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RESEARCH PAPER

A study on impact of watershed development project of Antisar watershed in Kheda district of Gujarat

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Abstract : The present investigation was undertaken during 2009-10 with a view to evaluate the impact of Watershed Development Project on different parameters *viz.*, land utilization pattern, irrigation status, cropping pattern, productivity, status of livestock, labour-use, cost of cultivation and income of beneficiaries using the data collected from Antisar watershed located in kheda district of Gujarat. The result of the study revealed that the net cropped area was increased from 71.96 per cent in pre-project position to 88.64 per cent in post-project position and it was also higher in beneficiaries' farms (88.64 %) than that of non-beneficiaries' farms (79.37 %). The cropping intensity and irrigation intensity were higher in post-project position of beneficiaries. The cropping pattern of beneficiaries was changed and shifted in favour of commercial crops because of watershed development activities. The productivity of major crops grown in watershed project area was increased in post-project position and watershed development has helped in the diversification of crop-livestock mixes too. It was found that though the cost of cultivation of beneficiaries was higher in post-project position as compared to pre-project position, the farm business income, family labour income and net income were increased during post-project position. Finally, it was concluded on the basis of findings that the watershed technology helps in augmenting returns from dry land crop production as well as other subsidiary activities on sustainable basis.

Key Words : Watershed development project

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INTRODUCTION

Agriculture is the backbone of Indian economy and is largely dependent upon natural resources like soil, water and vegetation. These resources are limited in supply and are getting depleted day by day. Among these resources, land and water are the most precious gifts of nature and the very base for existence of mankind. The total water resources of the country are approximately four per cent of the world's fresh water resources, whereas the country's population is slightly more than sixteen per cent of the global population (Singh and Sharma, 2007). These resources are under intense strain due to high population density, over-exploitation, inadequate management practices and high rate of soil erosion and sedimentation. One of the practical solutions for conservation of these limited natural resources and sustainable development is through proper watershed

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development strategy. The strategy emphasizes the need to go beyond conservation technologies to include multiple crop-livestock interventions that support and diversify livelihood opportunities for the poor and create synergies between targeted technologies, policies and institutions to improve productivity, resources use sustainability and market access. The watershed development projects play very important role in rain fed areas and government spending huge amounts on various projects of watershed development. It is assumed that watershed development projects enhance crop productivity, cropping intensity, income, fodder availability and water availability on sustainable basis. There are various views on the impact of watershed based programmes on rural development. Therefore, it is required to assess the impact of watershed development on different socio-economic aspects of rural community. It is also believed that watershed development programmes are one of the reasons for achieving high agricultural growth rate in Gujarat. The impact of this micro-watershed on different aspects of structural, operational, agricultural production, income, employment and extent of technological adoption needs to be examined. This information would lead to sound formulation of policy for upliftment of the rural communities as well as development of the villages. An impact evaluation of such programmes is essential to provide justification for the investment of scarce financial resources and to strengthen the hands of decision makers for future investments.

Department of Land Resources, Ministry of Rural Development, Govt. of India sanctioned a project for Antisar watershed under Integrated Wasteland Development Programme (IWDP) to the Central Soil and Water Conservation Research and Training Institute, Research Centre, Vasad as a Project Implementing Agency (PIA) during March 1997, which was completed on 31st march 2003. It aimed at treating the degraded lands with economically viable and locally acceptable technologies through participatory approach that seeks to secure active involvement of stakeholders. The main objective of the project was to promote overall economic development and improvement of the socio-economic conditions of the resource poor and disadvantaged sections of society inhabiting the project area. It was assumed that Antisar watershed was showing its full impact during 2009-10 on productivity, pattern of agriculture and income of the beneficiaries. Therefore, it was planned to evaluate the impacts of watershed development project of Antisar watershed during 2009-10 in context to changes in productivity and pattern of agriculture, changes in variable cost of major crops and changes in income from crop and dairy enterprise.

MATERIAL AND METHODS

The Antisar watershed, located at Kapadvanj taluka of Kheda district was purposively selected for the study where the watershed development project was initiated during the year 1997-98 under Integrated Wasteland Development Programme (IWDP). The study was mainly based on the primary data which were collected by personal interview method using a structured, pre-tested schedule of enquiry. The information pertaining to general information, cropping pattern, productivity, labour use, cost of cultivation and income were enumerated. The respondents were categorized as beneficiaries and non-beneficiaries (control group).The *ex-ante* and the *ex-post* approaches were adopted for the collection and analysis of data. The year 1997-98 was taken as the *ex-ante* (before) and the year 2009-10 being the study year represented the ex-post (after) situation. Considering a realistic comparison with the situation of the study year 2009-10 with the base year (1997-98), the data for the base year are adjusted by using the current prices.

A total of 110 respondents containing 70 from beneficiary group of and 40 from non-beneficiary group from the outside but adjacent to watershed area were selected for the study. To know whether the difference between pre-project position and post-project position, and difference between beneficiary and non-beneficiary is statistically significant or not, t-value was worked out. The cost concepts used in the analysis are those laid down in the farm management study *i.e.* Cost –A, Cost-B and Cost-C (Total Cost).

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Land utilisation pattern of sample cultivators :

Before analyzing the cropping pattern of sample cultivators, it was essential to understand the land utilization pattern of beneficiary and non-beneficiary group as it would help to analyze the cropping pattern

and other related issues in a better way. It had been proved by various studies that the availability of water and moisture is substantially higher in post-project position when compared to pre-project position, also when compared to the non-treated areas mainly due to treatments taken up under WDP to improve the rainwater harvesting. Therefore, it was expected that the land utilization pattern of the beneficiaries would be different in post-project position as well as from the non-beneficiary cultivators. As expected, the pattern of land utilization of beneficiaries was distinctly different in post-project and from the non-beneficiaries (Table 1).

Due to various treatments taken up under WDP to bring wasteland into cultivation, the percentage of cultivable wasteland was much less in post-project position (10.65 %) compared to pre-project position (25.21 %). It was also less among the beneficiaries compared to non-beneficiaries. While the cultivable wasteland accounts for 10.65 per cent in the total land holding of the beneficiaries, the same accounts for 18.98 per cent in the total land holdings of the non-beneficiaries, indicating a difference of 8.33 per cent. Although the difference in share of current fallow to total land holding is very less between beneficiaries (0.71%) and the non-beneficiaries (1.65 %), the differences are substantial in case of Net Cropped Area (NCA) and area cropped more than once. For instance, NCA accounts for 88.64 per cent in the total land holding of the beneficiaries, but the same is 79.37 per cent in case of the non-beneficiaries. Similarly, while area cultivated more than once accounts for 24.55 per cent of the total land holding of the beneficiaries, the same accounts for only 13.20 per cent in the total land holding of the non-beneficiaries. The cropping intensity had been increased from 113.17 per cent in pre-project period to 127.69 per cent in post-project period. The cropping intensity of non-beneficiaries was found to be lower compared to beneficiary farmers. Most of the farmers of the watershed area expressed that they could have convert their wasteland into cultivable land and increase the area cultivated more than once because of the various treatments taken under the watershed development project. The results gain support from the study conducted by Babu *et al*. (2004) and Singh and Jain (2004) who observed that implementation of watershed development project had resulted in decline of the area under wasteland and increase of the GCA, NCA and cropping intensity.

Area under irrigation :

One of the major constraints faced by the farmers

Table 1: Land utilization pattern of sample cultivators **(In ha)**

Particulars	Beneficiary		Non-beneficiary
	Pre-project position (*ex-ante)*	Post-project position (ex-post)	Post-project position
Total land holding	236.28	236.28	145.4
Cultivable waste land	59.56 (25.21)	25.16 (10.65)	27.6 (18.98)
Current fallow	6.68 (2.83)	1.68 (0.71)	2.4 (1.65)
Net cropped area (NCA)	170.04 (71.96)	209.44 (88.64)	115.4 (79.37)
Area cropped more than once	22.4 (9.48)	58 (24.55)	19.2 (13.20)
Gross cropped area (GCA)	192.44	267.44	134.6
Cropping intensity (%)	113.17	127.69	116.64

Note: Figures within the parentheses indicate percentage to total land holding

Table 2 : Area under irrigation **(In ha)**

Particulars	Beneficiary		Non-beneficiary
	Pre-project position	Post-project position	Post-project position
Well irrigated area	39.44 (79.13)	68.84 (71.09)	35.6 (82.79)
Other sources irrigated area	10.4 (20.87)	28 (28.91)	7.4 (17.21)
Net irrigated area	49.84 (100.00)	96.84 (100.00)	43 (100.00)
Area irrigated more than once	11.2	37.2	12.8
Gross irrigated area	61.04	134.04	55.8
Percentage of NIA to NCA	29.31	46.24	37.26
Percentage of GIA to GCA	31.72	50.12	41.46
Irrigation intensity	122.47	138.41	129.77

Notes: NIA – Net irrigated area; NCA – Net cropped area; GIA – Gross irrigated area; GCA – Gross cropped area

of rain fed areas is water scarcity and poor irrigation facility. Since irrigation water is important for improving the performance of agriculture and the socio-economic conditions of the people living in rain fed areas, major thrust is given to improve the availability of water by constructing rainwater harvesting structures like nala bunds, contour trenches, water absorbing trenches, contour guidelines, farm ponds, dug out ponds and other run off management structures under the watershed development project (WDP).

Figures within the parentheses indicate percentage to net irrigated area :

$$\text{Cropping intensity} = \frac{\text{Gross cropped area}}{\text{Net cropped area}} \times 100$$

Table 2 presents the details of area under irrigation for the beneficiaries and the non-beneficiaries. It is evident from the table that area under irrigation had increased among the beneficiaries after project implementation. The irrigation intensity was relatively higher (138.41 %) in case of beneficiaries compared to non-beneficiaries (129.77 %). Percentage of NIA to NCA was higher (46.24 %) in beneficiaries compared to non-beneficiaries (37.26 %). The results were in line with the findings of Arya *et al.* (1994) and Tilekar *et al.* (2009) who observed that there was remarkable increase under irrigated area of beneficiaries during post-project period.

Cropping pattern of sample cultivators :

Among the different factors determining the cropping pattern, irrigation availability plays a paramount role. Generally, area under water-intensive crops would be higher where the availability of irrigation is higher. It is seen in Table 2 that the availability of irrigation was higher for the beneficiaries compared to the non-beneficiaries due to various treatments taken up for improving the watershed system under WDP. Therefore, it was expected that the cropping pattern of the beneficiaries would be different from that of the non-beneficiaries. Besides comparing the cropping pattern of the beneficiaries with the non-beneficiaries during post-project period, the attempt was also made to find out as how the cropping pattern of beneficiaries have changed between pre-project position to post-project position.

Table 3 : Cropping pattern of sample cultivators **(In ha)**

Sr. No.	Crop	Beneficiary		Non-beneficiary
		Pre-project position	Post-project position	Post-project position
***Kharif* season**				
1.	Maize	37.24 (19.35)	56.24 (21.03)	31.6 (23.48)
2.	Cotton	26.4 (13.72)	39 (14.58)	16.6 (12.33)
3.	Pigeonpea	35.6 (18.50)	14 (5.24)	12 (8.92)
4.	Fennel (*Kharif*)	15.2 (7.90)	5.6 (2.09)	-
5.	Pearl millet	10.8 (5.61)	9.6 (3.59)	16.8 (12.48)
6.	Pearl millet + pigeonpea	28.8 (14.97)	13.2 (4.94)	14.4 (10.70)
7.	Maize + pigeonpea	10.4 (5.40)	34 (12.71)	9.6 (7.13)
8.	Green gram	–	5.6 (2.09)	3.2 (2.38)
9.	Sesame	–	7.2 (2.69)	4 (2.97)
10.	Tobacco	–	4 (1.50)	–
11.	Sorghum (Fodder)	5.6 (2.91)	14 (5.23)	7.2 (5.35)
12.	Maize + cotton	–	4.6 (1.72)	–
13.	Cotton + green gram	–	2.4 (0.90)	–
Total area under *Kharif*		170.04 (88.36)	209.44 (78.31)	115.4 (85.74)
***Rabi* season**				
1.	Isabgol	4.8 (2.49)	4.8 (1.79)	2.4 (1.78)
2.	Cumin	17.6 (9.15)	29.2 (10.92)	10.4 (7.73)
3.	Fennel	–	11.2 (4.19)	6.4 (4.75)
4.	Castor	–	12.8 (4.79)	–
Total area under *Rabi*		22.4 (11.64)	58 (21.69)	19.2 (14.26)
Gross cropped area		192.44 (100)	267.44 (100)	134.6 (100)

Note: Figures within the parentheses indicate percentage to gross cropped area

Data provided in Table 3 clearly depicts differences in the cropping pattern between above mentioned situations. There was increase in area under maize, cotton, maize + pigeonpea, sorghum (fodder) and cumin in post-project position as compared to pre-project position. The area under pigeonpea, fennel (*Kharif*) and pearl millet + pigeonpea declined considerably in post-project position. More crops (green gram, sesame, tobacco and castor) were included in cropping pattern in post-project position. The per cent area under cotton, maize + pigeonpea and cumin was found to be higher in case of beneficiaries when compared to non-beneficiaries. Percentage of area under *Rabi* crops to gross cropped area was higher in case of beneficiaries (21.69 %) when compared to non-beneficiaries (14.26 %). Similarly, Machiwal *et al*. (2004) and Tilekar *et al.* (2009) observed that the watershed helped farmers to bring more area under *Rabi* crops as well as the higher availability of water had resulted in diversification of the cropping pattern with the substitution of more profitable crops.

Productivity of major crops grown by sample cultivators :

It is hypothesized that productivity of crops increases because of watershed development activities. Therefore, productivity of major crops grown in watershed project area and adjacent area was worked out and presented in Table 4.

The productivity was increased in post-project period possibly due to the increase in irrigation facility, improvement in the fertility of the soil and increased moisture retention capacity. The highest productivity gain was observed in case of fodder sorghum (55.21 %) followed by pigeonpea (50.06 %) and cotton (41.20 %). Similar type of situation was also observed in mix crops.

The productivity of major crops was higher in case of beneficiaries compared to the non-beneficiaries. The productivity difference between the beneficiaries and non-beneficiaries was 8.33 per cent in cotton, 13.46 per cent in maize, 19.18 per cent in pigeonpea, 9.29 per cent in pearl millet, 18.17 per cent in sorghum (fodder) and 18.09 per cent in cumin. Here, also the productivity of mix crops was observed higher in case of beneficiaries than that of non-beneficiaries.

There were two main reasons for higher productivity among beneficiaries farmers. First, the beneficiaries used relatively higher amount of yield increasing inputs, which augmented productivity of different crops. Second, due to various treatments taken under the WDP, the

Table 4 : Productivity of major crops grown by sample cultivators **(kg/ha)**

Crop	Beneficiary			Non-beneficiary	
	Pre-project position	Post-project position	Per cent difference over pre-project	Post-project position	Per cent difference over non-beneficiary
Maize	1542.81	1962.26	27.19 (8.186**)	1729.55	13.46 (4.934**)
Cotton	1093.75	1544.41	41.20 (11.418**)	1425.60	8.33 (2.492*)
Pigeonpea	1216.15	1825.00	50.06 (4.150**)	1531.25	19.18 (3.800**)
Pearl millet	1285.42	1562.50	21.56 (1.752)	1429.69	9.29 (2.998*)
Pearl millet +	715.28	964.29	34.81 (5.599**)	862.50	11.80 (2.447*)
pigeonpea	368.06	500.42	35.96 (7.551**)	391.67	27.77 (7.657**)
Maize +	845.83	1106.06	30.77 (6.058**)	951.04	16.30 (3.566**)
pigeonpea	341.67	496.69	45.37 (3.037**)	381.25	30.28 (2.026)
Sorghum (Fodder)	5138.89	7976.19	55.21 (7.590**)	6750.00	18.17 (3.928**)
Cumin	614.72	811.86	32.07 (6.753**)	687.50	18.09 (6.884**)

Note: Figures within the parentheses indicate t - test value
* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 5: Change in livestock population

Livestock species	Beneficiary		Non-beneficiary
	Pre-project position	Post-project position	Post-project position
Buffaloes	14 (0.20)	31 (0.44)	12 (0.30)
Cows	20 (0.29)	16 (0.23)	12 (0.30)
Goats	19 (0.27)	35 (0.50)	17 (0.43)
Sheep	15 (0.21)	28 (0.40)	14 (0.35)
Total livestock	68 (0.97)	110 (1.57)	55 (1.38)

Note: Figures within the parentheses indicate average number of livestock per farm

availability of moisture has improved which ultimately increased the productivity of various crops. To know the difference of productivity between pre-project position and post-project position as well as between beneficiary and non-beneficiary, whether statistically significant or not, t-value was worked out with the help of SPSS software. The t-values indicate that the difference was statistically highly significant at 1 per cent level of significance for most of the crops. Thus, statistically the results were substantiated and it also revealed that WDP increases the productivity of the crops grown in watershed area. The results were in line with the findings of Jally *et al.* (1995); Rajput *et al.* (1996) and Kumar *et al.* (1999) who observed that increased soil moisture and fertility in watershed area positively lead to increase in the crop productivity.

Change in livestock population :

The watershed development project had also provided thrust to the livestock management components. It was observed that cow, buffalo, goat and sheep were the common livestock species in the area. Per farm livestock population was higher for the beneficiary farms (1.57) than that of the non-beneficiary farms (1.38). Crop-livestock linkages were improved after implementation of watershed development project, which was indicated by increase in the livestock population (Table 5). The total livestock population of beneficiaries was increased from 68 in pre-project period to 110 in post-project position. This indicated that watershed development has helped in the diversification of crop-livestock mixes too. Khatik *et al.* (1997); Babu *et al.* (2004) and Thomas *et al.* (2009) also reported similar findings that watershed development helped farmers of watershed area in improving their livestock status.

Labour-use in major crops grown by sample cultivators :

It was hypothesized that intensification and diversification of agricultural activity increased the opportunities of on-farm employment for the farmers. Crop-wise labour use presented in Table 6, reveals that the use of human labour for major crops was increased over pre-project position. The increase was maximum in the case of cotton (26.62 %), followed by maize (24.81 %) and maize + pigeonpea (20.19 %). The use of human labour was also found to be higher in beneficiary farms compared to non-beneficiary farms. Statistically the results were substantiated with the help of t-value. The results gain support from the study conducted by Babu *et al.* (2004) who observed that the labour-use in wheat increased from 53.87 to 84.60 man days/ha after implementation of project.

Variable cost of major crops grown by sample cultivators :

We have seen earlier that the productivity of different crops is higher among the beneficiaries than that of the non-beneficiaries and this difference might be due to the changing pattern of input utilization. Therefore, variable cost (Cost A) for pre-project position and post-project position as well as for beneficiaries and non-beneficiaries are to be required to compare. Table 7 presents the variable cost of different crops for both the beneficiaries and non-beneficiaries.

The data of the table indicate that variable cost of the major crops was higher in post-project position as compared to pre-project position and the difference was ranging from 14.52 per cent to 37.53 per cent. Similarly, the average variable cost of major crops was also found higher for the beneficiaries as compared to non-

Table 6 : Labour use in major crops grown by sample cultivators **(Man days/ha)**

Crop	Beneficiary			Non-beneficiary	
	Pre-project position	Post-project position	Per cent difference over pre-project	Post-project position	Per cent difference over non-beneficiary
Maize	32.88	41.04	24.81 (6.256**)	35.38	16.00 (2.842**)
Cotton	48.22	61.06	26.62 (4.764**)	55.54	9.94 (1.651)
Pigeonpea	41.04	48.97	19.31 (2.323*)	41.25	18.72 (1.370)
Pearl millet	31.00	36.46	17.61 (1.658)	34.19	6.64 (0.714)
Pearl millet + pigeonpea	34.39	41.23	19.89 (3.759**)	37.58	9.71 (1.271)
Maize + pigeonpea	36.71	44.12	20.19 (4.239**)	36.88	19.63 (4.318**)
Sorghum (Fodder)	31.11	33.63	8.10 (0.703)	30.63	9.79 (1.183)
Cumin	44.42	52.34	17.84 (2.752*)	47.50	10.19 (1.236)

Note: Figures within the parentheses indicate t - test value
* and ** indicate significance of values at P=0.05 and 0.01, respectively

beneficiaries and the difference ranged from 10.18 per cent to 19.70 per cent. The above discussed results were also statistically substantiated by working out t-test.

The higher average variable costs of beneficiary farmers include the additional costs incurred as a result of watershed development in the project area and these additional costs were expenditure on maintenance of water resource system of land improvement, improved seeds, higher use of fertilizers and plant protection measures and increased use of human and bullock labour/ machine labour on beneficiary farms. The results were in line with the findings of Narayanamoorthy and Kshirsagar (2002) who observed that the cost of cultivation of the majority of the crops was higher for the beneficiaries when compared to the non-beneficiaries because of the fact that the beneficiaries used relatively higher amount of modern inputs.

Impact of watershed development activities on income from crop and dairy enterprise :

One of the main objectives of the watershed project is to improve the household income of the farmers belonging to the rain fed areas besides conserving the land and water resources. Therefore, it was also tried to find out the impact of WDP on two main sources of income of farmers in watershed area *i.e.* income from crop and livestock enterprises.

Income pattern of crop production :

Comparison between pre-project and post-project position :

Per farm and per hectare income pattern of crop production have been shown in Table 8. Per farm gross income secured through crop production was increased from Rs. 68542.87 in pre-project period to Rs. 141664.56 in the post-project period (106.68 %). Similarly, per hectare gross income accrued from crop production was increased from Rs. 24932.44 in pre-project period to Rs. 37079.59 in the post-project period (48.72 %).

Per farm costs 'A', 'B', and 'C' showed the increase of 74.22 per cent, 97.57 per cent and 91.91 per cent over pre-project period, respectively. Similarly, per hectare costs 'A', 'B', and 'C' showed the increase of 25.36 per cent, 42.17per cent and 38.09 per cent over pre-project period, respectively.

Per farm analysis of farm business income, family labour income and net income showed gain of 122.30 per cent, 117.17 per cent and 135.05 per cent over pre-project period, respectively. Whereas, per hectare analysis showed gain of 59.96 per cent, 56.27 per cent and 69.13 per cent over pre-project period, respectively.

Comparison between beneficiaries and non-beneficiaries:

Per farm gross income of beneficiary household was 60.96 per cent higher than that of the non-beneficiary households. Similarly, per hectare gross income of beneficiary household was 41.77 per cent higher than that of the non-beneficiary households.

Per farm costs 'A', 'B', and 'C' showed the difference of 43.92 per cent, 56.84 per cent and 52.03 per cent between beneficiaries and non-beneficiaries, respectively. Similarly, per hectare costs 'A', 'B', and 'C' showed the difference of 26.76 per cent, 38.14 per cent and 33.91 per cent between beneficiaries and non-beneficiaries, respectively.

Per farm, farm business income, family labour and net income of beneficiary households were respectively 68.48 per cent, 65.51 per cent and 77.26 per cent higher than that of non-beneficiary households. Whereas per

Table 7 : Variable cost of major crops grown by sample cultivators **(Rs./h)**

Crop	Beneficiary			Non-beneficiary	
	Pre-project position	Post-project position	Per cent difference over pre-project	Post-project position	Per cent difference over non-beneficiary
Maize	5003.94	5733.71	14.58 (4.068**)	5053.62	13.46 (3.931**)
Cotton	13249.46	15999.59	20.76 (5.259**)	14264.20	12.17 (3.789**)
Pigeonpea	10282.49	13183.57	28.21 (4.613**)	11165.82	18.07 (3.219*)
Pearl millet	3297.01	3883.83	17.80 (1.612)	3440.59	12.88 (6.408**)
Pearl millet + pigeonpea	5042.33	6300.53	24.95 (5.183**)	5524.17	14.05 (5.755**)
Maize + pigeonpea	5623.57	6997.59	24.43 (2.572*)	5971.00	17.19 (1.731)
Sorghum (Fodder)	3296.23	4533.20	37.53 (2.364*)	3787.00	19.70 (1.754)
Cumin	11925.36	13657.13	14.52 (2.610*)	12395.72	10.18 (2.034)

Note: Figures within the parentheses indicate t - test value
* and ** indicate significance of values at P=0.05 and 0.01, respectively

hectare, farm business income, family labour income and net income of beneficiary households were, respectively 48.39 per cent, 45.77 per cent and 56.13 per cent higher than that of non-beneficiary households.

The t-values indicate that the difference between income of pre-project position and present position of beneficiaries as well as between beneficiaries and non-beneficiaries were statistically highly significant at 1 per cent level of significance for all types of incomes (farm business income, family labour income and net income).

The increase in the crop income of the beneficiary household was mainly because of three reasons. First, the watershed development project had increased the cropping intensity that has ultimately increased the gross income from per unit of land. Second, the watershed development project, by improving the availability of moisture and water, had helped to increase the productivity of different crops. Third, owing to increased availability of irrigation, the beneficiaries have shifted the cropping pattern from low value crops to high value commercial crops such as green gram, sesame and tobacco. The results were in line with the findings of Tilekar *et al*. (2009) who observed that per farm and per hectare income from crop production were increased in post-project period.

Income from livestock production :

The data on income from livestock production are presented in Table 9. The perusal of table shows that per farm net income from livestock was increased from Rs. 24443.07 to Rs. 52911.06 between the pre and post-project period. Per farm livestock income of the beneficiaries (Rs. 52911.06) was higher than that of the non-beneficiaries (Rs. 39319.60). Similar results were also obtained while analysing the data on per animal basis.

With the help of increased number of milch animals, substantial increase in milk yield and higher fodder and water availability for livestock production, the beneficiaries obtained higher per farm and per animal net income from livestock enterprise. The results were in line with the findings of Mahnot *et al.* (1992) who observed that the availability of more dry and green fodder from the watershed area increased gross return from milk production.

Conclusion and policy implications :

The study has brought to the fore that the percentage of cultivable wasteland was much less in post-project position compared to pre-project position. It was also less among the beneficiaries compared to non-beneficiaries. The net cropped area was increased from 71.96 per cent in pre-project position to 88.64 per cent

Table 8 : Income pattern of crop production

Particulars	Per farm			Per hectare		
	Beneficiary		Non- beneficiary	Beneficiary		Non-beneficiary
	Pre project position	Post project position		Pre project position	Post Project position	
Gross income (crop production)	68542.87	141664.56	88013.92	24932.44	37079.59	26155.64
Difference (%)		106.68	60.96		48.72	41.77
Costs						
Cost 'A'	22263.96	38787.54	26950.47	8098.47	10152.30	8009.05
Difference (%)		74.22	43.92		25.36	26.76
Cost 'B'	36689.37	72488.25	46217.17	13345.67	18973.18	13734.73
Difference (%)		97.57	56.84		42.17	38.14
Cost 'C'	45069.10	86490.08	56888.47	16393.66	22638.04	16906.01
Difference (%)		91.91	52.03		38.09	33.91
Farm business analysis						
- Farm business income	46278.91	102877.02	61063.45	16833.98	26927.30	18146.59
Difference (%)		122.30 (5.651**)	68.48(2.704**)		59.96(7.043**)	48.39(4.502**)
- Family labour income	31853.50	69176.31	41796.75	11586.77	18106.42	12420.91
Difference (%)		117.17(5.621**)	65.51(2.647**)		56.27(7.164**)	45.77(4.721**)
- Net income (Crop production)	23473.77	55174.48	31125.45	8538.78	14441.55	9249.63
Difference (%)		135.05(5.871**)	77.26(2.856**)		69.13(6.975**)	56.13(4.608**)

Note: Figures in parentheses indicate t - test value
* and ** indicate significance of values at P=0.05 and 0.01, respectively

in post-project position and it was also higher in beneficiaries' farms than that of non-beneficiaries' farms. Similarly, cropping intensity and irrigation intensity were higher in post-project position of beneficiaries.

More crops were included in cropping pattern in post-project position. Per cent area under cotton, maize + pigeonpea and cumin was found to be higher in case of beneficiaries when compared to non-beneficiaries. Thus, it was concluded that the cropping pattern of beneficiaries was changed and shifted in favour of commercial crops because of watershed development activities.

The productivity of major crops grown in watershed project area was increased in post-project position. The highest productivity gain was observed in case of fodder sorghum followed by pigeonpea and cotton. Similar type of situation was also observed in mix crops. The productivity of major crops was also higher in case of beneficiaries compared to the non-beneficiaries. Similar situation was observed in mix crops. Therefore, it was concluded that WDP increases the productivity of the crops grown in watershed area significantly. The total livestock population of beneficiaries was increased from 68 in pre-project period to 110 in post-project period. This indicated that watershed development has helped in the diversification of crop-livestock production system.

The use of human labour for major crops was increased over pre-project position. The increase was maximum in the case of cotton followed by maize and maize + pigeonpea. The use of human labour was also found to be higher in beneficiary farms compared to non-beneficiary farms indicating the WDP has helped addressing the pernicious problem of rural unemployment.

The variable cost of the major crops was higher in post-project position as compared to pre-project position indicating enhanced use of agricultural inputs. Similarly, the average variable cost of major crops was also found higher for the beneficiaries as compared to non-beneficiaries. Though the cost of cultivation of beneficiaries was higher in post-project period, the farm business income, family labour income and net income were also substantially higher during post-project period.

Per farm net income from livestock was increased between the pre and post-project period as well as the income of beneficiaries was higher than that of the non-beneficiaries.

Finally, it can be concluded from the findings that the Watershed technology helps in augmenting returns from dry land crop production as well as other subsidiary activities on sustainable basis. Therefore, it is suggested that the implementation of watershed development programme needs to be continued and extended to other areas.

Table 9 : Income from livestock production

Sr. No.	Particulars	Per farm			Per animal		
		Beneficiary		Non-beneficiary	Beneficiary		Non-beneficiary
		Pre-project position	Post project position		Pre-project position	Post project position	
1.	Fixed capital	51783.82	76009.44	57912.27	25891.91	29110.00	26543.13
2.	Variable cost						
	Fodder (Green + Dry)	10584.12	15828.33	12749.55	5292.06	6061.91	5843.54
	Concentrate feed mixture	8947.06	13250.00	10174.55	4473.53	5074.47	4663.33
	Labour	22470.59	32166.67	25636.36	11235.29	12319	11750
	Vet. + Medicine	435.29	694.44	554.55	217.65	265.96	254.17
	miscellaneous	764.71	1166.67	863.64	382.35	446.81	395.83
3.	Fixed cost	15743.40	23096.16	17609.04	7871.70	8845.34	8070.81
4.	Total cost	58945.16	86202.27	67587.68	29472.58	33013.64	30977.69
5.	Receipts						
	From sale of milk	76352.94	128663.33	99080.00	38176.47	49275.32	45411.67
	From sale of farmyard manure	3717.65	4977.78	3781.82	1858.82	1906.38	1733.33
	From sale of calf	3317.65	5472.22	4045.45	1658.82	2095.74	1854.17
6.	Total receipts	83388.24	139113.33	106907.27	41694.12	53277.45	48999.17
7.	Net income (Total receipts - Total cost)	24443.07	52911.06	39319.60	12221.54	20263.81	18021.48

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