



The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search

<http://ageconsearch.umn.edu>

aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

No endorsement of AgEcon Search or its fundraising activities by the author(s) of the following work or their employer(s) is intended or implied.

Vol XLVI
No. 2

ISSN 0019-5014

APRIL-
JUNE
1991

INDIAN JOURNAL OF AGRICULTURAL ECONOMICS



INDIAN SOCIETY OF
AGRICULTURAL ECONOMICS,
BOMBAY

Kandi Watershed and Area Development Project: Cost-Benefit Analysis of Investments in Two Watersheds

Karam Singh, H.S. Sandhu, Nirmal Singh and Balbir Kumar*

India's strategy of agricultural growth which continues to focus on foodgrains production, principally wheat and rice, has remained crop biased and irrigation biased. The irrigated area in India is still about 30 per cent of the cropped area and the ultimate irrigation potential is estimated to be about 56 per cent of the cropped area. Thus as much as 44 per cent of the crop land is likely to remain unirrigated where the watershed development strategy is the most appropriate. In the hilly/semi-hilly undulating tract which is more than 50 per cent of the rainfed area, the watershed development approach has to lay even greater emphasis on integration/close co-ordination of different activities/departments. The mismanagement and over-exploitation of these watersheds have led to the present state of degraded and still degrading soils, leading to very low and uncertain productivity.

Keeping in view the problems of soil and water erosion in the Kandi area, *i.e.*, the semi-hilly tract, the Kandi Watershed and Area Development Project was designed by the Punjab Government and aided by the World Bank. The Project aimed at comprehensive and integrated development of this economically backward area of the otherwise agriculturally highly progressive State of Punjab by rehabilitating the upper catchments through afforestation and soil conservation, to reduce the run-off and erosion, protecting these areas from excessive grazing through comprehensive livestock development programmes, controlling and utilising the run-off and developing farm lands through comprehensive programme of soil conservation, irrigation, fisheries and horticulture. The project thus offered a package directly to farmers and livestock owners, and indirectly to all and sundry through employment generation, flood and risk control and other infrastructural development in the area. It was a joint venture of various development departments such as Forest, Animal Husbandry, Soil Conservation, Horticulture, Irrigation and Fisheries, and the Punjab Agricultural University (PAU), Ludhiana.

The programme of watershed development is ambitiously being extended to all possible areas in the country. The analytical economic evaluation of such a programme is significant in that it would provide the economic justification of such use of scarce resources. This paper shows the cost-benefit analysis of two of the eleven watersheds developed in Phase-I of the project.

METHOD AND MATERIAL

The Kandi tract of Punjab has been mapped out into some 46 main watersheds of which eleven watersheds were taken up for development during Phase-I of the project. Two of these watersheds, one Maili, having irrigation-cum-attenuation dam, and the other, Chohal without dam, were selected purposively for this study. For these two watersheds, the data on project costs incurred on development works by the various departments engaged in

*Senior Economist, Farm Economist, Statistician and Assistant Sociologist, respectively, Department of Economics and Sociology, Punjab Agricultural University, Ludhiana.

The authors are thankful to the referees for their valuable suggestions. Errors, if any, are still ours.

project implementation were taken from the Chandigarh Office of the Joint Development Commissioner (JDC-KA) who was the co-ordinator of the project (Table I). It may be mentioned here that the project funded the works in addition to the normal works of the development departments (which of course had been at a very low key prior to the project), and thus could be referred to as the incremental cost streams. For some of the departments like Horticulture, JDC Office and the PAU, Ludhiana, these incremental costs were not available watershedwise; therefore, these are allocated on the basis of development works undertaken in these two watersheds in proportion to the works completed in all the watersheds.

TABLE I. PROJECT COSTS FOR DIFFERENT COMPONENTS, MAILI AND CHOHAL WATERSHEDS
(Rs. lakhs)

Particulars (1)	1980-81 (2)	1981-82 (3)	1982-83 (4)	1983-84 (5)	1984-85 (6)	1985-86 (7)	1986-87 (8)	1987-88 (9)	Total (10)
A. Maili watershed									
Forestry	6.93	14.94	30.28	70.07	50.23	18.39	11.93	5.86	208.63
Animal husbandry	-	4.47	4.01	8.68	7.42	4.78	12.40	0.46	42.22
Soil conservation	-	-	12.27	11.97	4.79	6.35	23.35	3.95	62.68
Horticulture	0.08	0.21	0.09	0.41	0.17	0.64	1.23	0.27	3.10
Overheads	2.59	8.93	16.33	11.95	10.05	8.62	12.50	2.10	73.07
Overall (excluding irrigation and fisheries)	9.60	28.55	62.98	103.08	72.66	38.78	61.41	12.64	389.70
Irrigation	-	-	-	-	128.90	155.90	102.30	36.45	423.15
Overall*	9.60	28.55	62.98	103.08	222.18	238.72	189.85	56.38	911.34
B. Chohal watershed									
Forestry	10.07	9.34	16.17	14.02	13.02	5.41	2.13	1.45	71.61
Animal husbandry	-	1.05	4.99	16.00	1.80	2.09	0.92	0.33	27.18
Soil conservation	-	-	8.16	7.96	7.69	8.70	21.71	3.00	57.22
Horticulture	1.78	2.13	1.78	2.78	2.12	1.71	1.40	1.34	15.04
Overheads	4.38	5.70	10.89	5.34	3.95	5.12	6.68	1.22	43.78
Overall	16.23	18.22	41.99	46.10	28.58	23.03	32.84	7.34	214.33

Source: JDC (KA). Kandi Watershed and Area Development Project, Government of Punjab, Chandigarh.

* Inclusive of overhead costs on irrigation as follows: Rs. 20.62 lakhs in 1984-85, Rs. 44.44 lakhs in 1985-86, Rs. 26.14 lakhs in 1986-87 and Rs. 7.29 lakhs in 1987-88.

Since the objective of the project was to rehabilitate the upper catchments and to reduce the run-off and erosion from hills through soil conservation and growth of appropriate vegetation, the actual technical parameters, such as changes in the run-off, siltation loads, groundwater recharge, etc., were to be continuously (or as and when desired) studied/generated by the concerned line departments. This information should supplement the economic information but it has not been generated in Phase-I. The evaluation cell of the project was set up in the Department of Economics and Sociology, Punjab Agricultural University, Ludhiana. The economic parameters relating to actual benefits/impacts flowing on the completion of the agreed development programmes were generated through three rounds of socio-economic surveys in respect of forestry, animal husbandry and soil conservation components and two in respect of horticulture and irrigation components. These coefficients were used to estimate the benefits from the development works executed under this project. The returns from the benefits which had started flowing by the time of the survey, such as incremental fodder and grass yields from afforested/reforested areas by forestry component, incremental milk yields from improved milch animals supplied by the

animal husbandry component, incremental yields from levelled/irrigated lands, etc., were measured through survey estimates. The returns from tree and fruit crop plantations were projected using estimates based on actual survival rates established through successive surveys. The actual costs incurred, actual and expected returns in the future for each component were discounted to net present worth (NPW) and benefit-cost ratios (BCR) worked out at 12, 15 and 20 per cent discount rates. The internal rate of return (IRR) for each component and project as a whole was worked out and compared with the expected IRR worked out in the feasibility reports.

A note on limitations needs to be added here; the output has been evaluated at base year prices and the project costs have been taken as incurred, which presumably means the current prices. Since a true deflator for the capital investment costs was not available for each component, therefore, the project costs could not be taken at base year prices. To this extent the estimates of NPW, BCR and IRR would be under-estimated. However, during the period of project investments, *i.e.*, 1980-81 to 1986-87, the index number of wholesale prices of 21 agricultural commodities increased from 100 to 131.5 which gives an inflation rate of 4.67 per cent only. The inflation in the capital investment items would be even lower. Thus the under-estimation in the evaluation parameters, which in any case are the indicators, is not very serious.

RESULTS AND DISCUSSION

The benefit streams and the estimated parameters of the cost-benefit analysis for each component of the project, as well as the project as a whole, in the two watersheds are discussed below.

Forestry Component

In the feasibility reports, it was envisaged to cover 2,350 hectares in Maili and 1,650 hectares in Chohal watershed at a cost of Rs. 113.30 lakhs and Rs. 73.03 lakhs respectively. The Maili watershed included a much larger additional area at the implementation stage, most of which being the upper catchment area required mainly the forestry treatments. The main emphasis in the forestry programme was on the planting of *Acacia catechu* (khair) in association with *Eulaliopsis binata* (bhabhar grass) and other species identified for this purpose for the rehabilitation of badly denuded and eroded area to the extent of 2,225 hectares in Chohal and 8,560 hectares in Maili watershed. The expenditure on reforestation/afforestation associated with structural conservation works such as vegetative and stone check dams, crate wire dams, debris basins, etc., aggregated to Rs. 208.63 lakhs for Maili and Rs. 71.61 lakhs for Chohal watershed during the project period. Thus the actual per unit cost of Rs. 2,437 per hectare in Maili and Rs. 3,218 per hectare in Chohal watershed was significantly lower than the estimated feasibility report cost of Rs. 4,821 per hectare and Rs. 4,426 per hectare in the corresponding watersheds. Evaluation surveys were conducted to estimate the number of plants planted per hectare and their final survival, the incremental grass yields due to plantation of bhabhar tufts and enclosure to grazing, etc.

The returns were mainly from the sale of fodder and bhabhar grasses, khair trees and bamboos. The prices used for these items (net of the harvesting costs) were the same as in the feasibility reports (which in fact are the base year, *i.e.*, 1980-81 prices), namely, fodder

grasses priced at Rs. 4 per quintal and bhabhar grasses priced at Rs. 25 per quintal. Final harvesting₃ of khair was considered in the 25th year yielding 0.14 m³ per tree with a price of Rs. 1,400 per m³. The price for bamboo was assumed as Rs. 3 per bamboo.

The final round of evaluation survey estimated 423 plants/ha in Maili watershed and 420 plants/ha in Chohal watershed finally surviving after six years of planting. The feasibility reports assumed planting of 2,800 to 3,000 bhabhar tufts per hectare on the banks of the trenches, assuming an yield of 2 quintals per hectare in the fourth year, increasing gradually to 12 qtl./ha at full development level from the tenth year onwards. However, according to the survey estimates, 637 and 811 bhabhar tufts were planted per hectare in Chohal and Maili watersheds respectively. The incremental yield of bhabhar per hectare from these tufts in Maili watershed was found to be 0.9 quintal in the third year, 1.09 quintal in the fourth year and was projected to be 6.1 quintals at full development level from the tenth year onwards. In the Chohal watershed it was 0.5, 0.6 and 3.7 quintals per hectare for the corresponding years.

To stabilise the choe embankments, the project envisaged the stubbing of bamboo clumps along the choe banks at a distance of four metres. The number of bamboo clumps planted in Chohal watershed was 3,500 during 1982-83 and 9,600 during 1983-84. In Maili watershed, it was 1,452, 804 and 1,900 during 1983-84, 1984-85 and 1985-86 respectively. It was assumed in the feasibility reports that the production from the bamboo clumps will start from the fifth year with 2 bamboos, increasing gradually to 12 bamboos per bamboo clump at full development level from the tenth year onwards.

The plantation of fodder grasses was almost negligible. The yield of bhabhar and fodder grasses (natural) increased following closure to grassing. Again, the per hectare incremental yields were estimated from various survey rounds. The incremental yield of bhabhar (natural) per hectare was 0.1 quintal in the third year, 0.2 quintal in the fourth and projected to 1.3 quintal from the tenth year onwards in Maili watershed. These figures for Chohal watershed were 0.2, 0.4 and 2.4 quintals per hectare respectively. The incremental yield of fodder grasses per hectare was more in Maili, being 1.0, 2.0 and 3.4 quintals during the second, third and fourth year respectively and it was projected to 6 quintals from the eighth year onwards. In Chohal watershed, the respective figures were 0.3, 0.6, 1.0 and 2.4 quintals/ha.

The net present worth at 12 per cent discount rate was computed at Rs. 252.95 lakhs for Maili watershed and Rs. 68.91 lakhs for Chohal watershed (Table IV). The benefit-cost ratio at this discount rate was more than 2 for both the watersheds. It was more than 1 at 15 per cent discount rate but less than 1 at 20 per cent discount rate. The IRR for this programme in Maili and Chohal watersheds was 18.23 per cent and 17.27 per cent respectively. The IRR for these two watersheds in the feasibility reports was 14 and 15 per cent respectively. Thus the forestry component yielded better than it was expected to do. However, as shown earlier, there was considerable scope to enhance these benefits.

Animal Husbandry Component

The objectives of the livestock improvement programme were to control open grazing in the hills, thereby improving the vegetative cover and to improve the socio-economic conditions and the nutritional levels of the local people. The programme included (i) exchange of two low yielding scrub milch cows/buffaloes or four goats for one improved

cow/buffalo that would be stall fed and (ii) improvement of succeeding generations of existing animals by means of artificial insemination. The expenditure on this component was Rs. 42.22 lakhs in Maili watershed where 564 improved animals were supplied, 16,182 quintals of feed/fodder were given at subsidised rates and 3,562 artificial inseminations were done under the cattle improvement programme during the project period. The corresponding data for Chohal were Rs. 27.18 lakhs, 277 milch animals, 9,273 quintals of feed/fodder and 2,502 artificial inseminations.

Various rounds of surveys showed that the proportion of improved animals (supplied under the programme) retained by the beneficiaries in Maili was 100 per cent during the first year, 70 per cent during the second year, 24 per cent during the third year and 11 per cent from the fourth year onwards (*i.e.*, up to the 12th year). The corresponding figures for Chohal watershed were 94, 79, 63 and 60 per cent respectively. The exodus of improved animals supplied under the project was a drain on its financial impact. Not only that, the average milk yield of these animals was declining over time. Assuming a lactation length of 18 months, the average annual milk yield of these animals in Maili was 1,528 litres during the first year, 1,232 litres during the second year, 1,151 litres during the third year and 1,109 litres from the fourth year onwards. Likewise, the milk yields in Chohal watershed were estimated at 1,539, 1,486, 1,308 and 1,031 litres respectively. The exodus of improved animals supplied under the exchange programme and their declining milk yield over time were due to the poor performance of the fodder sub-component of the project which envisaged the co-ordination with the forestry and the irrigation departments. To get the net incremental milk production due to cattle exchange programme, the average milk yield of replaced animals was estimated and was found to be 72.5 litres per year per replaced animal in both the watersheds. The income from the sale of these animals accrued to the beneficiaries unwarrantedly and hence was not taken as return to the project investment.

Besides the above incremental milk production, the incremental milk yield from the general animal improvement programme, *i.e.*, artificial insemination (AI) services was also estimated. For this purpose, the total number of AI done in the watershed was apportioned on the basis of targets fixed and the population of improved female offsprings due to AI was estimated using the following evaluation survey estimates: (i) 60 per cent A.I. success, (ii) 50 per cent ratio of females, (iii) 12 per cent death rate for young stock and (iv) the offspring in milk at the age of 4 years. Thus the female offsprings of improved breed animals due to AI done during the seventh year of the project (*i.e.*, 1986-87) would be in milk production in the eleventh year and carry on for the next ten years. Thus the benefits from the project investments in this component would be up to the 21st year of the project. The gap between the yields of the improved milch animals and local milch animals was estimated at 602 litres per year in Maili and 616 litres per year in Chohal watershed. The benefit streams from this component are given in Tables II and III.

The incremental financial returns from this component were computed using the net financial (market) price of milk at Rs. 1.10 per litre which excluded the cost of Rs. 1.90 per litre incurred by the beneficiary farmers. The net present value at 12 per cent discount rate stood at Rs. 3.37 lakhs for Maili and Rs. 5.38 lakhs for Chohal watershed. The benefit-cost ratio (BCR) at 12, 15 and 20 per cent discount rates was 1.14, 1.02 and 0.87 for Maili, and 1.31, 1.14 and 0.93 per cent for Chohal watershed respectively. The IRR was 15.63 per cent

for Maili and 18.49 per cent for Chohal, which were lower than those expected in the feasibility reports (30 per cent for Maili and 23.5 per cent for Chohal). The reasons for the lower financial rate of return were the exodus of improved stock and the decline in the milk yields of exchanged (improved) animals.

TABLE II. GENERALISED INCREMENTAL RETURNS FROM VARIOUS COMPONENTS,
MAILI WATERSHED, PUNJAB

(Rs. lakhs)

Year	Forestry	Animal husbandry	Soil conservation	Horticulture	Irrigation	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1(1980-81)	-	-	-	-0.06	-	-0.06
2	-	1.54	-	-0.17	-	1.37
3	0.05	2.09	-	-0.19	-	1.95
4	0.30	3.58	0.69	-0.41	-	4.16
5	0.96	4.55	1.53	-0.32	-	6.72
6	2.32	4.42	2.69	-0.54	-	8.69
7	3.91	3.84	3.85	-0.88	1.26	11.96
8	5.72	4.18	5.54	-0.37	6.52	21.69
9	8.31	5.13	6.44	0.30	11.15	31.33
10	10.95	6.46	7.92	1.24	15.48	42.05
11	13.66	6.46	8.16	2.28	19.97	50.53
12	15.93	6.46	8.16	2.93	22.00	55.48
13	17.93	6.46	8.16	3.52	22.92	58.99
14	18.80	6.33	8.16	4.24	22.92	60.45
15	19.19	6.23	8.16	4.47	22.92	60.97
16	19.19	6.00	8.16	5.50	22.92	61.77
17	19.19	5.32	8.16	6.27	22.92	61.86
18	19.19	4.52	8.16	6.41	22.92	61.20
19	19.19	3.56	8.16	6.41	22.92	60.24
20	19.19	2.50	8.16	6.41	22.92	59.18
21	19.19	1.33	8.16	6.41	22.92	58.01
22 to 24	19.19	-	8.16	6.41	22.92	56.68
25	103.89	-	8.16	6.41	22.92	141.38
26	527.29	-	8.16	6.41	22.92	564.78
27	1,289.29	-	8.16	6.41	22.92	1,326.78
28	3,813.39	-	8.16	6.41	22.92	2,850.88
29	1,966.69	-	8.16	6.41	22.92	2,004.18
30	577.77	-	8.16	6.41	22.92	615.26
31 to 35	-	-	-	6.41	-	6.41
36 to 50	-	-	-	1.94	-	1.94

Soil Conservation and Engineering Component

The on-farm soil and water management developmental works such as land levelling, bench terracing, underground pipe-lining, etc., were carried out on 1,086 and 1,047 hectares of land in Maili and Chohal watersheds respectively during the project period. The yearwise achievements were 155, 151, 146, 165, 412 and 57 hectares in Chohal and 205, 200, 80, 106, 390 and 66 hectares in Maili from the third year to the eighth year respectively. The evaluation surveys pertaining to this component using 'before and after' soil conservation treatment approach revealed significant shifts in land use, i.e., increase in irrigation from own sources (from 11 per cent to 49 per cent), decline in uncultivated area (or inversely additional area brought under cultivation) from 20 per cent before treatment to 0.17 per cent after treatment and the shifts in cropping pattern. The yield levels of all important crops

increased significantly after treatment. Due to the soil conservation treatment, the incremental gross margins, which take care of the incremental costs incurred by the farmer, were estimated at Rs. 338 per hectare after one year of treatment, at Rs. 412 per hectare after two years and at Rs. 780 per hectare at full development level (after the third year onwards). These coefficients were used to develop the benefit streams given in Tables II and III.

TABLE III. GENERALISED INCREMENTAL RETURNS FROM VARIOUS COMPONENTS,
CHOHAL WATERSHED, PUNJAB

(Rs. lakhs)					
Year (1)	Forestry (2)	Animal husbandry (3)	Soil conservation (4)	Horticulture (5)	Total (6)
1(1980-81)	-	-	-	-1.20	-1.20
2	0.05	0.35	-	-2.19	-1.79
3	0.10	1.61	-	-2.77	-1.06
4	0.21	2.70	0.52	-2.79	0.64
5	0.41	2.90	1.15	-1.28	3.18
6	0.68	3.36	2.32	-1.08	5.28
7	1.26	3.72	3.55	1.63	10.16
8	2.68	4.28	5.60	6.55	19.11
9	4.30	4.97	6.71	9.23	25.21
10	4.97	5.90	8.26	13.68	32.81
11	6.00	5.90	8.47	17.66	38.23
12	6.77	5.90	8.47	21.46	42.60
13	8.17	5.90	8.47	24.20	46.74
14	8.30	5.74	8.47	26.57	49.08
15	8.32	5.13	8.47	27.97	49.89
16	8.32	4.50	8.47	29.84	51.13
17	8.32	3.97	8.47	30.48	51.24
18	8.32	3.31	8.47	29.58	49.58
19	8.32	2.51	8.47	29.58	48.88
20	8.32	1.74	8.47	29.58	48.11
21	8.32	0.94	8.47	29.58	47.31
22 to 24	8.32	-	8.47	29.58	46.37
25	193.54	-	8.47	29.58	231.59
26	152.44	-	8.47	29.58	190.49
27	214.14	-	8.47	29.58	252.19
28	419.94	-	8.47	29.58	457.99
29	419.94	-	8.47	29.58	457.99
30	357.96	-	8.47	29.58	395.91
31 to 35	-	-	-	29.58	29.58
36 to 50	-	-	-	7.07	7.07

The project cost for this component was Rs. 62.68 lakhs in Maili and Rs. 57.22 lakhs in Chohal during the project period. The net present worth at 12 per cent discount rate worked out to be Rs. - 3.69 lakhs for Maili and Rs. 5.45 lakhs for Chohal (Table IV). The BCR at this discount rate was 0.90 for Maili and 1.16 for Chohal. The IRR for this component was 10.81 per cent and 14.43 per cent for Maili and Chohal respectively. It needs to be mentioned that the extension advisory services to the project beneficiaries for treated lands were grossly inadequate and had these been provided, the gross margins could have further increased thus making the programme a feasible one. Also, due to ineffective co-ordination with the Irrigation Department, the development works of the soil conservation component were not complemented with irrigation as expected; hence these could have been redesigned, if it were known, thereby increasing the benefits of the project.

TABLE IV. NET PRESENT WORTH (NPW), BENEFIT-COST RATIO (BCR) AND INTERNAL RATE OF RETURN (IRR) FOR DIFFERENT COMPONENTS, MAILI AND CHOHAL WATERSHEDS, PUNJAB

Particulars (1)	NPW (Rs. lakhs)			BCR at			IRR (per cent) (8)
	12 per cent (2)	15 per cent (3)	20 per cent (4)	12 per cent (5)	15 per cent (6)	20 per cent (7)	
A. Maili watershed							
Forestry	252.95	74.03	-40.54	2.74	1.55	0.66	18.23(14.00)
Animal husbandry	3.37	0.35	-2.33	1.14	1.02	0.87	15.63(30.00)
Soil conservation	-3.69	-	-	0.90	-	-	10.81(N.A.)
Horticulture	11.19	6.02	1.87	7.05	4.65	2.36	25.35(N.A.)
Irrigation	Negative	-	-	-	-	-	1.22(9.80)
Overall (including irrigation component)	-5.54	-	-	0.99	-	-	11.94(N.A.)
Overall (excluding irrigation)	213.60	24.35	-96.38	1.81	1.10	0.54	15.65(N.A.)
B. Chohal watershed							
Forestry	68.91	16.18	-19.52	2.27	1.32	0.59	17.27(15.00)
Animal husbandry	5.38	2.17	-0.90	1.31	1.14	0.93	18.49(23.50)
Soil conservation	5.45	-1.28	-	1.16	0.96	-	14.43(N.A.)
Horticulture	68.98	39.98	14.91	7.44	5.01	2.67	26.37(N.A.)
Overall	99.16	16.46	-44.97	1.66	1.12	0.64	16.76(N.A.)

Figures in parentheses indicate IRR expected in the feasibility reports.

N.A. = Not available.

Horticultural Component

This component planned to rejuvenate the existing orchards and induce fruit plantations in the project area by providing 50 per cent subsidy on purchase of plants, plant protection equipment, insecticides/pesticides and fencing material subject to an upper limit of Rs. 700 per farmer and in addition to these, the interest on loan was to be subsidised by 2.5 per cent. The expenditure on these subsidies along with the other capital investments is also included in the project costs shown in the budget for this component. This component established new orchards on 186.1 hectares in Maili and 900.1 hectares in Chohal watershed which were more than the targets fixed for these watersheds. These areas were apportioned on pro-rata basis into different types of orchards, namely, kinnow, mango, guava, etc., using the same proportion as existed for all the watersheds.

Itemwise costs and returns based on input-output data of five years were projected over the economic life period of the fruit crop from the farmer's point of view. The BCR at 12 per cent discount rate (to the farmers) for all types of orchards was more than 2 and the IRR varied from 25 to 50 per cent for different fruit species. The farmer's net benefit streams were used to work out the benefit for the project and are given in Tables II and III. The BCR at 12 per cent discount rate was more than 7 and IRR was more than 25 per cent for both the watersheds. However, it needs to be mentioned that most of the horticultural activity was taken on irrigated lands, though under the project, it was envisaged to be encouraged on rainfed lands.

Irrigation and Drainage Component

The irrigation and drainage component involved construction of earth fill dams in the selected watersheds to stop the incessant menace of damage to the fertile lands by floods and bringing about considerable improvement in the cropping pattern by providing irrigation facilities from the run-off water stored in the reservoirs. The dam and the irrigation scheme were completed in 1986 in Maili watershed at a cost of Rs. 423.15 lakhs, which was almost 2.5 times the estimated cost of the scheme in the feasibility report (Rs. 171.73 lakhs). At full development, the investment in dam is to irrigate 914 hectares (culturable command area - CCA). The area irrigated with the dam water was about 10 per cent of CCA during the first year (1986-87) and about 42 per cent during the second year. It was assumed that the full development level for irrigation will be achieved in the year 1991. In addition to the irrigation, the additional area protected from floods will also be available for cultivation to the extent of 561.4 hectares on full development.

The evaluation survey estimated the gross margins at Rs. 825 per hectare for the additional area cultivated (without irrigation) and at Rs. 2,225 per hectare during the first year and Rs. 2,780 per hectare from the second year onwards for the areas irrigated. The incremental gross margins from the area irrigated were Rs. 1,400 per hectare during the first year and Rs. 2,000 per hectare from the second year onwards. These coefficients were used to estimate the benefit stream for this component and the same is given in Table II. The life span assumed in the feasibility reports beginning from the year of start of construction has been taken as 30 years. Although the investments in irrigation in Maili watershed started in the fifth year of the project, the benefits started flowing in during the seventh year of the project and these have been taken to be flowing up to the year 30. The data on operational and maintenance costs were not available; further, these costs are to be incurred from the normal budget of the department; hence these could not be included in the cost streams of the projects. The cost-benefit analysis yields an IRR of 1.22 per cent which is too low to be economically justified. It should be realised that the investment of Rs. 423.15 lakhs in this dam with CCA of 914 hectares means an investment of Rs. 46,296 per hectare which requires an incremental gross margin of Rs. 5,747 per hectare from the very next year onwards for every hectare of CCA for a period of 30 years to yield an IRR of 12 per cent. The excessive cost escalation and considerable delays in providing irrigation eat into its viability.

Overall

Different components have different life spans. For an aggregate estimate of various evaluation parameters, the cost and benefit streams have been added as such because once the benefits due to (this) project investment are over for some component earlier than the other, a reinvestment in such a component would be required (not a case in this project) to make it match with the other component which yields benefits for a longer period. Although theoretically it can be matched, in practice it may be a rare situation. To compare the cost-benefit parameters of the two watersheds, the NPW, BCR and IRR were computed for Maili watershed by excluding and including the irrigation component (Table IV). The BCR at 12 per cent discount rate was 1.81 for Maili (excluding irrigation) and 1.66 for Chohal.

The rate of return for both the watersheds was more than 15.5 per cent. However, when the irrigation component was included in Maili, the project was not feasible at 12 per cent discount rate (IRR 11.94 per cent).

CONCLUSION

The forestry, animal husbandry, soil conservation and horticultural components of the integrated watershed development project in the Kandi tract of the Punjab proved to be economically justifiable. The rate of return (IRR) was more than 12 per cent in all these cases except for soil conservation in Maili watershed where it was not adequately complemented by the irrigation component. However, there was considerable scope for improvement. For forestry, the survival rate was less than expected and the plantation of bhabhar and fodder grasses was not given adequate attention. For animal husbandry, there was exodus of improved animals supplied and there was a successive decline in the milk yield of these animals. Agricultural extension advisory services particularly for the lands treated under the soil conservation component need to be developed. And horticulture needs to be tried in the rainfed areas. If taken care of, these developments would have enhanced the rate of return of the project.

The irrigation component through large schemes of dams with an exorbitant cost of more than Rs. 46,000 per hectare of CCA would never be justified economically compared with less than Rs. 20,000 per hectare as presented at the feasibility stage and it needs reconsideration. It may be mentioned that this component has been deleted from Phase-II of the project (which covers the other states too). However, the soil conservation department constructed small water harvesting tanks in some other watersheds, the command area of which ranged from 7 to 32 hectares. The feasibility of this sub-component for small scale irrigation possibilities needs to be evaluated.

In the case of an integrated watershed development project, the economic evaluation analysis needs to be supplemented with the changes in technical parameters such as reduction in the run-off, siltation loads, erosion losses, occurrence and severity of floods, etc., and improvements in general vegetation cover and soil productivity. These need to be given due emphasis in Phase-II of the project.

Received November 1988. Revision accepted May 1991.