the holdings together this percentage came out 62.28 per cent. The percentage area under all field crops has been worked out 95.92, 90.00 and 85.71 on the marginal, small and medium size of holdings respectively. Among all the holdings together this percentage came out 89.82 per cent. The percentage of area under horticulture crops has been worked out 4.08, 10.00 and 14.29 on the marginal, small and medium size of holdings. Among all the holdings together this percentage came out 10.18 per cent. This Table further reveals that the percentage of area under field crops shows a decreasing tendency with an increase in the size of holdings. Contrary to it the percentage of area horticulture crops shows an increasing tendency with an increase in the size of holding. This tendency in the use of land takes place due to the reason that the horticultural crops are more remunerative than the other crops, so households invest more in horticultural crops than the field crops.

2.2 Cropping Pattern among the Non-Beneficiary Sample Households

Cropping pattern among the Non-beneficiary sample households has been presented in Table 5. This table shows that the percentage of area under Cereals crops (i.e., maize, paddy, wheat, barley and small millets) has been

worked out 40.00, 27.81 and 18.71 on the marginal, small and medium size of holdings respectively, whereas among all the holdings together this percentage came out 25.52 per cent. The percentage of area under pulses has been worked out 1.67, 13.25 and 14.75 on the marginal, small and medium size of holdings respectively, whereas among all the holdings together this percentage came out 11.72 per cent.

Table: 5 Cropping Pattern among the Non-Beneficiary Sample Households

(Area in Hectares, Per Household)

Particulars	Size of Holdings			
	Marginal Holdings	Small Holdings	Medium Holdings	All Holdings
I. Cereals				
Maize	0.07 (11.67)	0.10 (6.62)	0.17 (6.12)	0.11 (7.59)
Paddy	0.08 (13.33)	0.12 (7.95)	0.20 (7.19)	0.12 (8.28)
Wheat	0.09 (15.00)	0.20 (13.25)	0.15 (5.40)	0.14 (9.66)
Sub-total	0.24 (40.00)	0.42 (27.81)	0.52 (18.71)	0.37 (25.52)
II. Pulses				
	0.01 (1.67)	0.20 (13.25)	0.41 (14.75)	0.17 (11.72)
III. Vegetables				
Arbi	0.03 (5.00)	0.13 (8.61)	0.30 (10.79)	0.13 (8.97)
French Bean	0.10 (16.67)	0.25 (16.56)	0.54 (19.42)	0.26 (17.93)
Cauliflower	0.01 (1.67)	0.05 (3.31)	0.30 (10.79)	0.10 (6.90)
Peas	0.18 (30.00)	0.33 (21.85)	0.46 (16.55)	0.30 (20.69)
Potato	0.01 (1.67)	0.04 (2.65)	0.03 (1.08)	0.03 (2.07)
Sub-total	0.33 (55.00)	0.80 (52.98)	1.63 (58.63)	0.82 (56.55)
Total Field Crops	0.58 (96.67)	1.42 (94.04)	2.56 (92.09)	1.36 (93.79)
IV. Horticultural Crops				
Apple & Others	0.02 (3.33)	0.09 (5.96)	0.22 (7.91)	0.09 (6.21)
Gross Cropped Area	0.60 (100.00)	1.51 (100.00)	2.78 (100.00)	1.45 (100.00)

Note: Figures in parentheses denote percentages to the column total.

The percentage of area under vegetables has been worked out 55.00, 52.98 and 58.63 on the marginal, small and medium size of holdings respectively, whereas among all the holdings together this percentage came out 56.55 per cent. The percentage area under all field crops has been worked out 96.67,

94.04 and 92.09 on the marginal, small and medium size of holdings respectively. Among all the holdings together this percentage came out 93.79. The percentage of area under horticulture crops has been worked out 3.33, 5.96 and 7.91 on the marginal, small and medium size of holdings. Among all the holdings together this percentage came out 6.21 per cent. This Table further reveals that the percentage of area under field crops shows a decreasing tendency with an increase in the size of holdings. Contrary to it the percentage of area under horticulture crops shows an increasing tendency with an increase in the size of holding. This tendency in the use of land takes place due to the reason that the horticultural crops are more remunerative than the other crops, so households invest more in horticultural crops than the field crops.

1.3 Percentage Change in Cropping Pattern among the Beneficiary Sample Households Incomparison to Non-Beneficiary Sample Households

The percentage change in cropping pattern among the beneficiary sample households incomparison to non-beneficiary sample households has been presented in Table 6.

Table: 6 Percentage Change in Cropping Pattern among the Beneficiary Sample Households Incomparison to Non-Beneficiary Sample Households

Particulars	Field Crops			Horticultural Crops		
	Beneficiary Households	Non-Beneficiary Households	Percentage Change	Beneficiary Households	Non-Beneficiary Households	Percentage Change
Marginal Holdings	95.92	96.67	-0.77	4.08	3.33	22.52
Small Holdings	90.00	94.04	-4.29	10.00	5.96	67.78
Medium Holdings	85.71	92.09	-6.93	14.29	7.91	80.66
All Holdings	89.82	93.79	-4.23	10.18	6.21	63.93

This table shows that the percentage change in area under all field crops has been worked out -0.77, -4.29 and -6.93 less on the marginal, small and medium size of holdings of the beneficiary households in-comparison to non-beneficiary sample households respectively. Among all the holdings together this percentage change came out -4.23 less on the beneficiary farms incomparison to non-beneficiary farms.

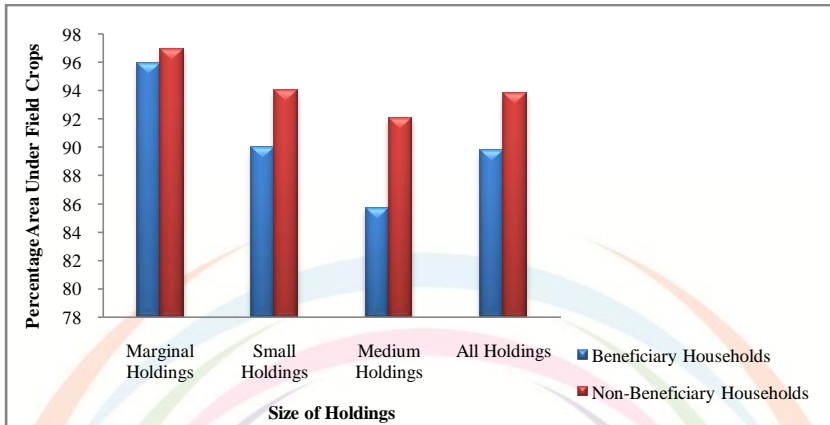


Figure: 3

Percentage Area under Field Crops among the Beneficiary and Non-Beneficiary Sample Households

The percentage change in area under horticultural crops has been worked out 22.52, 67.78 and 80.66 on the marginal, small and medium size of holdings of the beneficiary sample households in-comparison to non-beneficiary sample households. On all the holdings together this percentage change came out 63.93 per cent more among the beneficiary sample households in-comparison to non-beneficiary sample households. It is also evident from the Figures 3 and 4.

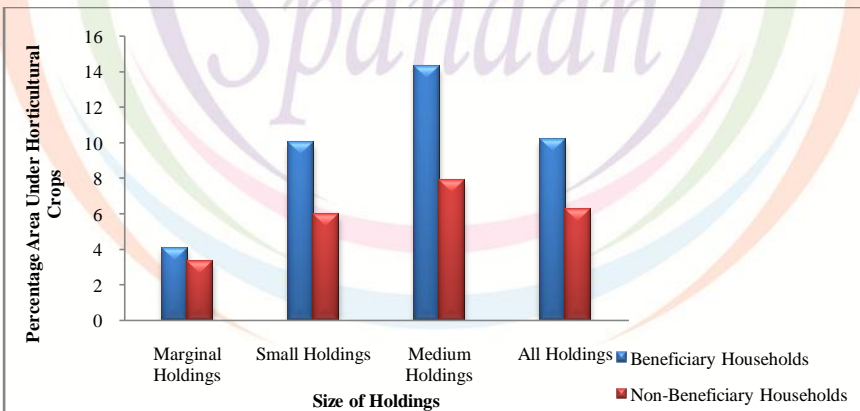


Figure: 4

Percentage Area under Horticultural Crops among the Beneficiary and Non-Beneficiary Sample Households

3. Cropping Intensity

The cropping intensity represents the percentage of the gross cropped area to the net area sown. The various activities of watershed development proved to be effective in the conservation of soil and water resources as a result of which the cropping intensity increased significantly. This section deals with the impact of watershed development programme on cropping intensity among the beneficiary and non-beneficiary households of the sample households. Cropping intensity has been worked out with the help of following formula.

$$\text{Cropping Intensity} = \frac{\text{Gross Cropped Area}}{\text{Net Area Sown}} \times 100$$

3.1 Cropping Intensity among the Beneficiary Sample Households

The cropping intensity by size of class of holdings among the beneficiary sample households has been presented in Table: 7. This Table shows that the cropping intensity on the marginal, small and medium size of holdings has been worked out 181.48, 152.38 and 150.86 per cent respectively. Among all the holdings together the cropping intensity came out 162.14.

Table: 7 Cropping Intensity among the Beneficiary Sample Households
(Area in Hectares)

Particulars	Size of Holdings			
	Marginal Holdings	Small Holdings	Medium Holdings	All Holdings
1. Net Area Sown	0.54	1.05	2.32	1.03
2. Gross Cropped Area	0.98	1.60	3.50	1.67
3. Area Sown more than once	0.44	0.55	1.18	0.63
4. Cropping Intensity	181.48	152.38	150.86	162.14

3.2 Cropping Intensity among the Non-Beneficiary Sample Households

The cropping intensity by size of class of holdings among the non-beneficiary sample households has been presented in Table 8. This Table shows that the cropping intensity on the marginal, small and medium size of holdings has been worked out 176.47, 149.50 and 145.55 per cent respectively. Among all the holdings together the cropping intensity came out 151.04.

Table: 8 Cropping Intensity among the Non-Beneficiary Sample Households
(Area in Hectares)

Particulars	Size of Holdings			
	Marginal Holdings	Small Holdings	Medium Holdings	All Holdings
1. Net Area Sown	0.34	1.01	1.91	0.96
2. Gross Cropped Area	0.60	1.51	2.78	1.45
3. Area Sown more than once	0.30	0.50	0.87	0.49
4. Cropping Intensity	176.47	149.50	145.55	151.04

3.3 Percentage Change in Cropping Intensity among the Beneficiary Sample Households In Comparison to Non-Beneficiary Sample Households

Percentage change in cropping intensity among the beneficiary sample households in comparison to non-beneficiary sample households has been worked out in Table 9.

Table: 9 Percentage Change in Cropping Intensity among the Beneficiary Sample Households In Comparison to Non-Beneficiary Sample Households

Particulars	Cropping Intensity		
	Beneficiary Households	Non-Beneficiary Households	Percentage Change
Marginal Holdings	181.48	176.47	2.84
Small Holdings	152.38	149.50	1.93
Medium Holdings	150.86	145.55	3.65
All Holdings	162.14	151.04	7.35

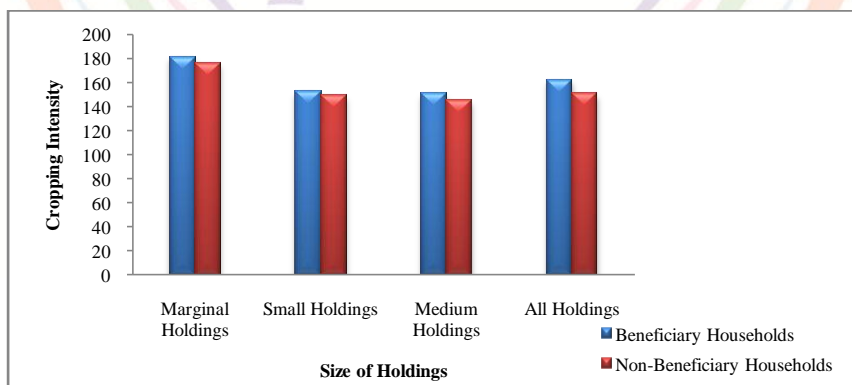


Figure: 5

Cropping Intensity among the Beneficiary and Non-Beneficiary Sample Households

This Table 9 shows that the cropping intensity on the marginal, small and medium size of holdings of the beneficiary households has been worked out 2.84, 1.93 and 3.65 more in comparison to non-beneficiary households respectively. Among all the holdings together these percentage change in cropping intensity came out 7.35 more on the beneficiary farms in comparison to non-beneficiary farms. It is also evident from the Figure 5. The percentage change in cropping intensity occurs due to watershed development activities on beneficiary farms such as soil conservation and other land development works etc.

4. Irrigation Intensity

The irrigation intensity represents the percentage of the gross irrigated area to the net irrigated area. This section deals with the impact of watershed development programme on irrigation intensity among the beneficiary and non-beneficiary of the sample households. The irrigation intensity has been worked out with the help of following formula.

$$\text{Irrigation Intensity} = \frac{\text{Gross Irrigated Area}}{\text{Net Irrigated Area}} \times 100$$

4.1 Irrigation Intensity among the Non-Beneficiary Sample Households

Table: 10 Irrigation Intensity among the Beneficiary Sample Households in Comparison to Non-Beneficiary Sample Households

(Area in Hectares and Per Household)

Particulars	Size of Holdings			
	Marginal Holdings	Small Holdings	Medium Holdings	All Holdings
1. Net Irrigated Area	0.34	0.75	1.92	0.78
2. Gross Irrigated Area	0.63	1.20	3.05	1.29
3. Irrigated Area Sown more than once	0.29	0.45	1.13	0.51
4. Irrigation Intensity	185.29	160.00	158.85	165.38

The irrigation intensity by size of class of holdings among the beneficiary sample households has been presented in Table 10. The irrigation intensity by size of class of holdings among the beneficiary households of the sample households has been presented in Table 6.10. This Table shows that the cropping intensity on the marginal, small and medium size of holdings has been worked out 185.29, 160.00 and 158.85 per cent respectively. Among all the holdings together the irrigation intensity came out 165.38

4.2 Irrigation Intensity among the Non-Beneficiary Sample Households

Table: 11 Irrigation Intensity among the Non-Beneficiary Sample Households
(Area in Hectares and Per Household)

Particulars	Size of Holdings			
	Marginal Holdings	Small Holdings	Medium Holdings	All Holdings
1. Net Irrigated Area	0.21	0.71	1.54	0.71
2. Gross Irrigated Area	0.38	1.11	2.33	1.11
3. Irrigated Area Sown more than once	0.17	0.40	0.79	0.40
4. Irrigation Intensity	180.95	156.34	151.30	156.34

The irrigation intensity by size of class of holdings among the non-beneficiary sample households has been presented in Table 11. This table shows that the irrigation intensity on the marginal, small and medium size of holdings has been worked out 180.95, 156.34 and 151.30 per cent respectively. Among all the holdings together the irrigation intensity came out 156.34.

4.3 Percentage Change in Irrigation Intensity among the Beneficiary Sample Households In Comparison to Non-Beneficiary Sample Households

Percentage change in irrigation intensity among the beneficiary sample households in comparison to non-beneficiary households has been worked out in Table 12.

Table: 12 Percentage Change in Irrigation Intensity among the Beneficiary Sample Households Incomparison to Non-Beneficiary Sample Households

Particulars	Irrigation Intensity		
	Beneficiary Households	Non-Beneficiary Households	Percentage Change
Marginal Holdings	185.29	180.95	2.40
Small Holdings	160.00	156.34	2.34
Medium Holdings	158.85	151.30	4.99
All Holdings	165.38	156.34	5.78

This table shows that the irrigation intensity on the marginal, small and medium size of holdings of the beneficiary sample households has been worked out 2.40, 2.34 and 4.99 more in comparison to non-beneficiary sample households respectively. Among all the holdings together this percentage change in irrigation intensity came out 5.78 on the beneficiary farms in comparison to non-beneficiary farms. It is also evident from the Figure 6. The percentage change in cropping intensity occurs due to

watershed development activities on beneficiary farms such as soil and conservation, land development works etc.

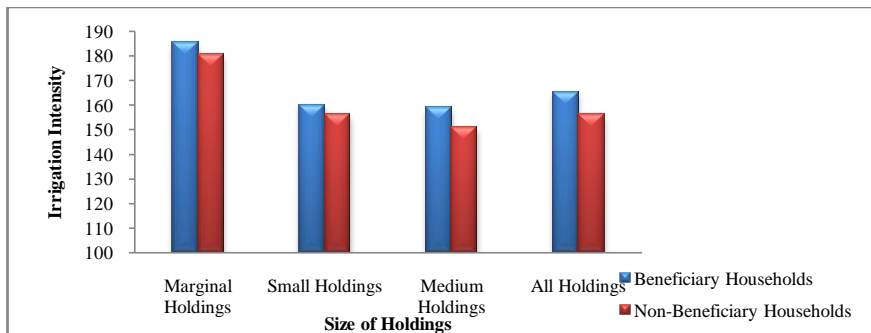


Figure: 6
Irrigation Intensity among the Beneficiary and Non-Beneficiary Sample Households

5. Magnitude of Crop Diversification among the Sample Households

The diversification in agriculture took place due to increasing trend of agricultural productivity because of technical changes and use of high yielding variety of seeds, fertilizers, pesticides and improved method of cultivation in agriculture. The level of diversification of crop enterprise reflects the extent of economic development in rural sector. The rural economy, crop diversification has been largely considered as a ray of hope for its economic uplift. The diversification in agriculture is also practiced with a view to avoid risk and uncertainty due to climatic and biological vagaries. In the early stage of development, the households generally used to grow subsistence crops and with the increase in human population, they tried to produce more to maximize total farm output and finally agricultural diversification has been practiced in order to further strengthen the existing level of development.

5.1 Magnitude of Crop Diversification among the Beneficiary Sample Households

The magnitude of crop diversification among the beneficiary sample households has been worked out with the help of Herfindhal Index in Table 13. This table shows that the value of Herfindhal Index has been worked out 0.1382, 0.1240 and 0.1156 on the marginal, small and medium size of holdings respectively. Among all the holdings together value of Herfindhal Index came out 0.1211.

Table: 13 Magnitude of Crop Diversification among the Beneficiary Sample Households

(Area in Hectares and Per Household)

Particulars	Size of Holdings											
	Marginal Holdings			Small Holdings			Medium Holdings			All Holdings		
	Ai	Pi	Pi ²	Ai	Pi	Pi ²	Ai	Pi	Pi ²	Ai	Pi	Pi ²
1.Maize	0.20	0.2041	0.0416	0.18	0.1125	0.0127	0.15	0.0429	0.0018	0.18	0.1078	0.0116
2.Paddy	0.02	0.0204	0.0004	0.03	0.0188	0.0004	0.06	0.0171	0.0003	0.03	0.0180	0.0003
3.Wheat	0.15	0.1531	0.0234	0.2	0.1250	0.0156	0.2	0.0571	0.0033	0.18	0.1078	0.0116
5.Pulses	0.03	0.0306	0.0009	0.05	0.0313	0.0010	0.19	0.0543	0.0029	0.07	0.0419	0.0018
6.Arbi	0.05	0.0510	0.0026	0.1	0.0625	0.0039	0.34	0.0971	0.0094	0.12	0.0719	0.0052
7.French Bean	0.17	0.1735	0.0301	0.3	0.1875	0.0352	0.68	0.1943	0.0377	0.31	0.1856	0.0345
8.Cauliflower	0.10	0.1020	0.0104	0.18	0.1125	0.0127	0.44	0.1257	0.0158	0.19	0.1138	0.0129
9.Peas	0.08	0.0816	0.0067	0.16	0.1000	0.0100	0.39	0.1114	0.0124	0.17	0.1018	0.0104
10.Potato	0.14	0.1429	0.0204	0.24	0.1500	0.0225	0.55	0.1371	0.0247	0.23	0.1497	0.0224
11. Apple	0.04	0.0408	0.0017	0.16	0.1000	0.0100	0.5	0.0857	0.0073	0.17	0.1018	0.0104
$\sum_{i=1}^n Pi^2$	0.98	1.0000	0.1382	1.6	1.0000	0.1240	3.5	1.0000	0.1156	1.67	1.0000	0.1211

Note: Ai indicates actual area under each crop Pi indicates proportionate area under each crop.

This table further shows that the value of Herfindhal Index shows a decreasing tendency with an increase of size of holdings, which confirms more crop diversification on large size of holdings

5.2 Magnitude of Crop Diversification among the Non-Beneficiary Sample Households

The magnitude of crop diversification among the beneficiary sample households has been worked out with the help of Herfindhal Index in Table 14. This table shows that the value of Herfindhal Index has been worked out 0.1762, 0.1337 and 0.1283 on the marginal, small and medium size of holdings respectively. Among all the holdings together the value of Herfindhal Index came out 0.1281.

Table: 14 Magnitude of Crop Diversification among the Non-Beneficiary Sample Households

(Area in Hectares and Per Household)

Particulars	Size of Holdings											
	Marginal Holdings			Small Holdings			Medium Holdings			All Holdings		
	Ai	Pi	Pi ²	Ai	Pi	Pi ²	Ai	Pi	Pi ²	Ai	Pi	Pi ²
1.Maize	0.07	0.1167	0.0136	0.10	0.0662	0.0044	0.17	0.0612	0.0037	0.11	0.0759	0.0058
2.Paddy	0.08	0.1333	0.0178	0.12	0.0795	0.0063	0.20	0.0719	0.0052	0.12	0.0828	0.0068
3.Wheat	0.09	0.1500	0.0225	0.20	0.1325	0.0175	0.15	0.0540	0.0029	0.14	0.0966	0.0093
4.Pulses	0.01	0.0167	0.0003	0.20	0.1325	0.0175	0.41	0.1475	0.0218	0.17	0.1195	0.0143
5.Arbi	0.03	0.0500	0.0025	0.13	0.0861	0.0074	0.30	0.1079	0.0116	0.13	0.0902	0.0081
6.French Bean	0.10	0.1667	0.0278	0.25	0.1656	0.0274	0.54	0.1942	0.0377	0.26	0.1793	0.0322
7.Cauliflower	0.01	0.0167	0.0003	0.05	0.0331	0.0011	0.30	0.1079	0.0116	0.10	0.0661	0.0044
8. Peas	0.18	0.3000	0.0900	0.33	0.2185	0.0478	0.46	0.1655	0.0274	0.30	0.2069	0.0428
9. Potato	0.01	0.0167	0.0003	0.04	0.0265	0.0007	0.03	0.0108	0.0001	0.03	0.0172	0.0003
10. Apple	0.02	0.0333	0.0011	0.09	0.0596	0.0036	0.22	0.0791	0.0063	0.09	0.0644	0.0041
$\sum_{i=1}^n Pi^2$	0.60	1.0000	0.1762	1.51	1.0000	0.1337	2.78	1.0000	0.1283	1.45	1.0000	0.1281

Note: Ai indicates actual area under each crop Pi indicates proportionate area under each crop.

This table further shows that the value of Herfindhal Index shows a decreasing tendency with an increase of size of holdings, which confirms more crop diversification on large size of holdings

5.3 Percentage Change in the Value of Herfindhal Index among the Beneficiary Sample Households Incomparison Non-Beneficiary Sample Households

The percentage change in the value of Herfindhal index among the sample households has been presented in Table 15. This table shows that the value of Herfindhal Index has been worked out -21.57, -7.26 and -9.90 per cent less on the marginal, small and medium size of holdings of the beneficiary sample households incomparison to non-beneficiary sample households. On all the holdings together this value came out -5.46 per cent less among the beneficiary sample households incomparison to non-beneficiary sample households. Which confirms more crop diversification on beneficiary farms incomparison to non-beneficiary farms. It is also evident from Figure 7.

Table: 15
Percentage Change in the Value of Herfindhal Index among the Beneficiary Sample Households Incomparison Non-Beneficiary Sample Households

Particulars	Value of Herfindhal index Among the Beneficiary Households	Value of Herfindhal index Among the Non-Beneficiary Households	Percentage Change
Marginal Holdings	0.1382	0.1762	-21.57
Small Holdings	0.1240	0.1337	-7.26
Medium Holdings	0.1156	0.1283	-9.90
All Holdings	0.1211	0.1281	-5.46

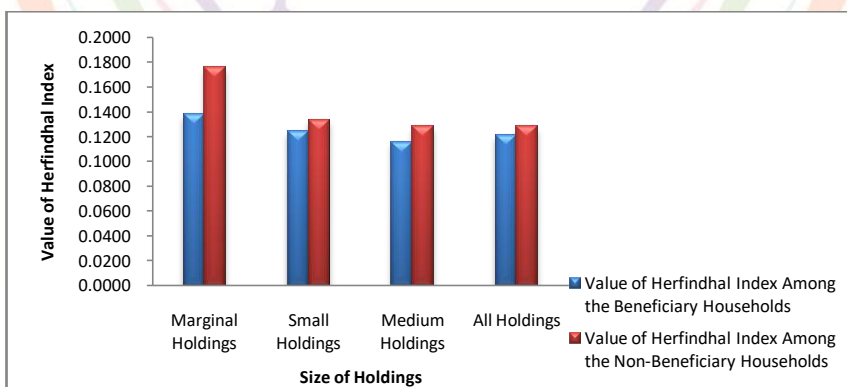


Figure: 7
Value of Herfindhal Index among the Beneficiary and Non-Beneficiary Sample Households

Conclusions and Recommendations

Thus from the above results it can be concluded that the percentage change in cropping intensity, irrigation intensity and crop diversification is comparatively high on the beneficiary farms in comparison to non-beneficiary farms, which confirms positive impact of watershed development programme on sustainability of hill agriculture. This may happen due to the watershed development works on beneficiary farms such as soil conservation works, provision of irrigation facilities, provision of high yielding variety of seeds, manure, fertilizer, insecticides, pesticides and awareness camps regarding farm management and different cultivation techniques and methods. During field survey it is noticed that the people are not fully aware of the programme and their participation is inadequate. The implementing agencies dominated by the big farmers or biasness could affect watershed programmes in a big way. There is a need for increasing the efficiency and effectiveness of expenditure. The lack of professionalism is seen in managing the funds and maintaining the accounts. Government must provide desired high yielding variety of seeds on cheap rate, open more fertilizer outlets in the watershed areas, distribute organic manure to the households to overcome the problem of manure, provide more adequate supply of plant protection material on cheap rate and more extension services regarding agriculture should be provided to households keeping their knowledge updated. Government must open horticulture nurseries in the watershed areas. The sapling of desired variety must be distributed in the watershed areas on cheap rate to overcome the problem of high cost of orchard establishment.

For the successful implementation of these programmes the beneficiaries should be selected in a fair manner without any bias and the benefits under these programmes should be given according to the needs and requirements of the people. The honest officials should be rewarded and the dishonest be penalized. After the selection of beneficiaries and the distribution of benefits, there should be regular monitoring of the implementation of these programmes. Therefore, the people should be made aware about the implementation of different Government programmes as well as the benefits provided under these programmes through radio, television and newspapers, whenever required, training be provided by arranging seminars and workshops. The success of any set of policies and programmes entirely depends upon the availability of finances, loyal, honest and efficient administration, honest politicians, dedicated intellectuals and institutional

reforms which will impart a greater re-distributive bias to public policies in favour of the poorest sections of the society on the one hand and an active involvement and participation of the weaker sections in this vital undertaking on the other.

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