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Watershed Projects: A Boon to the Rural Economy

(With special reference to the economy of Rajasthan)

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Ever since the creation of universe and the inception of human existence on this planet, man has been continuously exploring nature and natural resources for his basic needs and prosperity. A large portion of the rain fed areas in India is characterized by low productivity, high risk and uncertainty, low level of technology, and vulnerability to degradation of natural resources. Majority of the population in this region is dependent on agriculture, which is still under subsistence and prone to weather. Ironically, the rain fed areas are by-passed with respect to investment on infrastructure and technology intervention as compared to irrigated areas.

Water is critical for rain fed areas, not because of scarcity per se but lack of proper management that accelerates shortages. Broadly these areas are confronted with two major technical and water related problems, heavy and intense rainfall and surface runoff during the monsoon leading to soil erosion and siltation; and severe draught in the summer season leading to acute scarcity of water for post rainy season crops. These two eventualities have to be managed for enhancing agriculture productivity, augmenting income and preventing degradation of water and soil.

The approach of watershed development has undergone continuous evolution in terms of conceptual as well as practical aspect. The desert Development Programme was started in Rajasthan in 1974-75. In this programme the main activity was to develop water harvesting structure for soil and water conservation. The programme was reviewed in 1994-95 by a technical committee headed by C.V. HanumanthaRao.

Based on the recommendations of the committee headed by C.V.H. Rao, comprehensive guidelines for watershed development was issued in October 1994 and made applicable to the area development programme with effect from April 1995. Further revised guidelines for the programme were circulated in September 2001. Watershed development encompassed multifarious objectives, activities and outcomes within an integrated frame work. The main objective of watershed development programme is productivity enhancement, equitable distribution of benefits and environmental sustainability.

Watershed programme was initiated with the basic premise to overcome such anomalies in the country. It was viewed as the key Programme, which could meet the emerging and key challenges of rain fed areas e.g., deplorable poverty, huge unemployment and acute degradation of natural resources.

Rajasthan is the largest state of India having an area of about3.42 lakh sq. kms. A number of watershed development projects are being run through different agencies in the state that aims at protecting the inhabitants of the fragile ecosystem from acute distress caused by recurring draughts. These projects deal with multiple resources, through multiple activities and aim at multiple goals e.g., environmental, economic and social and this leads to a major problem of identification of measurable impact or performances indicators along the multifaceted avenues through which changes are taking place.

1.1 Overview of Literature:

A number of studies hadbeen conducted over the past decade, examining the impact of various watershed projects in the country. Samra and Sharma, 2000, identified essentials of integrated watershed management such as, strong interaction between community driven agencies and development department; flexiblebottom up approach having the capacity for making interim corrections, people's participation and gender neutrality etc. for accruing benefits from Watershed management.[1] A comprehensive study by Deshpande and Reddy, 1994, seeks to examine the impacts of National Watershed Development Project for Rain fed Areas in

Maharashtra. It tries to capture the impact of watershed project using 'with-without' comparison across different agro climatic conditions in the state.[2]Shiferaw; 2003; Reddy and Soussan, 2003 and Shah, 1997 also studied the productivity effect of these projects in different semi-arid regions of the country and found that the plot level productivity effect of the watershed projects was not significant in a pooled analysis of all crops and all villages.[3]

Based on a large-scale survey, the study by Kerr, 2002, observed only a limited impact of most of the projects. Shah, Anil, 2000 observed the positive impact of the projects on draught mitigation in dry land regions. These observations were often based on perception based information rather than quantitative estimates[4]. A few studies, mainly from agriculture universities and other scientific research institutions tried to measure the impact in terms of biophysical measures. A study by Karanth and Abbi, 2001, on the watershed project in Gulbarga, found that under similar rainfall conditions, the runoff had reduced by 30 percent over a period of 10 years. Batchler, 2002, studied the selected watershed projects in Karnataka and Andhra Pradesh and found that watershed projects often bring certain unintended changes in hydrology

It appears that whereas the existing studies do bring about some positive impacts of the various watershed projects in different parts of the country but the findings are not conclusive. From all these evaluations, one does not get direct indications of socio economic impact and environmental impact of these watershed projects in certain area. Therefore it will be useful to develop indicators and methodologies to capture separately the changes occurred due to these projects in selected areas.

1.2 Research Questions or Hypothesis:

The present research paper tried to explore the following pertinent questions in the context of impact assessment of watershed development projects:

1. What are the main activities covered under Watershed Development Project ?
2. What and how much changes are occurred due to watershed development projects in terms of conservation of naturalresources and agriculture productivity in different agro economic regions of the state?
3. Suggestions to improve watershed development project in Rajasthan.

1.3 Research Methodology:

To assess direct and indirect impacts of watershed projects on economy, both inductive and deductive method had been used. Before-After' comparison approach had been applied to assess the direct impacts of the programme and with-without' comparison approach had been applied to assess the indirect impacts of the programme.

a) Coverage :

The present study is mainly focused on the selected watershed development projects of Pali district in Rajasthan. Pali district lies in western part of the state having an area of about 12,39,000 hectares. Administratively it comprises 9 tehsils and 10 Panchayatsamities namely Jaitarn, Raipur, Sojat, Rohat, Pali, Marwar Junction, Rani, Sumerpur, Desuri and Bali. To cover all types of agro climatic conditions from Pali district, four tehsils i.e., Bali, Raipur, Pali and Rohat were selected for the purpose. Since many watersheds are being run in these Tehsils, one watershed from each Tehsil was selected.

To select the watershed from these Tehsils, long discussions were made with the officers, Scientists and staff of the DRDA, Pali, State Agriculture University and the Project Implementing Agency. Since this research is originally designed to examine only the impact of completed watersheds, where the staff had been withdrawn, A number of watersheds were visited by the Principle Investigator and Research Assistant along with the officers of Project Implementing Agency and on the basis of the survey four Watershed projects have been selected for purpose.

1.4 Major works in Watershed Projects:

Watershed Projects are designed to harmonize the use of soil and water in such a way that it increases Agriculture Productivity. In watershed Development Project, mechanical or vegetative structures are installed across gullies and rills and areas are earmarked for particular land use based on their land capability classification. To find out the impact of watershed project, it is necessary to know the major activities of the Projects. In this section, we will discuss some common activities and the structures built in the selected watersheds.

i) Entry Point activities:

These activities are meant for removing the credibility gaps between the implementing agency and village community and to create atmosphere conductive for working together for good of the village community. As mentioned in table 3.2, EPA in NayaBariya Watershed is Primary School Hall and in other watersheds it is Community Hall.

To develop awareness among villagers, Slogan writing, PrabhatPheris and competitions were also arranged in Watershed Project.

ii) Physical works:

As per the Haryali Guidelines, The work component has been kept 80% of the Project cost or Rs. 24 lakhs for 500 Hac. The analysis reveals that 91% of this workshare is utilized in soil conservation and Water Harvesting structures; 5.5 % is spent for Production measures and 3.5% is spent for Livestock development Activities. Major Physical works in almost all the selected Watersheds are as follows:

a) Khadins:

Khadins are earthen embankments ranging in height 1.5 to 2.5 mts., top width 1.5 to 2.5 mts. and bottom width 6.5 to 10.5 mts. built in the project area to impound rain water during monsoon. These earthen bunds have been provided with central or sidespillways to pass excess runoff safely. Spillways are built with masonry walls in cement mortar.

b) Tankas:

Tankas are the traditional water storage structures used by the farmers in western Rajasthan for storage of water. A number of tanks have been built in watershed Project. These structures are very useful as these collect rain water during July to September which lasts till February.

c) Contour Bunding:

Earthen bunds with small heights along with the land of same elevation adjacent to field in selected area have been built in almost all the selected Watersheds. These bunds are more like field bunds as these do not follow contours. Vegetation works to protect the slopes by planting Ratanjot, Stylohamata and Daman has been done on these bunds but due to prolonged dry spell in this region these are not found satisfactory.

d) Nadi Construction:

For harvesting rain water Nadis have been built in the watersheds. These Nadis cost Rs. 1 lakh each approximately. During good monsoon these Nadis are expected to serve well although there was not any good monsoon after the completion of these projects in this region.

e) Drainage Line Treatment:

To enhance infiltration of rain water and to reduce soil erosion due to run off various drainage line treatments are done during the programme. Some of them are as follows:

i) Anicuts:

Since the Watershed Development area have several well defined drainage lines so as a part of Drainage Line Treatment, anumber of Anicuts have been built. These are expensive hydraulic structures and therefore require careful planning and design.

ii) Loose Stone Check Dams:

To check soil erosion due to runoff water during monsoon these Loose Stone Check Dams (LSCD) are built in all the selected watersheds

f) Pasture development:

Pasture Development has been taken up on small patches of village common land in almost all the selected Projects. Tree species like Ber, Babool, Neem, ShishamRoida, Khejri, and Khumat were used in plantation work. Plants were procured from the forest nurseries. A person was also appointed to look after this pasture at NayaBariya watershed But due to acute shortage of water, survival rate of these plants in these watershed found very poor.

g) Live Stock Management:

Under this activity, Animal Health Care camps were arranged, where health checkups of animals were done and medicines were distributed. To improve fodder availability, massive vegetation was commenced for pasture development.

Impact Analysis.

To find out the impact of watershed programme, survey was conducted in the selected watersheds and farmers and stakeholders of watershed villages were interviewed. Well structured and elaborated questionnaires were prepared for the purpose. This survey schedule covered particulars of family members, Land resources, Livestock income from different sources, cropping programme, Yield of different crops before watershed and after watershed; employment generation, Ground water position; physical parameter e.g. run off reduction; soil erosion etc. The data collected were tabulated, classified, analyzed and presented under the following heads:

1. Impact on Agronomic practices:

One of the most important objectives of watershed Programme is to conserve natural resources so that crop productivity can be enhanced. Change in Agronomic practices can be discussed under following heads:

i) Change in land use pattern:

Table 1.1: Change in Land Use Pattern:

	Land type	Forest land	Cultivated land	Gocher and Panchayat land	Revenue waste land	Area not available for treatment	Total (hac.)
W_1	Before	0.0hac.	210 hac.	290	0.0 hac.	125 hac.	625
	After	0.0hac.	260HAc.	240 hac.	0.0 hac.	125 hac.	625
	% change	0	23.8	(-)17.2	0	0	
W_2	Before	65	405	25	5	250	750
	After	65	415	18	2	250	750
	% change	0.0	3.08	28	60.0	0.00	
W_3	Before	0.0	406.88	57.12	36.0	23.68	523.68
	After	0.0	419.88	50.12	30	23.68	523.68
	% change	0	3.1	(-) 12.25	(-) 16.66	0.0	
	Before	9.0	380	57	24	30	500
	After	9.0	394	50	17	30	500
	% change	0.0	3.7	(-) 12.28	(-) 29.1	0	
	Before	74	1401.88	429.12	65	428.68	2398.68
	After	74	1488.88	358.12	49	428.68	2398.68
	% change	0.0	87.00	71.00	(-) 16	0.0	

Source: DPR, PanchayatSamities and records of deptt. Of landrecords, Pali

Table 1.1 presents change in land use pattern in selected watershed. It is clear that cultivated land area is increased in almost all the four watersheds. In NayaBariya watershed (W1), cultivated land area is increased by 23.8%,IN Bisalpur watershed (W_2) it is increased by 30.8%; in Rampura (W_3) it is increased by 4.9 % whereas in Girwar (W_4) watershed,7.6 percent increase in cultivated land is reported. It must be noted that total sown area is also increased due to treatments applied on revenue waste land and Goccher and Panchayat land during the programme and this results improvement in extensive as well as intensive farming. Farmers started taking more than one crop on part of the land due to more availability of water and the treatments applied on land. Beside this, due to structures built during watershed programme, more land is being used for cultivation and collective influence of these is increase in total sown area. Revenue waste land area and Gocher and panchayat land area is decreased in all the selected watershed but this change is very little hence, due to Watershed Programs, change in land use pattern is found.

ii) Soil Conservation:

Soil Conservation is an important requirement of sustainable farming. One of the most important objectives of watershed Development Project is soil conservation. It is well known fact that 1mm of fertile soil layer is built in hundreds of years but erosion of the same takes a very few time so it is the most important objective of the programme to keep the fertile layer of soil conserved. 15 farmers of each type marginal, small and large were interviewed to know the status of Knowledge and practice of Soil conservation techniques from each watershed area and non watershed area. Responses are further grouped into two, Marginal and Small farmers in one group named SF and Medium and large farmers in another group named LF. Watershed wise responses are presented in table 4.2

Table1.2KnowledgeandPracticesonSoilconservation:

	% of farmers expressed knowledge

		W_1		W_2		W_3		W_4		Control	
		SF	LF	SF	LF	SF	LF	SF	LF	SF	LF
1	Were the programme on SC be carried out invillage	40	93	50	83	33	73	40	67	-	-
2	Do you have interest in SC	27	63	50	73	27	60	33	60	30	20
3	Do you know about										
3a	Contour Bunding	33.7	56.6	26.6	66.6	16.6	66.6	16.6	50	16.6	43.3
3b	Field Bunding	36.6	50	30	60	23.3	60	33.3	46.6	20	33.3
3c	Leveling	93.3	66.6	40	73.3	26.6	50	40	60	30	40
3d	Soil Concentration	33.3	93.3	40	66.6	66.6	63.3	33.3	90	30	40
4a	Field Bunding	26.6	66.6	30	66.6	26.6	60	33.3	60	26.6	33
4b	Leveling	33.3	33.3	33.3	73.3	20	63.3	30	43.3	10	23.3

The above table indicates that about 70% to 90% large farmers are aware of the soil conservation programme run in their village in all the selected watershed area and they are interested also but regrettably, the same is not found among small farmers. Less than 25% small farmers are aware of the soil conservation programme. Most of them are fatalist and did not show any interest in any soil conservation measure e.g. field bunding, Contour bunding or leveling etc.

It was observed that about 70 to 80 % large farmers were practicing soil conservation measures. In NayaBariya and Bisalpur watershed field bunding is the most common practiced measure as 67 % farmers reported for this, at the same time, Leveling and soil concentration is also equally adopted technique. Only 26 % to 33 % small farmers reported that they were practicing soil conservation. Leveling is the most adopted soil conservation manner among small farmers followed by field bunding and soil concentration in almost all the selected watersheds.The data were further examined and averaged for watershed and non watershed area and presented in table 4.3

1.3 Knowledge and Practice of SC Measures in Watershed and Non Watershed area

n=60

S. No.		% of farmers expressed Yes			
I	**Knowledge**	**Watershed**		**Non watershed**	
		SF	LF	SF	LF
1a	Interest inSoil Conservation	43	72.5	20	25
1b.	Contour Bunding	47.5	79	26.6	43.3
1c.	Field Bunding	30.75	78	30	33.3
1d.	Leveling	45.75	86	30	40
1e.	Soil Concentration	46.65	76.6	30	40
II	***Practicing***				
2A.	Field bunding	29.1	76.3	26	33

2B.	Leveling	43.3	83	10	23.3
2C.	Soil Concentration	39.15	63.3	23.3	33.3
2D	Contour Bunding	33.3	73.3	23.3	33.3

Source:Fielddata

The following picture emerges:

Watershed Programme made the farmers practice soil conservation better. About 76 % large farmers were interested in Soil Conservation and knew about different methods of Soil Conservation where as only 20 % farmers were found interested in soil conservation and 40% know about the methods. Leveling is the most adopted technique for soil conservation followed by field bunding, Contour bunding and Soil concentration. Soil conservation practices are found very less in non watershed area. Thus watershed programme is helpful in creating awareness about soil conservation techniques.

1.4 Change in Cropping Pattern and Crop Productivity:

To assess change/improvement in Cropping Pattern and Crop Productivity, data were collected for area and average yield of selected crops before watershed and after watershed. At first, some crops of Kharif season and Rabi season were selected from each of the selected watershed. These crops were selected on the basis of the discussions made with farmers, Sarpanch and villagers. Since data of crops and yield is not being aggregated at watershed level so in spite of many efforts made by Principal Investigator and co-Investigator, watershed level data of crops and yield could not be got therefore village level data is being used for analysis. One of the selected watersheds NayaBariya covered entire village so village level data and watershed level data are same but in other selected watersheds, village level data are the proxy indicators of watershed level data. Hence village level data of total cropping area and yield were collected for selected crops, and then the collected data were tabulated and analyzed. To test the significance of the change in area and yield t distribution was applied.

Major crops of this area are Bajra, Jwar, Maize, Moong and Til etc. in kharif season and Wheat, Barley, Gram, Mustard, Taramira and Kapas etc.in Rabi season. Bajra and moong in Kharif season and Wheat, Barley and Gram in Rabi season are grown predominantly in selected area. Change in crops due to land treatment was not observed as similar types of crops were grown in area before watershed and after watershed, still increase in cropping area is found in all the watersheds and positive change in crop rotation was observed due to watershed treatment. Practice of keeping land fallow was reduced and that resulted in higher crop intensity after the treatment.

To assess impact of watershed programme on cropping area and average yield, data of cropping area under selected crops and average yield were collected before and after the programme. Watershed wise information of the same are presented in table 4.4 to 4.8

Table 1.4 Change in Area and yield of Selected crops in NayaBariya Watershed (W1) (Cropping Pattern)

S. No.	Name of the crop	Before		After		Change in Area	Change in Yield
		Area (Hec)	Yield (Q/hec.)	Area (Hec.)	Yield (Q/hec.)	(%change)	(%change)
1.	Wheat	80 (18.01)	12	80 (18.2)	15	0 (-1.54)	3 (25)
2.	Jeera	15 (3.4)	2	15 (3.1)	2.5	0 (-0.3)	0.5 (25)
3.	Gram	35 (7.9)	6	35 (7.2)	6	0 (-0.3)	0.0
4.	Kapas	30 (6.8)	22	30 (6.2)	24	0 (-0.6)	2 (9.1)

5..	Maize	37 (8.4)	24	40 (8.3)	27	3 (-0.6)	3 (12.1)
6	Bajra	115 (26.01)	10	120 (24.8)	12	5 (-1.21)	2 (20)
7.	Jwar	63 (14.2)	4	65 (13.5)	5	2 (-0.7)	1 (25)
8.	Moong	13 (2.9)	5	20 (4.1)	6	7 (1.02)	1 (20)
9.	Til	17 (3.8)	2	25 (5.2)	3	8 (1.4)	1 (50)
10	Raida	20 (4.5)	10	20 (4.1)	11	0 (-0.4)	1 (10)
11.	Moth	17 (3.8)	.02	25 (5.2)	.03	8 (0.7)	.01 (50)
	Total	407 (100)		475 (100)	68		

Note: Figures in parenthesis is % of the total;

SIWT = 22.38

tcal= 3.009 (change in area)

tcal = 3.985 (change in yield)

t.05 = 2.23 at 5% significance level for 10 d.f.

Source: NayaBariya Gram Panchayat office/ Raipur Panchayatsamiti

Table 1.4 represents cropping area and yield (qui/hac.) of selected crops before watershed and after watershed. In NayaBariya, total cropping area is increased by 41 HAC.(9.2 %) due to watershed. Although cropping area under Wheat, Jeera, Gram and Kapas is not changed, Yet percentage of area under these crops is abridged due to augment in total cropping area. Cropping area under other crops e.g. Bajra, Jwar, Moong and Till is increased and maximum increase is reported in Till and then in Moong.

Wheat was the dominant crop of Rabi season before watershed and the same situation is reported after watershed. Bajraand Moong were the dominant crops of Kharif season. On discussion, it came out that farmer of this area started taking more than one crop after this watershed programme. It was found that Cropping area under Moong, Til Moth was increased by 1.02%, 1.4%, and 0.7% respectively. This increase is due to the increased prices of commercial crops e.g. Till and Moong and increased demand, More availability of water due of structures built and better marketing facilities also motivated them for taking double crop. Data of yield of different crops in Q/hec. also show improvement. Maximum increase is reported in wheat and that is of 3 quintal/ Hec (25%), Average yield of other crops e.g. maize, Bajra, Jawar, Til etc. were also improved.

To test the significance level of change in area and yield ofdifferent crops, t distribution is applied. The value of tcalis 3.009 forchange in area and 3.985 for change in yield, where as tabulated value of t for 10d.f. at 5 % level of significance, is 2.23. Since calculated value of t is more than the tabulated value for both the changes (tcal> t tab.) Hence, Null hypothesis (Ho) is proved true and It is concluded that there is significant improvement in cropping area as well as yield due to watershed programme in NayaBariya Watershed. Sustainable Index of watershed Technology of thiswatershed is 22.38, which further indicates 22.38 % sustainability ofthe improvements due to treatments applied.

Table 1.5 Change in Area and yield of Selected crops inBisalpur Watershed (W2) (Cropping Pattern)

S.No.	Name of the crop	Before	After	Change in Area	Change in Yield

		Area (Hec)	**Yield (Q/hec.)**	**Area (Hec.)**	**Yield (Q/hec.)**		
1.	Wheat	131 (12.8)	11	135 (12.7)	15	4	4 (36.36)
2.	Barley	4 (0.4)	7	6 (0.56)	8.5	2	1.5 (21.4)
3.	Gram	1 (0.09)	1	2 (0.19)	1.5	1	0.5 (50)
4.	Mustard	12 (1.17)	8	15 (1.4)	9	3	1.0 (12.5)
5.	Fodder	11 (1.07)	40	18 (1.69)	43	7	3.0 (7.5)
6.	Maize	24 (2.34)	4	24 (2.26)	4	Nil	0
7.	Bajra	321 (31.3)	6	329 (30.98)	7.5	8	1.5 (25)
8.	Jwar	17 (1.66)	2	20 (1.88)	2.5	3	0,5 (25)
9.	Til	17 (3.8)	2	25 (5.2)	3	8 (1.4)	1 (50)
10	Raida	20 (4.5)	10	20 (4.1)	11	0 (-0.4)	1 (10)
11.	Moth	17 (3.8)	.02	25 (5.2)	.03	8 (0.7)	.01 (50)
	Total	407 (100)		475 (100)	68		

Note: Figures in parenthesis is % the total;

SIWT = 24.5

tcal= 3.62(change in area)

tcal = 3.16 (change in yield)

t.05= 2.23 at 5% level of significance for 10 d.f.

Source: Bisalpur Gram Panchayat office/ Bali Panchayatsamiti

Table 1.5 represents cropping area and yield of selected crops in Bisalpur village before watershed and after watershed programme. Total cropping area is increased from 1023 hec. to 1062 hec. by 3.8 %.Wheat was the dominant crop of Rabi season where as Bajra, MoongTil and Moth were of Kharif season. Although area under almost all the selected crops were increased yet percentage area under some crops decreased due to more increase in total cropping area. Increase in cropping area under Mustard, Til and Moong is more than other crops. Improvement in average yield is also found in almost all the selected crops, maximum increase in average yield is found in Gram and Moth and that is 50%; then in wheat (36.39), This increase in yield is due to various reasons e.g. land treatments applied during watershed programme, Soil conservation measures practiced by farmers, use of improved seeds, manure and fertilizer etc; awareness among the farmers etc.

Sustainable Index of watershed Technology of this watershed is 24.5, which indicates 24.5 % sustainability of the improvements due to treatments applied.

Difference in area and average yield is further tested by t' distribution. Calculated value of ët' statistic is 3.62 and 3.16 for change in area and change in yield where as tabulated value of t for 10df at 5 % level of significance is 2.23. Since calculated value of ët' is more than the tabulated value for both the changes (tcal>ttab.) Hence, Null hypothesis (Ho) is proved true and It is

concluded that there is significant improvement in cropping area as well as yielddue to watershed programme in Bisalpur Watershed.

Table 4.6 Change in Area and yield of Selected crops inRampura Watershed (W3) (Cropping Pattern)

S.No.	Name of thecrop	Before		After		Change in Area	Change in Yield
		Area (Hec)	Yield (Q/hec.)	Area (Hec.)	Yield (Q/hec.)		
1.	Wheat	14 (1.5)	8	14 (1.3)	8	0.0	0.0
2.	Barley	29 (3.1)	6	35 (3.4)	8	6	2 (33.3)
3.	Gram	345 (36.8)	16	358 (34.8)	18	13	2 (12.5)
4.	Mustard	17 (1.8)	2	22 (2.1)	3	5	1 (50)
5.	Taramira	3 (.32)	1.5	5 (.48)	2	2	0.5 (33.3)
6.	Maize	50 (5.3)	2.5	58 (5.6)	3	8	1.5 (20)
7.	Bajra	250 (26.6)	5.5	265 (25.7)	6.5	15	1.0 (18.18)
8.	Jwar	50 (5.3)	5	58 (5.6)	7	8	1 (20)
9.	Moong	100 (10.6)	8	122 (11.8)	9.5	22	1.5 (18.75)
10.	Til	N.A	N.A	N.A	N.A		

Note: Figures in parenthesis is % of the total;

SIWT = 18.73

tcal= 4.39 (change in area)

tcal = 7.67 (change in yield)

t.09= 3.36 at 1% level of significance for 8 d.f.

Source: Rampura Gram Panchayat office/ RohatPanchayatsamiti

Table 1.6 represents cropping area and yield of selected crops in Rampura village of RohatPanchayatSamiti before and after watershed programme. Total cropping area is increased from 937 hac. to 1029 hac. by 9.8 %.Gram was the dominant crop of Rabi season where as Bajra, Moong, Til and Jawar were of kharif season. Although area under almost all the selected crops were increased yet percentage area under some crops decreased due to more increase in total cropping area. Increase in cropping area under Mustard, Til and Moong is more than other crops. Improvement in average yield is also found in almost all the selected crops, maximum increase in average yield is found in Gram and Moth and that is 50%; then in wheat (36.39), This increase in yield is due to various reasons e.g. land treatments applied during watershed programme, Soil conservation measures practiced by farmers, use of improved seeds, manure and fertilizer etc; awareness among the farmers etc.

Sustainable Index of watershed Technology of this watershed is 18.73, which indicates 18.73 % sustainability of the changes occurred due to treatments applied during the programme.

Difference in area and average yield is further tested by ët' distribution. Calculated value of t statistic is 4.39 and 7.67 for change in area and change in area and change in yield where as tabulated value of t for 10df at 5% level of significance is 2.23. Sincecalculated value ofët' is more than the tabulated value for both the changes (tcal> t tab.) Hence, Null hypothesis (Ho) is proved true and It is concluded that there is

significant improvement in cropping area as well as yield due to watershed programme in Rampura Watershed.

Table 1.7 Change in Area and yield of Selected crops in Girwar Watershed (W_4) (Cropping Pattern)

S.No.	Name of thecrop	Before		After		Change in Area	Change in Yield
		Area (Hec)	Yield (Q/hec.)	Area (Hec.)	Yield (Q/hec.)		
1.	Wheat	239 (7.15)	10.25	242 (6.8)	12.5	3 (1.25)	2.25 (21.95)
2.	Jeera	15 (0.44)	2	15 (0.44)	2.5	0.0	0.5 (25)
3.	Gram	726 (21.7)	10.75	743 (20.9)	11.75	17 (2.34)	1 (9.3)
4.	Kapas	30 (0.88)	22	30 (0.85)	24	0.0	2 (9.09)
5.	Maize	161 (4.8)	8.375	174 (4.9)	9.5	13 (8.07)	1.125 (13.43)
6	Bajra	936 (28.03)	6.875	970 (27.4)	8.12	34 (3.63)	1.245 (18.1)
7.	Jwar	180 (5.39)	3.75	198 (5.6)	4.75	18 (10)	1 (26.6)
8.	Moong	412 (12.3)	7	460 (12.9)	8	48 (11.6)	1 (14.8)
9.	Til	168 (5.03)	3.5	180 (5.08)	4.75	12 (7.1)	1.25 (35.7)

Note: Figures in parenthesis is % of the total

Source: Girwar Gram Panchayat office/ PaliPanchayatsamiti

SIWT = 8.52

tcal= 3.009 (change in area)

tcal= 3.985 (change in yield)

t.05 = 2.82 at 5% level of significance for 9 d.f.

Table 1.7 represents cropping area and yield of selected crops in Girwar village of PaliPanchayatSamiti before watershed and after watershed programme. Total cropping area is increased from 937 hac. to 973.5 hac. by 8.73 %.Wheat was the dominant crop of Rabi season where as Bajra, MoongTil and Moth were of Kharif season. Although area under almost all the selected crops were increased yet percentage area under some crops decreased due to more increase in total cropping area. Increase in cropping area under Mustard, Til and Moong is more than other crops. Improvement in av

erage yield is also found in almost all the selected crops, maximum increase in average yield is found in Gram and Moth and that is 50%; than in wheat (36.39), This increase in yield is due to various reasons e.g. land treatments applied during watershed programme, Soil conservation measures practiced by farmers, use of improved seeds, manure and fertilizer etc; awareness among the farmers etc.

Difference in area and average yield is further tested by ët' distribution. Calculated value of t statistic is 3.62 and 3.16 for change in area and change in yield respectively where as tabulatedvalue of t for 10 df at 5 % level of significance is 2.23. Since calculated value of ët' is more than the tabulated value of ët' for both the changes (tcal>ttab.) Hence, it is concluded that there is significant improvement in cropping area as well as yield due to watershed programme in Girwar Watershed.

Table 1.8 Aggregate Change in Area and yield of Selected watershed (Cropping Pattern)

S.No.	Name of thecrop	Before		After		Change in Area	Change in Yield
		Area (Hec)	Yield (Q/hec.)	Area (Hec.)	Yield (Q/hec.)		
1.	Wheat	239 (7.15)	10.25	242 (6.8)	12.5	3 (1.25)	2.25 (21.95)
2.	Jeera	15 (0.44)	2	15 (0.44)	2.5	0.0	0.5 (25)
3.	Gram	726 (21.7)	10.75	743 (20.9)	11.75	17 (2.34)	1 (9.3)
4.	Kapas	30 (0.88)	22	30 (0.85)	24	0.0	2 (9.09)
5.	Maize	161 (4.8)	8.375	174 (4.9)	9.5	13 (8.07)	1.125 (13.43)
6	Bajra	936 (28.03)	6.875	970 (27.4)	8.12	34 (3.63)	1.245 (18.1)
7.	Jwar	180 (5.39)	3.75	198 (5.6)	4.75	18 (10)	1 (26.6)
8.	Moong	412 (12.3)	7	460 (12.9)	8	48 (11.6)	1 (14.8)
9.	Til	168 (5.03)	3.5	180 (5.08)	4.75	12 (7.1)	1.25 (35.7)
10	Raida	20 (0.59)	10	20 (0.56)	11	0.0	1 (10)
11.	Moth	169 (5.06)	.02	180 (5.08)	.03	11 (6.5)	0.01 (50)
12.	Barley	62 (1.85)	6.33	67 (1.9)	7	5 (8.06)	0.67 (10.5)
13.	Mustard	46 (1.37)	4.16	56 (1.6)	4.66	10 (21.7)	0.50 (12.01)
14.	Fodder	90 (2.69)	40	110 (3.10)	43	20 (22.2)	3 (7.5)
15.	Taramira	6 (0.17)	1.5	9.5 (0.26)	1.75	3.5 (58.3)	0.25 (16.6)
16	Gwar	79 (2.36)	7	85 (2.40)	7.5	6 (7.6)	0.5 (7.14)

	Total	3339 (100)		3539.5 (100)		200.5 (6.0)	

Source: Computed from the data collected from P.S.

Note: Figures in parenthesis is % of the total;

SIWT = 18.53

tcal= 3.186 (change in area)

tcal= 3.85 (change in yield)

t.05=2.13 at 5% level of significance for 15 d.f

Table 1.8 represents aggregate cropping area and yield of selected crops in selected Panchayatsamities before watershed and after watershed programme. Total cropping area is increased from 3339 hac. to 3539.5 hac. by 6.0 %.Wheat was the dominant crop of Rabi season where as Bajra, MoongTil and Moth were of Kharif season. Although area under almost all the selected crops wereincreased yet percentage area under some crops decreased due to more increase in total cropping area. Increase in cropping area under Mustard, Til and Moong is more than other crops. Improvement in average yield is also found in almost all the selected crops, maximum increase in average yield is found in Gram and Moth and that is 50%; than in wheat (36.39), This increase in yield is due to various reasons e.g. land treatments applied during watershed programme, Soil conservation measures practiced by farmers, use of improved seeds, manure and fertilizer etc; awareness among the farmers etc.

Difference in area and average yield is further tested by ët' distribution. Calculated value of t statistic is 3.186 and 3.85 for change in area and change in yield respectively where as tabulated value of t for 15 df at 5 % level of significance is 2.13. Since calculated value of ët' is more than the tabulated value of ët' for both the changes (tcal>ttab.) Hence, it is concluded that there is significant improvement in cropping area as well as yield due to watershed programme.

The above analysis indicates improvement in average yield after watershed programme. Impact of watershed programme can further be analyzed by comparing these results with the data of average yield of selected crops of nearby non watershed village. This with-without exercise helped us to get clearer picture of the impact of this area development programme. Keeping other factors same, difference in average yield of both the area exclusively reposed the contribution of this area development programme to contribution the average yield of area.

Sustainable Index of watershed Technology of this watershed is 8.52, which further indicates 8.52 % sustainability of the improvements due to treatments applied.

Table 1.9 Change in average yield of selected crops in watershed and non watershed village.

S.No	Crop	W_1		W_2		W_3		W_4	
		Change in average yield							
		Watershed	N.W.	Watershed	N.W.	Watershed	N.W.	Watershed	N.W.
1.	Wheat	3	1	4	0.0	1	0.0	2	1.0
2.	Jeera	0.5	0.0	-	-	-	-	-	-
3.	Gram	0.0	0.0	0.5	0.5	2	0.5	2	0.5
4.	Kapas	2	1	-	-	-	-	-	-
5.	Maize	3	0.5	0	0.0	2.5	1.0	1	0.5
6.	Bajra	2	1	1.5	0.5	1.0	0.5	0.5	-
7.	Jwar	1	1	0.5	0.5	1.0	0.5	0.5	-
8.	Moong	1.0	0,5	1.0	1	1.5	0.5	0.5	-
9.	Til	1	0.0	1.5	0.5	-	-	-	-
10.	Raida	1	0.5	-	-	-	-	-	-

11.	Moth	.01	0.0	.01	0.0	-	-	-	-
12.	Barley	-	-	1.5	.5	2	1.0	.5	0.1
13.	Mustard	-	-1.0	.5	1	.5	0.5	0.5	0.0
14.	Fodder	-	-	3.0	1.0	-	-	-	-
15.	Taramira	-	-	-	-	0.5	0.0	0.0	0.0

Source: Computed from the data collected from Gram Panchayat office

F.05 =3.18(for 10 d.f.) F.05 =3.18(for 10 d.f.) F.05 =3.44(for 8 d.f.) F.05 =3.44(for 8 d.f).

Data of change in average yield of selected crops in selected watershed and non watershed villages are presented in table 1.9. Crops at watershed level were selected on the basis of the discussions made by researcher with farmers of that area. 11 main crops from NayaBariya and Bisalpur and 9 main crops from Rampura and Girwar watershed were selected for the purpose.

The data indicate that average yield of selected crops also increased in non watershed area, since NayaBariya watershed covered entire village positive effects of the measures of watershed activities in this village can also be observed in near bynon watershed village but change in average yield during the same period is less in non watershed village than watershed village. Change in yield due to programme intervention is proved significant on the basis of F test also.

iv) Use of External inputs:

Use of External inputs e.g. improved seeds, fertilizer etc. have been assessed in various crop production system in selected watershed. These are as follows.

Table 1.10 Change in use of external inputs :

	%Increaseinuseofexternalinputs				
Input/watershed	**W_1**	**W_2**	**W_3**	**W_4**	**Aggregate**
Seed	52	43	27	23	36.25
Manure/fertilizer	18	22	15	13	17
Pesticides/Ins.	12	5	17	18	13
Implements	N.A.	7	12	15	11.3

Source: field data

a) Introduction of improved seeds:

Introduction of improved seeds is one of the most important factors to determine crop productivity. Number of camps wereorganized to enhance crop productivity and to distribute improved seeds among farmers and to motivate all types of farmers to use improved high yielding seeds in watershed area. Data of percent increase in use of improved seeds by farmers were collected and presented in table 4.9. The data suggest that there is 52% increase in use of improved seeds in NayaBariya watershed and minimum increase is reported in Bisalpur watershed

b) Use of manure and fertilizer:

Optimum use of manure and fertilizer is the key factor deciding the crop productivity. Motivation and Awareness of farmers by the watershed management team have increased the use of manure and fertilizer in production system. Percent increase in use of manure and fertilizer in selected watershed is presented in table 4.9.

c) Use of pesticides/insecticides:

Increase in use of pesticides/ insecticides also observed by researcher due to watershed intervention. Farmers of the area became aware of the crop diseases and were using protection measures. Present increase in use of pesticides and insecticides is presented in table 4.9

d) Use of improved implements:

Use of improved implements in agriculture helps to increase crop productivity. Tractor drawn implements i.e. harrow have been used in watershed area, but it was also not found very common. Few large farmers started tractor down disc plough for deep village during kharif

season only in three years to enhance crop productivity.

There is not any change is reported in use of improved implements in farming in Naya Bariya watershed, where as farmers of Rampura and other selected watersheds started using improved implements. It must be noted here that these data are approximate only as reported by the farmer of watershed area, sothese may be considered near to real change therefore, it may be concluded that increased awareness among farmers due to watershed intervention leads to increase in use of external inputs which increased the average yield of watershed villages.

Output Input Analysis:

Output - input analysis is an important technique to find out the economic status of the crops grown in selected area, for this data of cost of inputs of major crops and value of output for per hectare of land area were collected in selected watersheds.

Table 1.11 : Input use and production of major crops

	Input use and production(inRs.)					
Part./crop.	**Moong**	**Till**	**Wheat**	**Bajra**	**Jwar**	**Raida**
Area	**1hec.**	**1hec**	**1hec**	**1hec**	**1hec**	**1hec**
Cost ofland preparation	2000	1200	3600	2000	2000	3125
Seed (Rs,)	250	250	1500	150	1200	187.5
Fym (Rs.)	750	750	1875	750	1000	1875
Fertilizer DAP, Urea	-	-	900 334	550 467	550	900 934
Pesticides	500	1000	250	100	100	625
Irrigation Charges			3125	-		3330
Hired labors	1000	5000	2500	1500	1500	1460
Family labors	5000	2000	1250	600	600	1460
Total	9500	21000				
Production (Rs.)	14000	15000	60000	9000	10000	15000
Fodder(Rs.)	2000	13000	2000	500	1500	2200
Output Input ratio	1.70	1.59	3.89	1.12	1.36	1.24

Source : computed from field data

Average cost of two crops of Rabi season ñ wheat and Raida, and 4 crops of kharif season Moong ,Bajra, Till and Jwar and average value of output for one hectare land area are presented in table 1.11.

The data indicate that at present output input ratio of wheat and raida is 3.89 and 1.24 respectively where as in Moong, Till, Bajra and Jwar it is 1.70, 1.59, 1.12 and 1.36 respectively. Since data of cost of input and value of output before watershed could not be got, the change in out put input ratio due to intervention of the programme could not be worked out. Farmers of watershed area reported that due to watershed intervention they are now taking more than one crop and this has increased cropping intensity and total sown areas but no major change in cost of input and value of output is reported between watershed area and no watershed. Hence, output input ratio of major crops of no watershed area had been excluded from analysis.

II) Impact on Livestock & Livestock resources

Live Stocks are the most important resource of an economy. They create employment/ income for the people of the region and help in maintaining ecological balance. Many efforts had been made during watershed programme for improvement in live stock of the region. Few of them are pasture development, organizing animal health campus etc.

Animal husbandry is the most popular occupation of watershed families. Each household has average 3-4 animals which used to give about 25-35 liters of milk per day. To assess impact of watershed programme on livestock, data of number of livestock before watershed and after watershed were collected and presented in table 1.12

Table 1.12 Livestock population in selected watersheds (before/ after)

Livestock	before	After	Change	Before	After	Change	Before	After	Change	Before	After	Change
Cow/ Bullock	721	745	24	930	964	34	933	965	32	300	328	28
Buffaloe	214	226	12	422	445	23	432	445	13	106	115	9
Sheep	1354	1360	6	2528	2520	8	51	55	4	2000	2100	100
Goat	619	678	59	1689	1723	34	373	395	22	700	730	30
Camel	2	2	0	N.A.	1723	-	N.A	N.A.	-	15	21	6
Other	3	3	0	244	264	20	N.A	N.A.	-	N.A.	N.A.	-

Source: Records of Gram Panchayat

Conclusion and Suggestions:

There is general improvement in all agronomic practices i.e. knowledge and practicing of soil conservation; increase in cropping area and yield etc.,still more attention is required in certain areas, which are as follows:

- Watershed investments should incorporate activities such as development of fodder banks in order to meet the increased demand for stall feeding. This could also involve promotion of leasing arrangements of common lands to the landless forcultivation of fodder crops.
- There is an urgent need for a package of sustainable dry landagriculture practices to be incorporated into the watershedprogramme.
- Many research centers e.g. AFRI, ICRISAT and ICAR etc. areworking for dry land agriculture practices but the problem is that these centers work in isolation from the farms for which their research is meant, the packages developed by thesescientists are in crying need of field-testing. Without this they remain ideal-types lacking the application in real world.
- Special provisions must be made for the landless and the dalits, more attention needs to be paid to develop common lands and making sure that landless/dalits access to them is not reduced as in many watershed projects so far.
- Continuous research and improvement is required at most to enhance productivity through this area development programme. Lessons learnt from the drawbacks of earlier completed watershed projects should be used to rectify the further programme at all level.
- Updated technology based on market trends is important for the sustainability of watershed programme. It is found that regular flow of improved technology generally increases the agriculture productivity which further increases the farmincome.
- Access to both input and output markets is essential for thesuccess of watershed programme. This enables the beneficiaries to buy inputs and sell their produce at reasonable prices. It is found that in most

of the watersheds considerable importance is given to the conservation of resources and to enhance productivity and no serious efforts were made for the access to market. There is a need to integrate production with the market for the success of the watershed.

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