An Economic Enquiry into Synergistic Effects of Watershed Development Project on Farm Economy in Hot Semi-Arid Eco-Region of Rajasthan, India

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Abstract: This paper is an attempt to evaluate the various synergistic effects of watershed development project on rural households in hot semi -arid region of Rajasthan, India. The evaluation is subjected to before and after analysis. The data gathered through households survey of all the beneficiaries during 1997—1998 in the Chhajawa national watershed developed under ICAR model watershed scheme between 1985—1989 and compared to bench mark. The study indicate that land utilisation in watershed increased by 57 %, while gross irrigated area from 32.5 ha in before project situation to 376.7ha in 1997—1998.A complete shift of cropping pattern in favour of more remunerative and quality crops such as soybean in monsoon season and mustard, wheat and coriander in winter season was observed. The results also highlights a remarkable improvement in the yield of various crops such as wheat (309%)and linseed (95%) after the project The average productivity increases by 87% after the project. The study also examines the economic viability of the project and found that the project was economically viable with 96.94 lakh of NPV, 96.25 of IRR and 2.03 of BCR at 12% discount rate.
Keywords: productivity, gross return, discount rate, economic viability, runoff, NPV, BCR

1 Introduction

Scientific research initiated during 1970s have increasingly demonstrated the synergetic relationship between improved soil moisture and modern crop yield augmenting inputs like improved seed and fertilizer (Desai *et al.,* 1994).Together, these forces have led to a situation where higher levels of crop productivity becomes essential not only for sustaining the overall agricultural production at the macro-level but also for sustaining a large proportion of rural households depending on this uncertain economic activity with a declining per capita resource base. Conservation of rain water, soil erosion control, therefore, become the central themes for development of dryland farming. The formulation of integrated watershed development programmes especially since the mid -1980s is a manifestaion of such realisation (Shah1998). As result, a number of studies have been conducted to assess the impact and economic viability of watershed development projects in different regions of India. These studies have been conducted either during or just after the completion of the projects. Since watershed development projects have been undertaken with a view to improve and stabilise crop productivity in rainfed areas on sustained basis. Therefore, it is evident that some components of the watershed require time to show their full impact. Therefore, there is a need to evaluate the watershed development projects after providing some gestation period on the completion of the projects. In view of this, an attempt was made to evaluate the Chhajawa watershed located in hot semi-arid region of Rajasthan and developed under ICAR model watershed scheme between1985—1989. The watershed with a total area of 453.8 ha was covered under different soil and water conservation measures involving a total expenditure of *Rs* 10.66 lakh.

2 Methdology

The present study was subjected to before and after project analysis approach. The changes made by

the project in the watershed area were assessed by comparing the agro-economic data of the beneficiaries at the two point of time i.e. before and after project. The data collected at the time of project launched was taken as benchmark and stated as before project situation. As far as the after project was concerned, a detailed survey of all the beneficiaries in the watershed was done during 1997—1998 to ascertain the changes made by the project. Based on farm level data, complemented by documented information on costs and prices, financial analyses were undertaken for the above watershed. A 12% real discount rate is used in the present analysis, since the standard practice is to use a rate of 10%—12% to calculate the net present analysis (Nadkarni *et al*., 1992 and ADB,1997).Financial indicators such as benefit-cost ratio(BCR) Internal rate of return(IRR), and Net present value(NPV) were calculated using standard formulae.

3 Results and discussion

3.1 Land utilization and water resource development

The study shows that land utilization in the watershed has increased by 57% after the project implementation. As far as the water resources development are concerned, a total number of 46 wells/tubewells have come up in the post period, in addition to the already existing 16 numbers of wells. As a result, the gross irrigated area under wells has increased from 32.5 ha to 376.7 ha in 1997—1998 (Table1).

3.2 Cropping pattern

It could be seen from the Table 2 that out of 95.5 ha area in kharif season 86% covered by sorghum alone followed by soybean, and ground nut etc before the implementation of project. As far as the rabi season was concerned, it was found that maximum area was sown under chickpea(46%) followed by coriander(30%),wheat (12%) and other crops (12%).Now the study indicated a complete shift of cropping pattern in favour of more remunerative and quality crops such as soybean in kharif and mustard, wheat and coriander in rabi season. It was interesting to note that the area under mustard have significantly increases from .78% to 64% of the gross cropped area in rabi season.

3.3 Fertilizer consumption

Watershed farmers did use chemical fertilizers before the project in very meagure quantity due to the fear that it may spoil their fields besides non-availability of irrigation and cash to purchase to them. Table 3 shows that farmers were applying only 9.3 kg and 12.3 kg of nitrogen (N) and phosphorus(P_2O_5)per hectare respectively before the project. It rose to the level of 42.67 kg/ha and 24.15 kg /ha N and P_2O_5 during 1997—1998 i.e. after the project. Thus, presently farmers are using more quantity and balanced doses of chemical fertilizer than before and are very much concerned about the maintenance of sustainable yields.

3.4 Changes in crop yield

Analysis provides yields of various important crops in Chhajawa watershed before and after taking up the project. Table 4 showed a remarkable improvement in the yield of various crops after the project. The maximum increase in yield was recorded in case of wheat (309%) and minimum in case of linseed (95%).

3.5 Production and productivity

Table 5 depicts the changes in production of different cereals, pulses, oilseed and spices in pre and post project situations. It was observed that after taking up project there is a significant increase in the production of oilseeds while reduction in pulses. Table further shows that average productivity increases by about 87% after the project which could be considered as significant achievement in order to maintain

food security.

3.6 Changes in farm assets

The investment in the farm Machinery and implements improved after the project. The number of tractors and tubewells increased from 4 and 0 to 14 and 29 respectively, whereas of threshers from 2 to 12, and bullock carts from 45 to 60. These changes in the watershed are note worthy. The improved water regime encouraged the farmers to invest in farm mechanization .

3.7 Vegetative cover

Count and comparison of woody vegetation before and after project situation revealed considerable increase in population of forest / fruit trees from 256 to 2,403. The overall tree density in watershed increased from 0.56 trees/ha in 1985—1986 to 5.29 trees/ha in 1997—1998. This is one of the welcome features and desirable effect of soil conservation measures adopted in the watershed.

3.8 Run-off

To determine the efficacy of soil and water conservation works under the watershed development project 4 year average results indicated that run-off was 10.5 percentage points less in treated watershed as compared to untreated i.e.control, which showed that soil and water conservation measures not only enhance the income of the farmers but also mitigate the further soil erosion.

3.9 Gross return

The gross return from arable lands in the watershed progressively increased from *Rs* 6.51 lakhs to *Rs* 69.05 lakhs in 1997—1998 ,i.e. about 10 times increase in gross return in spun of 12 years mainly because of the combined effect of soil and water conservation treatments ,improved package of practices,increase in irrigation facilities and more area under high value crops such as mustard, coriander and soybean.

3.10 Economic viability of the project

The incremental costs and returns from the Chhajawa watershed are presented in Table 6. The incremental costs consists of the project costs (initial costs under watershed scheme) and the additional costs of cultivation on the farms of the watershed for both crop and dairy enterprises. It can be seen that the incremental annual cost was estimated to be *Rs* 8.9 thousand per hectare per annum and it was *Rs* 40.44 lakhs for the project as a whole for the year1997—1998. The incremental benefits consists of additional gross income from both the crop and dairy enterprises on the farms of the watershed worked out to be *Rs* 15.44 thousand per hectare and *Rs* 70.11 lakh for the project as a whole. The net present value(NPV) and benefit-costs ratio (BCR) were worked out at 12% opportunity cost of capital. It can be seen from table that at 12% discount rate the project registered a positive NPV of *Rs* 96.94 lakhs,96.25 per cent of IRR and BCR of 2.03 indicating the economic viability of the Chhajawa watershed development project.

4 Conclusion

From the foregoing analysis above, it can be concluded that watershed project in Chhajawa have a very significant impact on beneficiaries of watershed because the study clearly indicated that the watershed project in rainfed area of Chhajawa are not only able in enhancing income but also improve their overall socio-economic status. besides increase biomass also creates some environmental benefit in the vicinity of watershed area .However, there are three possible sources by which the growth in the crop yields achieved in the watershed could be sustained, even enhanced in future, given the resources and infrastructure set up in the project area.

(1) To make efforts to improve the farm level land efficiency and management of input use especially water.

(2) The sustainability will also depend upon the preservation and maintenance of the infrastructure and engineering structures created.

(3) The technology embodied cultivation practices should be undertake on a full scale to take the advantage of the increased irrigation and soil moisture

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Table 1 Increase in land utilization and water resources after the application of the soil Water conservation technologies in Chhajawa Watershed. Area (ha)

Sl. No.	Name of the Indicators	Before Project (1985—1986)	After Project (1997—1998)
1.	Land utilization		
	A. Kharif	95.40	132.40
	B. Rabi	240.80	395.41
2.	Cultivable area	417.85	417.85
3.	Cropping Intensity (%)	80.46	126.31
4.	Gross cropped area	336.20	527.81
5.	Increase in gross cropped area (%)	—	56.99
6.	Nos. of well	16	62
7.	Gross Irrigated area	32.5	376.70

Table 2 Changes in area under different crops in Chhajawa Watershed. (area in ha)

Sl. No.	Season/Crop	Before project (1985—1986)	After project (1997—1998)
A.	Kharif (Monsoon)	82.0	10.00
	Sorghum	(85.95)	(7.55)
	Soybean	6.7	118.40
		(7.02)	(89.43)
	Groundnut	6.3	2.50
		(6.62)	(1.88)
	Maize	0.4	—
		(0.41)	
	Misc.	—	1.5
			(1.14)

Continued

Sl. No.	Season/Crop	Before project (1985—1986)	After project (1997—1998)
	Total	95.4 (100.00)	132.40 (100.00)
B.	Rabi (Winter)		
	Chickpea	111.6 (46.34)	6.69 (1.69)
	Coriander	72.3 (30.02)	95.00 (24.02)
	Wheat	29.0 (12.04)	39.00 (9.86)
	Chickpea+Linseed	26.0 (10.79)	1.00 (0.25)
	Misc.	—	
	Total	240.8 (100.00)	395.41 (100.00)

Figures in Parentheses indicate percentage to total.

Table 3 Changes in Fertilizer Consumption in Chhajawa Watershed (kg / ha)

NUTRIENTS	BEFORE PROJECT	AFTER PROJECT	% INCREASE
Nitrogen	9.3	42.67	358.81
Phosphorus	12.3	24.15	96.34
Potash	—	—	—

Table 4 Changes in yield of major crops in Chhajawa Watershed. Quintal/ha

Sl. No.	Name of the crop	Before Project (1985—1986)	After Project (1997—1998)	% Increase
1.	Sorghum	7.0	15.60	122.85
2.	Wheat	8.0	32.72	309.00
3.	Chickpea	5.0	11.61	132.20
4.	Linseed	4.0	7.80	95.00
5.	Mustard	6.0	16.15	169.16

Table 5 Change in total cropped area, cropping intensity,grain production and average Productivity in Chhajawa Watershed

Year	Cropped Area(ha)	Grain Production (tones) Cereals	Pulses	Oilseeds	Coriander	Total	Average Productivity kg /ha
1985—1986 (before-project)	336.2 (80.46)	137.2	73.5	24.6	44.7	280.00	833
1997—1998 (after-project)	527.81 (126.31)	143.2	7.7	567.91	102.79	821.59	1557

Table 6 Economic viability of Chhajawa Watershed (*Rs* in lakh)

YEAR	COST			Benefits	Net Benefits	Discounted at 12% discount rate		
	Capital cost	Annual cost	Total cost			Cost	Benefit	Net Benefits
1985—1986	3.01	—	3.01	—	–3.01	3.01	—	–3.01
1886—1987	2.11	1.54	3.66	4.06	0.40	3.27	3.63	0.35
1987—1988	0.67	4.33	5.01	12.00	6.98	3.99	9.56	5.56
1988—1989	4.86	7.26	12.12	13.77	1.65	8.63	9.81	1.17
1989—1990		5.17	5.17	20.97	15.80	3.29	13.34	10.05
1990—1991	—	8.24	8.24	27.58	19.33	4.67	15.63	10.96
1991—1992	—	11.28	11.28	29.06	17.78	5.72	14.73	9.01
1992—1993	—	19.73	19.73	45.07	25.33	8.92	20.37	11.45
1993—1994	—	25.61	25.61	53.13	27.52	10.34	21.41	11.12
1994—1995	—	28.41	28.41	63.11	34.70	10.25	22.72	12.52
1995—1996	—	30.18	30.18	66.28	36.09	9.71	21.27	11.62
1996—1997	—	39.25	39.25	68.78	29.52	11.26	19.74	8.47
1997—1998	—	40.44	40.44	70.11	29.66	10.39	17.94	7.62
TOTAL						90.49	190.1	96.94

$$NPV = \sum \frac{B_n}{\left(1+\frac{R}{100}\right)^t} - \sum \frac{C_n}{\left(1+\frac{R}{100}\right)^t} = 96.94\text{Lakhs}$$

$$BCR = \sum \frac{B_n}{\left(1+\frac{R}{100}\right)^t} \Bigg/ \sum \frac{C_n}{\left(1+\frac{R}{100}\right)^t} = 2.03$$

$$IRR = \sum \frac{B_n}{\left(1+\frac{R}{100}\right)^t} = \sum \frac{C_n}{\left(1+\frac{R}{100}\right)^t} = 96.25\%$$