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IMPACT OF WATERSHED DEVELOPMENT PROGRAMMES ON LIVELIHOOD CONDITIONS OF FARMERS IN HARYANA

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ABSTRACT

Watershed development programmes are being implemented with a broad objective to improve socio-economic conditions of the resource-poor and disadvantaged sections of rural population through conservation, regeneration and judicious use of all natural resources, keeping in view of rural development. So, this study assesses the impact of watershed development programmes on agricultural production, yield, cropping pattern and cropping intensity, livestock population, milk production and feed and fodder. For this, two districts were selected from two watershed development programmes on the basis of maximum completed projects and maximum covered area. Two micro watersheds were randomly selected from each district. 30 beneficiary and 30 non-beneficiary households were selected through random sampling from each micro watershed. Average and percentage methods were used for analysing the results. The study found that impact of DDP and IWDP watershed development programmes had been positive on agricultural yield, cropping pattern and benefit-cost ratios in watershed area (WSA), while impact had been weak on cropping intensity. The study also found that watershed development programmes had positive impact on the population of livestock in WSA of Bhiwani and Rohtak districts, but it had weak impact in Hisar and Kaithal districts. The impact of DDP on total milk production and green fodder was positive in both of Bhiwani and Hisar districts but weak impact on IWDP programme. Both programmes had positive impact on employment generated in per acre mandays from agriculture. DDP had positive impact on employment generated from livestock.

Keywords: DDP, IWDP, WSA, Non-WSA, Watershed Development Programme.

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Introduction

India is a developing country with most of its population living in rural areas. Majority of population in the rural areas have agriculture as their principal occupation with dairy/livestock as subsidiary occupation. Large portion of the net cultivated area in India is still rain-fed. This rain-fed area had a great potential to increase production and yield of agriculture sector. For this, it was necessary to conserve and develop degraded natural resources, harvest the rainwater so that soil erosion could be prevented, groundwater depth table recharged and natural vegetation could be regenerated. On the other hand, livestock sector plays an important role in the rural economy as supplementing family incomes, generating gainful employment and improving socio-economic condition of mainly small, marginal, landless farmers and women (Phand et al., 2015). Besides providing supplementing income and generating employment, this sector also contributes to supply of cheap and nutritious food to millions of masses of India. It also makes substantial contribution to environmental conservation, manure for fertiliser and domestic fuel that save on the use of non-renewable resources like petro-products (Kumar et al., 2008). There is a strong interlinkage between agriculture and livestock sectors as well. The agriculture sector provides green and dry fodder to the livestock as feed. The fodder crops provide all the critical elements to the livestock like highly digestible protein, carbohydrates, fats and minerals. This feed is also a cheap source of nutrients as compared to concentrates. Water resources management is an essential component of agricultural development through increase in water use. Proper watershed management entails double benefits to rural population. Firstly, it maintains the productive capacity of natural resources by arresting the degrading process. Secondly, it promotes overall economic development through improving socio-economic conditions of the resource-poor and disadvantaged sections. Watershed development programmes mainly aim at harvesting every drop of rainwater, restoring ecological balance and mitigating the adverse effects of extreme climatic conditions such as drought and desertification on crops, human and livestock population so as to create sustainable sources of income, increase the employment opportunities, reduce poverty in rural areas and develop human and other economic resources for the overall development of rural areas (Department of Land Resources, 2012). Different watershed development programmes have been implemented in India for achieving the objectives of conserving and developing degraded natural resources and harvesting rainwater. It has increased agricultural production and yield of rain-fed area. The cropping pattern has changed in favour of more profitable crops and livestock development could be sustained. The study aims to analyse the impact of watershed development programme on livelihood conditions of farmers with the following specific objectives:

1. To study the impact of watershed development programmes on agricultural production, yield, cropping pattern, cropping intensity and benefit-cost ratios.

2. To analyse the impact of watershed development programmes on population of livestock, milk production, feed and fodder.

3. To assess the impact of watershed development programmes on employment from agriculture and livestock sectors.

Methodology

The watershed development programmes in Haryana are being run through the Haryana Rural Development Department and Haryana Agriculture Department. Among these, the programmes under the Haryana Rural Development Department are carried out through the entire state except Kurukshetra district, while the programmes under Haryana Agriculture Department cover only a few districts of the State. Therefore, the present study takes up only the watershed programmes being undertaken by the Haryana Rural Development Department out of which one was DDP (Desert Development Programme) and another was IWDP (Integrated Wasteland Development Programme).

In Haryana, both the programmes were launched by the Ministry of Rural Development, Government of India during the year 1995-96. The main objectives of DDP watershed development projects were developing wasteland/degraded lands, drought-prone and desert areas, promoting overall economic development and improving socio-economic condition of the resource-poor and disadvantaged sections, mitigating the adverse effects of the extreme climate conditions such as drought and desertification of crops, harvesting every drop of rainwater for the purpose of irrigation, plantations, fisheries, pasture development, etc., restoring ecological balance by harnessing, conserving and developing natural resources, i.e. land, water, vegetative cover and encouraging village community toward sustained community action for operation and maintenance of the assets created and further development of the potential of the natural resources in the watershed. The basic objective of the IWDP scheme was an integrated wasteland development based on village/micro watershed plans. These plans were prepared after taking into consideration the land capability, site condition and local needs of the people. The scheme also aimed at rural employment, besides enhancing the contents of people's participation in the wasteland development programmes at all stages, which was ensured by providing modalities for equitable and sustainable sharing of benefits and usufructs arising from such projects.

Generally, activities such as water conservation work, stock ponds, water channels, gully plugging, percolation embankment, field bunding, afforestation, check dams, pasture development, land levelling, piped water supply for irrigation, etc., are being taken up under DDP watershed development programme. The major activities taken up under the IWDP scheme were in situ soil and moisture conservation measures like terracing, bunding, trenching, vegetative barriers and drainage

line treatment, planting and sowing of multi-purpose trees, shrubs, grasses, legumes and pasture land development, encouraging natural regeneration, promotion of agro-forestry and horticulture, wood substation and fuelwood conservation measures, awareness raising, training and extension, encouraging people's participation through community organisation and capacity building, drainage line treatment by vegetative and engineering structures, development of small water harvesting structures, afforestation of degraded forest and non-forest wasteland, development and conservation of common property resources. In Bhiwani and Hisar (under DDP) districts, percolation tanks, water channel and land levelling were main activities done on the ground level. The main activities done on the ground level in Rohtak and Kaithal districts were underground pipeline, water channel and percolation tanks. Thus, broad objectives of both the watershed development programmes (under DDP and IWDP) were similar, and strategies for implementation of activities and the nature of activities were also found to be similar, specifically in Haryana.

Brief description related to soil types and rainfall conditions according to ground water information booklet of selected districts:

Bhiwani: The normal annual rainfall of the district is 420 mm which is unevenly distributed over the area in 22 days. The southwest monsoon, sets in from last week of June and withdraws in end of September, contributed about 85 per cent of annual rainfall. July and August are the wettest months. Rest 15 per cent rainfall is received during non-monsoon period in the wake of western disturbances and thunderstorms. Generally, rainfall in the district increases from southwest to northeast (Central Ground Water Board, 2012).

Hisar: The normal annual rainfall of the district is 330 mm which is unevenly distributed over the area in 22 days. Around 75 to 80 per cent of the annual rainfall is received during southwest monsoon season (June to September) with 50 per cent coefficient of variation (CV). The average annual rainfall is around 450 mm, of which the average monthly rainfall received during July and August months is 133.4 and 116.2 mm, respectively. The average monthly rainfall during September is 54.5 mm and June 49.8 mm. The average rainfall received during normal monsoon season is 283 mm. Generally, rainfall in the district increases from southwest to northeast. The soils of the district are of three types, i.e. Arid brown solonized (in northeastern parts covering north eastern part of Narnaund and Uklana Mandi blocks.), Sierozem (in major parts covering Barwala, Hansi-I, Bass (Hansi-II), Hisar-I and Agroha blocks and parts of Uklana, Narnaund, Adampur and Hisar-II blocks) and desert soils (in southern western parts covering part of Adampur and Hisar-II blocks) (Central Ground Water Board, 2013).

Rohtak: The normal annual rainfall in Rohtak district is about 592 mm spread over 23 days. The southwest monsoon sets in the last week of June and withdraws towards the end of September and contributes about 84 per cent of the annual rainfall. July and August are the wettest months. 16 per cent of the annual

rainfall occurs during the non-monsoon months in the wake of thunderstorms and western disturbances. The soils of the district are fine to medium textured. It comprises sandy loam in Rohtak, Sampla and Lakhan Majra blocks whereas it is loamy sand with occasional clay loam in Kalanaur and Meham blocks. High potassium, medium phosphorus and low nitrogen occur in the soils. The soils of the district are classified as arid brown (solemnized) and sierozem(Central Ground Water Board, 2013).

Kaithal: The normal annual rainfall of the district is 511 mm which is unevenly distributed over the area in 30 days. The southwest monsoon, sets in from last week of June and withdraws in end of September, contributed to about 85 per cent of annual rainfall. July and August are the wettest months. Rest 15 per cent rainfall is received during non-monsoon period in the wake of western disturbances and thunderstorms. Generally, rainfall in the district increases from southwest to northeast and varies from 400 mm at Rajound to more than 563 mm at Kaithal and Gulha. The district has two types of soils viz., sierozem and desert soils. The sierozem soil is found in major parts of the district while desert soil is comparatively found in smaller areaof the district, especially in the northern part. Sierozem soil is found in the areas where the normal annual rainfall varies from 300 to 500 mm. These soils vary from sandy loam to loamy sands in texture and are marginally fertile. Degree of salinity and alkali hazards is highly variable, though salinity is a major hazard (Central Ground Water Board, 2013).

Selection of Sample Watersheds: The Haryana Rural Development Department has implemented the watershed development programmes under the Desert Development Programme and Integrated Wasteland Development Programme. In the Desert Development Programme, micro watersheds have been taken up and in Integrated Wasteland Development Programme, cluster of micro watersheds have been taken up.

Only the watersheds implemented since 2003-04 have been taken up in the present study. The reasons for this are as given below:

i. This was the year of release of Guideline for Haryali by the Ministry of Rural Development.

ii. The time period for completion of the watershed programme is five years (as per guidelines). In practice, it may take one or two years more to complete the project. Besides, some time period is required for finding the impact of the project. Therefore, it seems to be the optimum time for taking up as the initial period.

Further, two districts (from each programme) have been selected in the manner as explained below:

i. The selection has been made only from those districts in which watershed projects have been completed. The impact and the constraints in the implementation of the programmes (which are the objectives of the study)

can be better understood in the districts where the projects have been completed. The watershed projects under IWDP and DDP have been completed in three (Rohtak, Yamuna Nagar and Kaithal) and five (Bhiwani, Hissar, Sirsa, Narnaul and Rewari) districts, respectively till 31-07-2013.

ii. The selection of two districts (out of three and five districts as mentioned above) for each programme has been done on the basis of maximum area covered. The reasons for this are as given below:

- Total area which has been treated in watershed development projects was taken according to the criteria given in Haryali guideline. Fund expenditure has been done according to area treatment. So, those districts which have maximum area have got maximum fund in absolute terms.

Impacts could be better measured in those districts which have maximum area covered under the programmes.

Further, two micro watersheds (from each selected district) have been selected in a manner as explained below:

- Firstly, two clusters of micro watershed project under IWDP and one batch of micro watersheds under DDP have been selected randomly from each selected district. As some clusters and batches have same area, random sampling seemed to be more suitable for selection of cluster and batch.
- From selected clusters and batches of micro watersheds, two micro watersheds were selected randomly from each district selected under DDP and IWDP watershed development programmes.

Selection of the Sample Household: From each sample micro watershed, 30 beneficiaries having land in the watershed area and 30 non-beneficiary households having land in non-watershed area were selected through random sampling. In all, from eight selected micro watersheds, a total number of 240 sample households of beneficiaries were selected. Further, 240 sample households of non-beneficiaries from non-watershed area were also selected for the study. The non-beneficiary households were selected either from non-watershed areas of the villages of selected watershed or nearby non-watershed villages for each selected watershed.

Reference Year: The field data were collected from the selected sample households for the agricultural year July 2014 - June 2015.

Source of Data: The study has made an intensive reference to the primary data in trying to analyse the study objective. The interview schedule method has been used as the main tool for collection of primary data. The schedule was well structured and pre-tested.

Analytical Techniques and Analysing the Results: The present study used average and percentage techniques to study the impact

of watershed development programmes on agricultural production, yield, cropping intensity, cropping pattern, population of livestock, milk production, feed and fodder. For analysing the results, the following concepts have been used:

Production = 100 acres as base of gross cropped area for all crops × yield per acre of each crop

Yield (per acre) = Total production from total operational holding land / number of acres

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

Net Area Sown: This represents the total area sown with crops. Area sown more than once in the same year is counted only once.

Gross Cropped Area: This represents the total area sown once and/or more than once in a particular year, i.e. the area is counted as many times as there are sowings in a year. This total area is also known as total cropped area or total area sown.

Estimation of Production Cost: In this study, criteria given by Directorate of Economics and Statistics (DES), Ministry of Agriculture, Government of India (2007) have been used with one minor change in machinery and farm implements used (owned) as removing the effect of own machinery and farm implements and providing the same cost conditions in respect of machinery & implements for estimation of production cost.

Total production cost has been calculated by including following costs:

Variable Cost = Operational Cost + Interest of Working Capital (12.5 per cent p.a. for half the period of crop)

Total Cost = C_2 [Variable Cost + Rental Value of Land + 10 per cent p.a of present value of fixed assets] + 10 per cent of C_2 as managerial input

Milk Production= Lactation period × Milk yeild per day

Availability of Feed and Fodder Area per Animal: For working out the requirement of per animal feed and fodder area available, all animals were converted into standard and livestock units (buffalo equivalent). One animal was treated as equivalent to 1 buffalo/1 bullock/ 0.80 cow/ 2 calves/ 7 goats (above 1 year)/ 14 goats (up to one year).

Results and Discussion

The findings have been presented in three parts, i.e. a) Impact of watershed development programmes on agricultural production, yield, cropping pattern, cropping intensity and benefit-cost ratios; b) Impact of watershed development programmes on population of livestock, milk production, feed and fodder; c) Impact of watershed development programmes on employment from agriculture and livestock sectors. The details are as given below:

a) *Impact of Watershed Development Programmes on Agricultural Production, Yield, Cropping Pattern, Intensity and Benefit-Cost Ratios*

In this part, findings on impact of DDP and IWDP watershed development

programmes on agricultural production, yield, cropping pattern and intensity have been discussed. Tables 1 to 4 summarise the findings of the impact of DDP watershed development programme and Tables 5 to 8 summarise the findings of IWDP watershed development programme on these aspects.

Table 1 reveals that the production of wheat, paddy, cluster bean and sugarcane crops in Bhiwani district and mustard, pearl millet, cluster bean and carrot crops in Hisar district have been higher in WSA as compared to non-WSA as the area under these crops was higher in WSA as compared to non-WSA. The yield of all crops was found to be marginally higher in WSA as compared to non-WSA in both districts except yield of paddy crop in Hisar district. The lower yield of paddy crop in WSA may have been due to the fact that additional water resources were available in non-WSA from one minor passing through nearby it in watershed-3. The agricultural production and yield of other

Table 1: **Impact of DDP on Agricultural Production and Yield in Selected Districts**

(Production in quintals and yield in kg/acre)

Bhiwani District							
Name of Crops		WSA		Non-WSA		Deviation in production	Deviation in yield
		*Production	Yield	*Production	Yield		
Rabi	Wheat	619.66	1773	564.85	1730	54.82	0.43
	Mustard	78.53	640	92.56	600	-14.03	0.40
Kharif	Pearl millet	22.72	496	24.28	459	-1.56	0.37
	Paddy	484.64	1729	392.95	1658	91.69	0.71
	Cluster bean	20.52	346	14.36	206	6.16	1.40
	Cotton	42.95	599	62.75	572	-19.80	0.27
	Sugarcane	2046.27	28943	1424.68	28608	621.59	3.35
	Hisar District						
Rabi	Wheat	870.16	1835	871.92	1826	-1.76	0.09
	Mustard	40.25	963	29.68	958	10.57	0.05
Kharif	Pearl millet	41.33	973	22.39	783	18.94	1.90
	Paddy	71.81	1610	138.21	1719	-66.40	-1.09
	Cluster bean	12.33	411	6.69	378	5.64	0.33
	Cotton	194.48	569	204.25	568	-9.77	0.01
	Sugarcane	0.00	0	0.00	0	0.00	0.00
Vegetable	Carrot	527.10	21000	84.32	16533	442.78	44.67

Source: Field Survey.

*Taking 100 acres as base of total gross cropped area for all crops multiplied by yield of per acre for each crop.

crops in Hisar district were higher in WSA as compared to non-WSA. The highest change was observed in case of carrot vegetable crop (which was third crop in a year due to increase in the water resources in WSA). The results of Bhiwani matched with the findings of Chauhan et al. (2009) and Singh et al. (2009). The results of Hisar district matched with the findings of Pathak et al. (2013).

The study reveals that related to impact of DDP on cropping pattern in selected districts that area under more water requiring crops has been higher in WSA as compared to non-WSA in Bhiwani district as water resources increased in WSA as compared to non-WSA. In Hisar district, gross cropped area under mustard, pearl millet, cluster bean and carrot crops was found to be higher in WSA as compared to non-WSA. This may be due to the fact that the yield of these crops was higher as compared to other crops within WSA as well as the crops of non-WSA. Further, these crops were more remunerative. The results corroborating the findings of Singh and Parkash (2010), IIM (2004) which revealed that change in cropping pattern was marginal from traditional crops to vegetables and cash crops. The results of Bhiwani district corroborated with the findings of Lal (2001).

Table 2 reveals that DDP watershed development programme had positive impact on cropping intensity of different crops in Hisar district due to increased availability of water resources. The vegetables were taken as third crops in a year. In Bhiwani district, DDP programme had positive impact on production, yield and cropping pattern of major crops but cropping intensity has been lower in WSA as compared to non-WSA. This may be due to the fact that cropping pattern shifted in favour of sugarcane (a yearly crop requiring more water resources). The results of Hisar district corroborated with the findings of Sreedevi et al. (2004).

Table 2: Impact of DDP on Agricultural Cropping Intensity in Selected Districts

(Area in acres)

	Particulars	Bhiwani	Hisar
WSA	Gross Cropped Area	1640.18	411.01
	Net Cropped Area	899.42	207.25
	Cropping Intensity (in %)	182.36	198.32
Non-WSA	Gross Cropped Area	824.50	791.63
	Net Cropped Area	445.50	401.25
	Cropping Intensity (in %)	185.07	197.29
Deviation in Cropping Intensity (in %)		-2.71	1.03

Source: Field Survey.

Table 3: Impact of DDP on Benefit-Cost Ratio of Crops in Bhiwani District

(₹ per acre)

	Particulars	Wheat	Mustard	Pearl millet	Paddy	Cluster bean	Cotton	Sugarcane
WSA	Variable cost	11980.89	8635.25	3989.36	17714.61	6910.90	18031.45	38492.14
	Total cost	24007.10	20326.91	8719.55	36811.07	11933.24	30662.71	76991.36
	Returns	25921.00	19054.75	5952.00	69160.00	17300.00	30795.00	86105.43
	By-product	10749.50	3997.50	1000.00	2000.00	2000.00	850.00	10130.05
	Gross return	36670.50	23052.25	6952.00	71160.00	19300.00	31645.00	96235.48
	Net return	12663.41	2725.35	-1767.55	34348.93	7366.76	982.29	19244.12
	B:C ratio	0.53:1	0.13:1	-0.20:1	0.93:1	0.62:1	0.03:1	0.25:1
Non-WSA	Variable cost	12061.44	8509.94	3684.89	18263.54	7034.54	17322.14	38385.36
	Total cost	24095.71	20189.06	8384.63	37414.90	12069.25	29882.48	76873.90
	Returns	23212.00	17873.78	5508.00	66320.00	10300.00	29385.00	85108.80
	By-product	10595.00	4197.50	1000.00	2000.00	1200.00	850.00	10012.80
	Gross return	33807.00	22071.28	6508.00	68320.00	11500.00	30235.00	95121.60
	Net return	9711.29	1882.22	-1876.63	30905.10	-569.25	352.52	18247.70
	B:C ratio	0.40:1	0.09:1	-0.22:1	0.83:1	-0.05:1	0.01:1	0.24:1
Deviation between B:C ratios		0.13:1	0.04:1	0.02:1	0.10:1	0.67:1	0.02:1	0.01:1

Source: Field Survey.

Table 4: Impact of DDP on Benefit-Cost Ratio of Crops in Hisar District

(₹ per acre)

Particulars	Wheat	Mustard	Pearl millet	Paddy	Cluster bean	Cotton	Carrot	
WSA	Variable cost	12800.16	8348.69	7682.84	28488.05	7830.96	21141.95	34964.53
	Total cost	28301.11	23404.50	22672.07	47506.85	20885.93	37477.09	46641.85
	Returns	26036.75	21576.00	11670.00	61180.00	17056.50	24853.88	168000.00
	By-product	9467.50	2777.25	2300.00	900.00	2000.00	900.00	0.00
	Gross return	35504.25	24353.25	13970.00	62080.00	19056.50	25753.88	168000.00
	Net return	7203.14	948.75	-8702.07	14573.15	-1829.43	-11723.21	121358.15
	B:C ratio	0.25:1	0.04:1	-0.38:1	0.31:1	-0.09:1	-0.31:1	2.60:1
Non-WSA	Variable cost	13312.55	9070.21	5682.64	36107.12	7244.57	23705.86	36026.72
	Total cost	29961.99	25295.43	21569.09	58082.34	20240.90	41394.63	47810.26
	Returns	26089.25	26343.00	9396.00	65322.00	15800.40	24720.00	132264.00
	By-product	9510.00	4051.25	1650.00	900.00	2200.00	900.00	0.00
	Gross return	35599.25	30394.25	11046.00	66222.00	18000.40	25620.00	132264.00
	Net return	5637.26	5098.83	-10523.10	8139.66	-2240.50	-15774.64	84453.74
	B:C ratio	0.19:1	0.20:1	-0.49:1	0.14:1	-0.11:1	-0.38:1	1.77:1
Deviation between B:C ratio		0.06:1	-0.16:1	0.19:1	0.17:1	0.16:1	-0.09:1	0.83:1

Source: Field Survey.

Tables 3 & 4 reveal that gross and net returns in Bhiwani district were higher in WSA as compared to non-WSA as yield was higher for these crops in WSA. In Hisar district, net return for most of the crops was higher in WSA as compared to non-WSA except mustard and cotton crops. The benefit-cost ratios were higher for all crops in Bhiwani district and deviation between benefit-cost ratio varied from 0.01 (in case of sugarcane crop) to 0.67 (in case of cluster bean crop). In Hisar district, positive deviation between benefit- cost ratios varied from 0.06 (in case of wheat crop) to 0.83 (in case of carrot crop).

Impact Analysis of IWDP Watershed Development Programme on Agricultural Production, Yield, Cropping Pattern, Intensity and Benefit-Cost Ratios at District Level

Table 5 explains that IWDP programme had positive impact on the yield of all crops in both districts. Further, the production of most of the crops have been higher in WSA as compared to non-WSA in both districts due to positive impact of watershed development programme on the gross cropped area of these crops except paddy and sugarcane crops in Rohtak district and paddy crop in Kaithal district. This may be due to the fact that water resources did not increase sufficiently. The yield of these crops was also not sufficiently higher in WSA. The yield of crops varied between 0.03 quintals per acre in case of cotton crop to 3.90 quintals per acre in case of sugarcane crop in WSA as compared to non-WSA in Rohtak district. In Kaithal district, yield of crops was found to be negligibly higher which varied from 0.12 quintals per acre in case of paddy crop to 1.72 quintals per acre in case of pearl millet crop in WSA as compared to non-WSA. The results related to the yield of Rohtak district corroborated the findings of Panda et al. (2007), Chauhan et al. (2009) and results related the yield of Kaithal district corroborated the findings of Mukherji et al. (2002) and Prasad et al. (2005).

Table 5: Impact of IWDP on Agricultural Production and Yield in Rohtak District

(Production and yield in quintals)

Rohtak District							
	Name of Crops	WSA		Non-WSA		Deviation in production	Deviation in yield
		*Production	Yield	*Production	Yield		
Rabi	Wheat	783.01	1729	723.94	1631	59.07	0.98
	Mustard	34.82	835	24.13	520	10.69	3.15
	Barley	9.16	825	4.40	800	4.76	0.25
Kharif	Pearl millet	12.39	596	10.03	520	2.36	0.76
	Paddy	298.47	1424	318.75	1378	-20.28	0.47
	Cotton	90.76	433	81.44	430	9.31	0.03
	Sugarcane	1535.95	28391	1794.86	28001	-258.91	3.90

Table 5 (Contd.....)

Kaithal District							
Rabi	Wheat	864.15	1710	856.91	1696	7.25	0.14
	Mustard	0.00	0	0.00	0	0.00	0.00
	Barley	0.00	0	0.00	0	0.00	0.00
Kharif	Pearl millet	5.79	526	1.73	354	4.05	1.72
	Paddy	549.42	1643	603.92	1630	-54.50	0.12
	Cotton	110.26	740	77.72	652	32.54	0.88
	Sugarcane	0.00	0	0.00	0	0.00	0.00

Source: Field Survey.

*Taking 100 acres as base of total gross cropped area for all crops multiplied by yield of per acre for each crop.

The study summarised the findings related to impact of IWDP on cropping pattern in selected districts which reveals that area under mustard, paddy and sugarcane crops has been lower in WSA as compared to non-WSA in Rohtak district. It may be summarised that cropping pattern has not changed significantly because water harvesting structure created water resources only for a small portion of area despite the fact that almost entire area of the village was covered under watershed programme and most of water harvesting structures already existed at micro watershed level. These were only extended/deepened. In Kaithal district, area under paddy crop has been lower in WSA as compared to non-WSA because lower size of landholdings due to fragmentation in WSA. Further, only a small portion of the watershed area was benefited due to watershed development programme. The results given in Table 5 also reveal that cropping pattern has not changed significantly and some marginal shift has been observed from more water requiring crops to less water requiring crops. Results of both micro watersheds corroborate the finding of Puskur et al. (2004), Thomas et al. (2009) and Singh and Nouriyal (2012).

Table 6 summaries the findings of the study on impact of IWDP of agricultural cropping intensity in selected districts. The findings reveal that IWDP watershed development programme had marginal positive impact on cropping intensity of different crops in Rohtak district due to increased availability of water resources as a result of which more crops were cultivated in same size of landholdings. In Kaithal district, IWDP watershed development programme had only a marginal positive impact on cropping intensity as improvement in water resources had been very little in WSA. The results of both districts matched with the findings of Thomas et al. (2009), Singh and Parkash (2010).

Table 6: Impact of IWDP on Agricultural Cropping Intensity in Selected Districts

(Area in acres)

	Particulars	Rohtak	Kaithal
WSA	Gross cropped area	789.20	724.50
	Net cropped area	422.00	362.50
	Cropping intensity (in %)	187.01	199.86
Non-WSA	Gross cropped area	967.30	973.75
	Net cropped area	520.50	488.00
	Cropping intensity (in %)	185.84	199.54
Deviation in Cropping Intensity (in %)		1.17	0.32

Source: Field Survey.

Table 7: Impact of IWDP on Benefit-Cost Ratio of Crops in Rohtak District

(₹ per acre)

	Particulars	Wheat	Mustard	Barley	Pearl millet	Paddy	Cotton	Sugarcane
WSA	Variable cost	14056.63	11390.86	8598.23	4805.04	32735.86	18003.44	48227.33
	Total cost	27012.29	26389.95	23318.05	16835.55	47559.45	33663.78	76150.06
	Returns	24199.00	25050.00	8167.50	7146.00	39593.85	17536.50	84393.07
	By-product	8365.00	3105.00	0.00	1175.00	700.00	650.00	9928.15
	Gross return	32564.00	28155.00	8167.50	8321.00	40293.85	18186.50	94321.22
	Net return	5551.71	1765.06	-15150.60	-8514.54	-7265.58	-15477.28	18171.16
	B:C ratio	0.21:1	0.07:1	-0.65:1	-0.51:1	-0.15:1	-0.46:1	0.24:1
Non-WSA	Variable cost	14213.30	8939.73	9162.55	4871.56	33541.30	22349.02	49333.08
	Total cost	26607.13	20806.20	23938.81	16331.22	47867.94	38443.93	76211.38
	Returns	22827.00	15461.50	7840.00	6234.00	38570.00	17200.00	83232.94
	By-product	8152.50	2160.00	0.00	1100.00	700.00	600.00	9295.83
	Gross return	30979.50	17621.50	7840.00	7334.00	39270.00	17800.00	92528.77
	Net return	4372.37	-3184.70	-16098.80	-8997.23	-8597.94	-20643.90	16317.39
	B:C ratio	0.16:1	-0.15:1	-0.67:1	-0.55:1	-0.18:1	-0.54:1	0.21:1
Deviation between B:C ratio		0.05:1	0.22:1	0.02:1	0.04:1	0.03:1	0.08:1	0.03:1

Source: Field Survey.

Table 8: Impact of IWDP on Benefit-Cost Ratio of Crops in Kaithal District

(₹ per acre)

	Particulars	Wheat	Pearl millet	Paddy	Cotton
WSA	Variable cost	8966.62	5420.38	26546.78	16717.00
	Total cost	29137.35	21410.54	48475.52	37662.76
	Returns	23933.00	7627.00	51793.00	33928.00
	By-product	9402.25	1200.00	2000.00	975.00
	Gross return	33335.25	8827.00	53793.00	34903.00
	Net return	4197.91	-12583.54	5317.49	-2759.76
	B:C ratio	0.14:1	-0.59:1	0.11:1	-0.07:1
Non-WSA	Variable cost	8805.11	4780.09	25454.13	15617.11
	Total cost	29609.37	25181.86	47923.30	37102.57
	Returns	23737.00	7235.50	48016.00	30020.00
	By-product	9325.25	1025.00	2000.00	900.00
	Gross return	33062.25	8260.50	50016.00	30920.00
	Net return	3452.89	-16921.34	2092.71	-6182.60
	B:C ratio	0.12:1	-0.67:1	0.04:1	-0.17:1
Deviation Between B:C Ratio		0.02:1	0.08:1	0.07:1	0.10:1

Source: Field Survey.

Tables 7 and 8 reveal that net returns were found to be higher in WSA for most of crops in both districts. It was due to higher yield in WSA. The deviation between benefit-cost ratios were positive for all crops which varied from 0.02:1 (in case of barley) and to 0.22:1 (in case of mustard) in Rohtak district. In Kaithal district, deviation between benefit-cost ratios was positive for most of crops which varied from 0.02:1 (in case of wheat crop) to 0.10:1 (in case of cotton crop). It may be highlighted here that barley, pearl millet, paddy and cotton crops in Rohtak district, and pearl millet and cotton crops in Kaithal district could not even cover their production cost because high land rent increased the total cost invariably.

b) Impact of Watershed Development Programmes on Population of Livestock, Milk Production, Feed and Fodder

In this part, findings on impact of DDP and IWDP watershed development programmes on livestock's population, milk production and feed and fodder have been discussed at district level. Tables 9 to 11 summarise the findings of the impact of DDP watershed development programme and Tables 12 to 14 summarise the findings of IWDP watershed development programme on these aspects.

Table 9 reveals that population of all livestock was found to be higher in WSA as compared to non-WSA in Bhiwani district. Increase in availability of water resources for the livestock seems to be the reason behind it. In Hisar district, the total population of livestock was found to be lower in WSA. The population of buffalo livestock was higher in WSA, cow and bullock livestock population was the same in both areas, while the population of other livestocks was lower in WSA as compared to

non-WSA. Water resources had not increased sufficiently in WSA of Hisar, which reflected in population of livestock. The highest percentage deviation 75 per cent as observed in bullock population in Biwani district underlines the relevance of bullock in farm mechanisation in agricultural economy. The population of buffalo has been higher in WSA as compared to non-WSA in both districts. Thus, we may conclude that DDP watershed development programme had the positive impact on the population of livestock in WSA in Bhiwani district but insignificant impact in Hisar district. The results of Bhiwani district corroborate the findings of Singh and Parkash (2010) and Shah (2010) which showed positive impact of watershed development programme on livestock population in their studies. The results of Hisar district corroborate the findings of Puskur et al. (2004) and Prasad et al. (2005), which were reported in their study that watershed development programme did not have any positive impact of on livestock population.

Table 9: Impact of DDP on Livestock Population and Milk Production in Selected Districts

(Milk in litre)

Name of ruminants	Bhiwani			Hisar		
	No. of livestock		Deviation (in %)	No. of livestock		Deviation (in %)
	WSA*	Non-WSA*		WSA*	Non-WSA*	
Buffalo	97	68	42.65	84	83	1.20
Cow	21	17	23.53	6	6	0.00
Bullock	7	4	75.00	24	24	0.00
Others	91	73	24.66	101	105	-3.81
Total	216	162	33.33	215	218	-1.38

Milk production per year					
	Particulars	Bhiwani		Hisar	
		Buffalo	Cow	Buffalo	Cow
WSA	Total milk production	202210	47400	158770	11710
	Milk production per milch animal	2085	2257	1890	1952
Non-WSA	Total milk production	143540	38200	149040	10770
	Milk production per milch animal	2111	2247	1796	1795
Deviation (in %)	Total milk production	40.87	24.08	6.53	8.73
	Milk production per milch animal	-1.24	0.45	5.26	8.73

Source: Field Survey.

Note: *60 respondents have been taken in each WSA/non-WSA.

** Average has been worked out by dividing the number of livestock by total number of respondents.

The data given in the Table 9 showed that impact of DDP watershed development programme on total milk production was positive in both of Bhiwani and Hisar districts as population of milch animals was higher in WSA of both the districts. The milk production per buffalo was found to be lower in WSA of Bhiwani district and higher in WSA of Hisar district when comaped to non-WSA on both the districts. Per animal availability of area under fodder, which was higher in WSA of Hisar is the main reason behind it. We may conclude that DDP watershed development programme had the positive impact on milk production in WSA. These results corroborate with the findings of Pathak et al. (2007) and Singh et al. (2010), which showed positive impact of watershed development programme on milk production in their findings.

The study summarises the findings of the study on impact of DDP on area under green fodder in the selected districts. It reveals that total area under green fodder was higher in WSA in Bhiwani district but per animal area availability under green fodder was lower in WSA as compared to non-WSA. Similarly, the percentage of area to the total owned land was lower in WSA of Hisar. Higher number of milch animal and smaller size of landholdings may be the reasons for the above said findings. In Hisar district, total area under green fodder available has been lower in WSA as compared to non-WSA. However, per animal area available under green fodder has been higher in WSA. Higher size of landholding in WSA of Hisar district may be reason for it. Thus, we may summarise that the impact of DDP watershed development programme on the availability of green fodder in WSA as compared to non-WSA has been positive. These results corroborate with the findings of Kumar (2012), Rao and Mathur (2012) and Pathak et al. (2013). It also reveals that 92.98 per cent of farmers used own farm produced dry fodder in WSA compared to 96.15 per cent in non-WSA in Bhiwani district. More farmers in WSA used harvester combine machine for harvesting wheat crop as compared to non-WSA. The dry fodder, which came out from using harvestor combined machine, was not so good for milch animal. As a result, some farmers had to purchase dry fodder from other farmers. In Hisar district, 100 per cent farmers used own farm produced dry fodder under both areas. Thus, DDP programme has negligible impact on dry fodder in both districts.

Table 10 reveals that livestock population was found to be lower in WSA as compared to non-WSA in both districts. This may be due to the fact that the size of landholdings in WSA was lesser than non-WSA. As a result, the farmers of WSA had to spare more land in terms of percentage to total land owned, thus putting more pressure on them. As a result, they may have chosen to have lesser number of livestock populations. However, if the effect of size landholdings is being accounted for, then watershed development programme seems to have positive impact on livestock population in Rohtak district as percentage deviation between landholdings of WSA and non-WSA was 6.7, while, percentage deviation between livestock population was just 1.55. For Kaithal district,the figures were found to be 5.88 and 6.39 per cent, respectively, thus

nullifying the effect of each other. Thus, we may summarise that watershed development programme in Rohtak district showed positive impact on livestock population as water resources increased. Table 10 also reveals that total milk production of buffalo was less in WSA as compared to non-WSA. This was due to the fact that the total area availability under green fodder and population of buffalo was lower in WSA as compared to non-WSA in both districts. However, milk production per buffalo was marginally higher in WSA as compared to non-WSA in both districts as area available per animal was higher in WSA as compared to Non-WSA. In case of total milk production by cow and per cow milk production, both the districts have shown positive percentage deviations as population of cow is higher in WSA and water resources availability increased for livestock purpose. Thus, we may say that IWDP watershed development programme had positive impact on milk production of per milch animal. However, the impact was not as significant in case of total milk production due to lower population of milch animal in WSA as compared to non-WSA.

Table 10: Impact of IWDP on Livestock Population in Selected Districts

(Milk in litre)

Name of ruminants	Rohtak			Kaithal		
	No. of livestock WSA*	Non-WSA*	Deviation (in %)	No. of livestock WSA*	Non-WSA*	Deviation (in %)
Buffalo	70	81	-13.58	104	110	-5.45
Cow	15	10	50.00	9	8	12.50
Bullock	14	15	-6.67	19	20	-5.00
Others	92	88	4.55	117	128	-8.59
Total	191	194	-1.55	249	266	-6.39

Milk production per year					
	Particulars	Rohtak		Kaithal	
		Buffalo	Cow	Buffalo	Cow
WSA	Total milk production	142210	28320	184200	14160
	Milk production per milch animal	2032	1888	1771	1573
Non-WSA	Total milk production	157985	18540	185310	10590
	Milk production per milch animal	1950	1854	1684	1324
Deviation (in %)	Total milk production	- 9.99	52.75	-0.60	33.71
	Milk production per milch animal	4.16	1.83	5.14	18.85

Source: Field Survey.

Note: *60 respondents have been taken in each WSA/non-WSA.

** Average has been worked out by dividing the number of livestock by total number of respondents.

The study reveals that related to the impact of IWDP on area under green fodder in selected districts, the total area under green fodder was found to be marginally higher in WSA as compared to non-WSA in Rohtak district due to availability of more water resources in WSA. However, in Kaithal district, total area under green fodder was found to be lower in WSA as compared to non-WSA because water resources had not increased sufficiently for agriculture purpose. Area available per animal under green fodder has been higher in both districts in WSA as compared to non-WSA as number of livestock was lower in WSA as compared to non-WSA. It also reveals that response of farmers related to impact of IWDP on dry fodder was non-existent. All the farmers under WSA and non-WSA used the own farm produced dry fodder in both the districts.

c) The Impact of Watershed Development Programmes on Employment from Agriculture and Livestock Sectors

In this part, findings on impact of DDP and IWDP watershed development programmes on employment from agriculture and livestock sectors have been discussed at district level. Tables 11 to 13 summarise the findings of the impact of watershed development programmes on this aspect.

Table 11 reveals that per acre employment (in mandays) were higher in WSA for all crops by 5.38 mandays in Bhiwani district and by 4.34 mandays in Hisar district. The deviation in employment generated per acre mandays varied from 0.40 (in case of wheat and mustard crops) to 2.00 mandays (in case of sugarcane crop) as yield of crops were higher in WSA in Bhiwani district except mustard and paddy crops. Higher availability of water resources led to lesser number of mandays to flood on areas. In Hisar district, the deviation in employment generated per acre mandays varied from 0.45 (in case of cotton crop) to 2.95 man days (in case of wheat crop). The employment generated in total mandays was also higher in micro watersheds. Thus, DDP had positive impact on employment generated in both districts.

Tables 12 reveals that per acre employment in mandays from all crops were higher by 10.97 mandays in Rohtak district and by 7.4 mandays in Kaithal district. The deviation in employment generated per acre man days varied from .66 (in case of pearl millet crop) to 5.25 man days (in case of sugarcane crop) as yield of crops were higher in WSA as compared to non-WSA in Rohtak district except cotton crop. In Kaithal district, the deviation in employment generated per acre mandays varied from 0.44 (in case of wheat crop) to 4.40 mandays (in case of cotton crop). The employment generated in terms of total mandays was also higher in Kaithal district. But, the employment generated in terms of total mandays was lower in Rohtak district as farmers shifted from high labour requiring crops to less labour requiring crops. Thus, IWDP had positive impact on employment generated in Kaithal district in terms of total employment days and per acre employment days. In Rohtak district, IWDP had positive impact on employment generated in terms of per acre employment days.

Table 11: Impact of DDP on Employment from Agriculture in Selected Districts

(In mandays)

Crops	Bhiwani District						Hisar District					
	WSA		Non-WSA				WSA		Non-WSA			
	Total mandays of emp.*	Per acre emp.	Total mandays of emp.*	Per acre emp.	Change in employment in total mandays	Change in emp. per acre	Total mandays of emp.*	Per acre emp.	Total mandays of emp.*	Per acre emp.	Change in employment in total mandays	Change in emp. per acre
Wheat	299.17	8.56	266.59	8.17	32.58	0.40	569.99	12.02	433.09	9.07	136.90	2.95
Mustard	112.48	9.16	135.33	8.77	-22.85	0.40	36.14	8.65	27.13	8.75	9.01	-0.11
Pearl millet	50.65	11.06	57.18	10.81	-6.53	0.25	41.95	9.87	25.57	8.94	16.38	0.93
Paddy	665.71	23.75	551.03	23.25	114.69	0.50	144.41	32.38	280.44	34.88	-136.02	-2.50
Cluster bean	52.36	8.83	58.41	8.38	-6.05	0.45	22.65	7.55	12.39	7.00	10.26	0.55
Cotton	300.03	41.85	443.96	40.47	-143.93	1.38	1686.95	49.36	1758.62	48.91	-71.67	0.45
Sugarcane	472.84	66.88	323.10	64.88	149.74	2.00	-	-	-	-	-	-
Carrot	-	-	-	-	-	-	67.47	26.88	12.65	24.81	54.82	2.07
Total	1953.24	170.09	1835.6	164.73	117.65	5.38	2569.56	146.71	2549.89	142.36	19.68	4.34

Source: Field Survey.

Note: *Total mandays of employment from 100 acres = Per acre employment X Gross cropped area taking equal to 100 acres as base for all crops.

Table 12: Impact of IWDP on Employment from Agriculture in Selected Districts

(In mandays)

Crops	Rohtak district						Kaithal district					
	WSA		Non-WSA				WSA		Non-WSA			
	Total mandays of emp.*	Per acre emp.	Total mandays of emp.*	Per acre emp.	Change in employment in total mandays	Change in emp. per acre	Total mandays of emp.*	Per acre emp.	Total mandays of emp.*	Per acre emp.	Change in employment in total mandays	Change in emp. per acre
Wheat	303.28	6.70	254.86	5.74	48.43	0.96	182.99	3.62	160.97	3.19	22.02	0.44
Mustard	54.21	13.00	42.20	9.10	12.01	3.91	-	-	-	-	-	-
Barley	11.10	10.00	5.50	10.00	5.60	0.00	-	-	-	-	-	-
Pearl millet	26.01	12.51	22.86	11.85	3.15	0.66	9.22	8.38	3.13	6.38	6.09	2.00
Paddy	885.66	42.26	961.81	41.57	-76.15	0.69	949.14	28.38	1030.73	27.82	-81.59	0.56
Cotton	146.72	7.00	142.05	7.50	4.67	-0.50	720.42	48.35	523.82	43.95	196.59	4.40
Sugarcane	432.48	79.94	478.76	74.69	-46.29	5.25	-	-	-	-	-	-
Total	1859.46	171.41	1908.04	160.45	-48.58	10.97	1861.77	88.73	1718.65	81.34	143.11	7.4

Source: Field Survey.

Note: *Total mandays of employment from 100 acres = Per acre employment X Gross cropped area taking equal to 100 acres as base for all crops.

Table 13: Impact of DDP and IWDP on Employment from Livestock in Selected Districts

(In mandays)

Name of districts and programmes		Per day employment		Yearly employment		Deviation (in %)
		WSA	Non-WSA	WSA	Non-WSA	
DDP	Bhiwani	41.85	29.77	15275.25	10865.14	40.58
	Hisar	37.89	38.15	13831.22	13924.75	-0.68
	Total	79.74	68.16	29103.28	24879.31	16.99
IWDP	Rohtak	35.34	36.86	12897.28	13453.9	-4.12
	Kaithal	51.98	54.20	18972.24	19782.09	-4.10
	Total	86.63	90.56	31618.13	33055.31	-4.34

Source: Field Survey.

Table 13 reveals that DDP watershed development programme had positive impact on employment generated from livestock. Per day and yearly employment from livestock were higher in WSA of Bhiwani district as compared to non-WSA but they were found to be marginally lower in Hisar district. The reason seems to be higher population of livestock in WSA of Bhiwani district and lower population in WSA of Hisar district. The IWDP did not have positive impact on employment generated from livestock. Per day and yearly employment from livestock were lower in WSA of both districts as compared to non-WSA as population of livestock was lower in WSA.

Conclusion

After discussing the results of above Tables, it may be concluded that DDP watershed development programme had positive impact on agricultural production of those crops which were cultivated in higher area of WSA as compared to non-WSA in both districts. The impact of watershed development programme on agriculture yield was positive in both districts, except paddy crop in Hisar district. The area under more water requiring crops was found to be higher in WSA as compared to non-WSA in Bhiwani district. In Hisar district, the area under mustard, pearl millet, cluster bean and carrot crops was found to be higher in WSA as compared to non-WSA. DDP watershed development programme had positive impact on cropping intensity in Hisar district but negative impact in Bhiwani district as farmers shifted to sugarcane crop (an annual crop). To summarise, we may say that IWDP had positive impact on the agriculture production and yield in both districts except production of paddy and sugarcane crops. The impact of watershed development programme was not significant on change in cropping pattern in WSA as compared to non-WSA. The cropping intensity has been higher marginally in WSA. The DDP and IWDP watershed development programmes had positive impact on benefit-cost ratios of all the crops. The positive deviation between benefit-cost ratios ranged from 0.01 in case of sugarcane crop (Bhiwani district) to 0.83 in case of carrot (Hisar district) crop in DDP

programme. The positive deviation between benefit-cost ratio ranged from 0.02 in case of barley crops to 0.22 in case of mustard crop in IWDP programme.

It may also be concluded that the population of all livestock was found to be higher in WSA as compared to non-WSA in Bhiwani district. Increase in availability of water resources for the livestock seems to be the reason behind it. In Hisar district, the total population of livestock was found to be lower in WSA. Water resources had not increased sufficiently in WSA of Hisar, which was reflected in population of livestock. Thus, we may conclude that DDP wateershed development programme had positive impact on the population of livestock in WSA of Bhiwani district but insignificant impact in Hisar district. The impact of DDP watershed development programme on total milk production was positive in both Bhiwani and Hisar districts as population of milch animals was higher in WSA of both the districts. The impact on the availability of green fodder in WSA as compared to non-WSA has also been positive. The DDP programme had negligible impact on dry fodder in both the districts.

The watershed development programme in Rohtak district showed positive impact on livestock population as water resources increased but it was significant in Kaithal district. The impact of IWDP was not as significant in case of total milk production due to lower population of milch animal in WSA as compared to non-WSA. The impact of IWDP watershed development programme on total green fodder was positive in Rohtak district, but it was significant in Kaithal district. The impact of IWDP on dry fodder was non-existent. All the farmers under WSA and non-WSA used own farm produced dry fodder in both the districts.

DDP and IWDP watershed development programmes had positive impact on employment generated in terms of total mandays and per acre mandays in all selected districts except employment generated in total mandays of Rohtak district as farmers shifted from high labour requiring crops to less labour requiring crops. DDP watershed development programme had positive impact on employment generated from livestock sector as population of livestock was higher in WSA as compared to non-WSA. IWDP watershed development programme did not have a positive impact on employment generation from livestock sector as population of livestock was lower in WSA as compared to non-WSA.

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