

**COST-BENEFIT ANALYSIS
OF
PARTICIPATORY IRRIGATION MANAGEMENT**
A Case Study of Dharoi Irrigation Project, Gujarat

Research Report

(PIM)

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Preface by

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Content

Preface.....	i
Executive summary.....	v
List of Tables.....	viii
List of Annexure.....	viii

Chapter 1: Introduction

Background.....	1
Rationale of the study.....	1
Objectives.....	2
Hypothesis.....	2
Methodology.....	2
Variables and Calculations.....	4

Chapter: 2 Analysis and Findings

Benefits.....	5
Cropping pattern.....	5
Increase in irrigated area.....	6
Increase in canal water availability.....	7
Water Expense.....	7
Crop productivity.....	8
Employment generation.....	10
Employment status for landless labour.....	11
Milk Production.....	11
Impact on ground water.....	12
Benefit due to time saved in watering.....	13
Benefit of conflict resolution.....	13

Chapter 3: Benefit Cost Ratio

Benefit Cost Ratio.....	14
DSC total Area.....	20

Chapter 4 : Conclusion.....

Annexure.....	23
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Preface

Participatory Irrigation Management (PIM) Can Work Viably And More¹

Anil C Shah²

This is a small but a uniquely significant research that looks into issue of financial viability of an irrigation system transferred to management of a Farmers' Organization. Since canal irrigation is in the public domain, the investment decisions are taken by the Government, which has to show that the benefits to society are more than the cost the Government would incur. To get such projects approved the projected costs are minimized and the expected benefits are exaggerated. The interesting part is what happens to these assumptions. When the project is completed, benefits are not looked into again. If this is the condition when construction is undertaken for hundreds of small and large surface irrigation projects, there would be the least concern about investment being made in promoting Participatory Irrigation Management where the cost is incurred not only by Government Irrigation Department but also by Farmers' Organizations and if there is a facilitating agency whether Governmental or NGO their costs are not even properly recorded.

So far as cost incurred by the farmer leaders (office-bearers of Farmers' Organizations) when they devote their time to the affairs of organization such as visiting the site on the canal where rehabilitation work is going on or where there might be some dispute between farmers, attending meetings of the Executive Committee, meeting visiting officers, auditors etc.; such time need not be taken as cost because outsiders assume that villagers have plenty of idle time and therefore devoting sometime for their own benefit of managing their programme need not be counted as cost! I have examined this separately in another study on cost benefit of Joint Forest Management³ and it was found that of the total cost incurred on protecting the forest by the community on an average constitutes about 51.5% of the total average cost of time incurred by the office bearers of the forest protection committee and the volunteers who protected the forest. It is time therefore that "time contribution" by villagers is not considered without opportunity cost and therefore free. Villagers have plenty of productive work to do on their farm and in the village and they even have right to take time off for leisure after arduous work during busy seasons of high agriculture activity.

Encouraging findings of an exploratory study

Development Support Center has always been curious about the cost and investment of any development activity. It has therefore also undertaken the cost benefit study of watershed programme⁴ also. In case of PIM, DSC first undertook an exploratory study conducted in 2004⁵, which was to give an overall picture of cost benefit of PIM. Even though based largely on participatory rural appraisal (PRA) technique, it gave a fairly good idea that benefits are much more than the costs incurred. The benefit cost ratio was almost 7. When the findings of sample villages in the small study were extrapolated to the whole project of 56800 ha. DSC made an estimate that when all the planned investment was made over 10 years, it would amount to Rs18 crores by 2008 and benefit from 10th year onwards would be Rs 44 crores per year. Very impressive indeed!

¹ Preface for a study "CBA of PIM" by Research Unit of DSC - Feb 2007

² Chairman (Emeritus), Development Support Centre

³ Preface by Anil C Shah for DSC Research Study on **Joint Forest Management, Minimising Costs Maximising Benefits**,2002

⁴ Refer to Research Paper on Cost Benefit of Watershed Development: *An exploratory study in Gujarat*, conducted by Vaibhav Chaturvedi, March 2005

⁵ The pilot study was conducted by Vaibhav Chaturvedi in year 2004

However we thought let us look more closely at the cost benefit by supplementing PRA technique with traditional questionnaire methodology also. Three villages selected had been practicing PRA for more than five years and enough data was available, as was the cooperation of the villagers for sharing their experience and information. Detailed Study brought out more impressive and widespread benefits against costs.

The costs were grouped under three heads:

- i) Rehabilitation cost (90% contributed by Irrigation Department)
- ii) Administration cost of the facilitating agency (Development Support Center in this study)
- iii) Administration cost of managing the Irrigation Cooperative.

The benefits were also grouped under three heads:

- i) Due to increase in crop productivity
- ii) Due to income from additional employment
- iii) Income due to increase in milk production

Based on the figures of investment made on the three irrigation cooperatives studied, the overall picture of the investment made for the entire PIM project area i.e. 56800 ha. promoted jointly by DSC and State Irrigation Department ,by 2008 would be as; 1) Cost of rehabilitation of canal by government would be Rs 12.9 crores. 2) Cost allocated by the facilitating agency would be Rs.2.59 crores and 3) Administrative and R&M cost of managing irrigation cooperatives would be Rs.4.33 crores. Thus total cost to be incurred would be Rs.20 crores by 2008; whereas the benefits would be Rs 25 crores over 10-year period. Thus the overall BCR ratio would be 1.25. Since after 2008 there would be no expenditure on rehabilitation the overall benefit for the project would be Rs.25 crores per year even considering three out of 10 years as lean years. Average net benefit per year would be Rs.18 crores

Depending upon several factors the benefits and costs were different in three villages, the benefit-cost ratios in all three were positive ranging from 1.3 to 4.5. The more elaborate study therefore reiterated the findings of the preliminary study, rather more forcefully.

The PIM Study brings spread out benefits to farmers as well as employment seekers and livestock families

DSC's Research has looked into the finer aspects of impact of PIM. For our purpose we may look into the essential parameters that indicate whether the system is working more satisfactorily after PIM than was before. We have looked into selected parameters of:

1) Efficiency of water utilization:

The area irrigated by the canals increased by 55%, 40% and 30% in three irrigation projects of Rangpur, Kiyadar and Thalota respectively.

2) Saving in cost of water:

The planning of water distribution was more satisfactory and reliable and therefore, farmers did not have to run around to secure water for their farm. According to their experience, the study showed that on an average reduction in water expenses per hectare was Rs.2026 for Rangpur, Rs.1228 for Kiyadar and Rs.848 for Thalota.

3) Crop Productivity Enhancements:

On account of the assured and timely water availability, the crop yields improved. Keeping in view the area under different crops in different villages. There is a large variation in yields and income but the taking average

the findings indicate that after PIM there is increase in yield by 20% to 60%. Depending upon crop, the increase in income was of the range from Rs 6000 to Rs16000 per hectare. On the whole the researcher has concluded that after PIM the average income per hectare per year has increased by Rs8000.

4) Additional employment generation after PIM:

When water distribution is managed according to PIM regulations there is increase in intensity of cultivation and also diversification. Both have contributed to increase in demand for labour. Research finding indicates that on an average there is an increase in wage income of Rs.250 per year per hectare.

5) Impact on livestock population and milk production:

With better availability of water and increased production of fodder, the increase in milk yield is 1260 litres per animal per year and in terms of money, Rs11340 per animal per year. Taking the entire command area of the three irrigation systems, the increase in income from livestock is estimated at Rs482 lakhs per year.

Do not rush to conclude that introduction of PIM will necessarily benefit all stakeholders in the command area

Benefit of PIM will spread to all sections of rural society dependent upon irrigation in terms of increase in yield and income, increase in wage employment and also increase in income derived from livestock. This will be a false and misleading conclusion. The comparatively more satisfactorily working of PIM in the north Gujarat projects of Dharoi, Guhai and Mazam areas due to very a large effort that has gone into making a success of each component. The Irrigation Department committed itself to provide adequate funds and technical inputs for rehabilitation of the canal, while transferring them to farmers' organizations for management; Development Support Centre, which has long experience, understanding and a competent team to provide software support for the formation of irrigation cooperatives and equipping them for their new role, may not be available wherever PIM is promoted. The farmer leaders who constituted executive committees of irrigation cooperatives were very responsive and cooperative to various requirements that would make PIM a success. It is a matter of speculation if the leadership in these projects was exceptional or whether the facilitating agency, Development Support Centre, was able to bring out the best elements essential for successfully running of PIM organization.

Lessons of the study that can be applied to areas where PIM is to be introduced:

From the experience of introducing PIM in north Gujarat irrigation projects of Dharoi, Guhai and Mazam, with fairly positive results in terms of financial viability and other essential parameters of sound institutional functioning; Prof Kirit Parikh, Member, Planning Commission compared the model developing of PIM in Dharoi etc with the white revolution that Gujarat gifted to the nation through the Amul model naming it a blue revolution. Based on their experiences, the two packages were developed by State Irrigation Department and DSC, which are now known all over the country as Gujarat model of PIM packages. These are known as; 1) Package of incentives for the farmers and 2) Package of software support by facilitating agency

Background

Cost-Benefit Analysis (CBA) is one of the tools used by policy makers for decision-making about alternative opportunity for investment. It is a widely practiced technique for testing the financial viability of any project i.e. whether the investment to be made is worth; whether the project is financially rewarding. Costs can be described as the intended or unintended negative effects of project investment. Benefits can be described then as the intended or unintended positive effects of a project.

The key principle is that the impact on each affected person, experienced over a period of time, is identified (gain or loss), quantified, valued and aggregated. A CBA consists of four steps:

1. Identification of costs and benefits
2. Quantification of costs and benefits
3. Valuation of costs and benefits
4. Aggregation and comparison of costs and benefits

Irrigation increases crop production by increasing crop yield, cropping intensity and making possible cultivation of high value and remunerative crops. This was the objective with which the irrigation system was started. However, mere provision or irrigation facility to the land does not ensure enhanced agricultural production. The productivity impact of irrigation is critically dependent on the way water is applied and utilised. The quality of irrigation service in terms of adequacy, timeliness, equity, dependability, predictability and convenience in its supply remarkably determine the yield from irrigation. For obtaining optimum yield, water should be provided in time and in adequate quantity according to the water requirement of the crops at their various growth stages. Irrespective of the location and size of the farm, water should be allocated equitably among the head enders and tail enders and also large farmers and small farmers. For planning the cropping pattern, farmers need to know in advance the timing and quantity of water supply. This was not happening satisfactorily when managed by irrigation bureaucracy. As a consequence, the 'National Water Policy of India adopted in 1987 and again in year 2002 clearly envisages that 'Farmers should be involved progressively in various aspects of management of irrigation system, particularly in water distribution and collection of water rates'. Of late, most of the state governments in India have taken a policy decision to introduce Participatory Irrigation Management (PIM) and turning over the management of tertiary segment of the canals like minor/sub-minors/ distributaries to Water Users' Associations (WUAs). It is envisaged that WUAs will be entrusted with the responsibilities of operation and maintenance of the tertiary units, distribution of water among water users and collection of water rates.

Rationale of the study

A number of Irrigation Cooperatives (ICs) have been promoted in Gujarat in the backdrop of the Participatory Irrigation Management (PIM) policy laid down by the Government of Gujarat (GoG) in 1995. The benefits of these institutions are known. Many researchers have studied the benefits of the PIM efforts, e.g. increase in area irrigated, increase in the agriculture production, less number of conflicts, better service delivery, improvement in maintenance of irrigation system, etc. but most of the studies have not compared the benefits in money terms with the investment over a periods of time. Comparison of benefits with costs can give a reliable idea about the relative importance of the investments in the PIM programme.

Objectives

The objective of the study is to find out the financial benefit against the project cost over a period. The steps followed are;

- Identification, quantification and valuation of cost/ investment incurred and benefits in money terms obtained in the implementation of a PIM project over 10 years period
- Aggregation of costs and benefits
- Calculation of Benefit Cost Ratio
- Lastly, recommend steps for minimizing costs and maximizing benefits and improve enabling framework for PIM implementation

Hypothesis

Due to intervention of Participatory Irrigation Management, the farmers have benefited with respect to, increase in irrigated area, increase in productivity, crop diversification resulting in value addition, employment generation and increase in milk productivity. There are some non-monetary benefits also such as better conflict resolution, and participatory decision making mechanism. For obtaining these benefits investments have been made, costs incurred by the state irrigation department, by beneficiary farmers and by facilitating agencies. The hypotheses is that under PIM costs in aggregate are less than the benefits the farmers derive, The study seeks to bring out the quantum of costs and benefit and thus verify the hypothesis that benefit cost ratio of PIM is positive.

Methodology

The study was conducted in, Dharoi irrigation project in North Gujarat. For finding the Benefit Cost Ratio (BCR), out of 15 Irrigation Cooperatives (ICs), having 3 to 5 years of waterings experience after PIM, three were selected for the study. For analysis 'Pre-PIM' and 'Post-PIM' approach was followed. The Rabi Normal year (when number of canal watering provided is 5 to 6) is considered for the study. The details of the three villages studied are as shown in Table-1.1.

Table-1.1: ICs studied

S.No.	Name of villages	Reach	Minor	Command Area (Ha)
1	Rangpur	Head	M5L, M3LA	616
2	Kiyadar	Middle	M8R, M8R1	327
3	Thalota	Tail	DSM1, DSM1/4, DSM2, DSM3, M14	315

Source: Secondary data

The research methodology was mainly sample-based. The sampling method used was stratified proportionate random sampling as shown in flow diagram below in Fig 1.

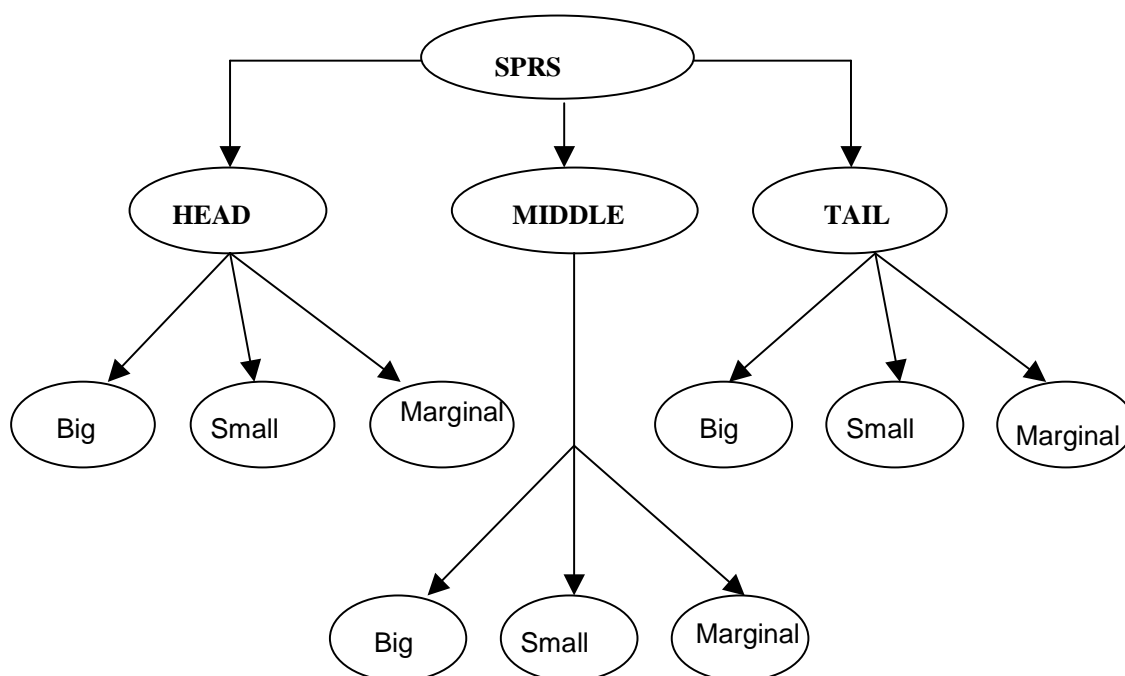


Fig: Flow diagram of sampling

The first stratum or layer of sample is the location of IC on irrigation system i.e. head, middle and tail reach of the system. One IC each, from three reaches, was selected. The second stratum is the location of farmers on the minor i.e. head, middle and tail reach of ICs' minor. The third stratum is the size of the landholding. Depending on the size of the land 10% farmers are picked from big¹, small and marginal land size from each three locations on the minor.

Table 1.2: Sampling detail

Reach	Rangpur (258*)			Kiyadar (110*)			Thalota (260*)		
	Big	Small	Marginal	Big	Small	Marginal	Big	Small	Marginal
Head	2	3	2	1	1	2	2	3	4
Middle	2	4	5	1	3	3	2	3	4
Tail	2	3	4	2	2	2	2	4	5
Total	6	10	11	4	6	7	6	10	13
% of sample	11			15			11		

*- Number of members

Table-1.2 shows the detail of the members in the IC, interviewed. The total percentage of sample ranged from 11% - 15%. Two landless farmers from each of the three IC were also interviewed. The team that conducted the data collection consisted of two persons, one researcher and another investigator.

The technique used for collecting primary information was through a questionnaire and Participatory Rural Appraisal (PRA).

² Big- land size greater than 2.5 ha
 Small – land size less than 2.5 ha and greater than 1 ha
 Marginal – land size less than 1 ha

Variables and Calculations:

Benefits

- Increase in irrigated area (Head, Middle and Tail).
- Adequate water supply as per their cropping pattern
- Timely availability of water.
- Equity (small and marginal farmers)
- Decrease in water expense
- Increase in crop productivity
- Increase in milk production
- Increase in employment in mandays (agricultural labours)
- Ground water recharge.
- Crop diversification
- Occupation diversification (Animal Husbandry)

Cost factor

Cost factors included

Irrigation Cooperative cost

- Cost of administration, operation, maintenance and water charges collection by Irrigation Cooperatives
- Rehabilitation cost shared by Irrigation Dept (90%) and IC (10%).

Organization cost of facilitating agency (DSC)

- 1) Field office- Salary, travel
- 2) Central office- Salary, travel
- 3) Software support- Exposure visits, training materials, street shows, video shows, flyers etc.

Benefits

Benefits can be seen at two levels, primary and secondary. At both levels they can either be quantitative or qualitative. The flow chart below shows them in detail with respect to the ICs studied.

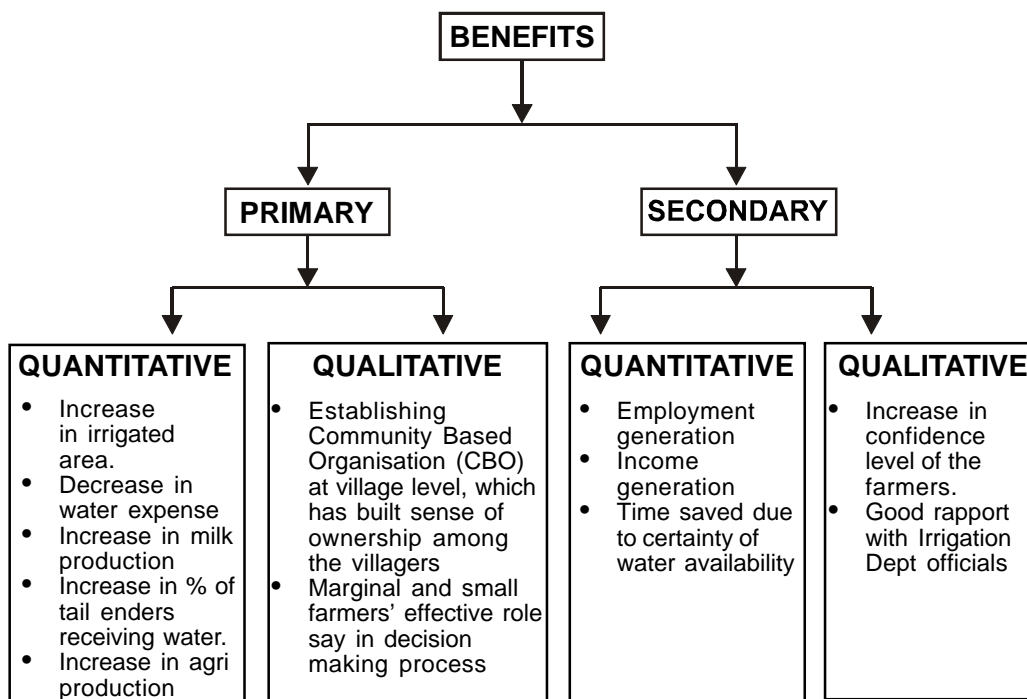


Fig 2: Flow diagram of benefits

Cropping pattern

Tables-2.1, 2.1 and 2.3, show the changes in cropping patterns of Rangpur, Kiyadar and Thalota command areas respectively. The crops that were mostly taken are wheat, mustard, castor and cotton. The general trend that was found before PIM was that farmers went for mustard, which requires less water. Wheat requires 6 to 7 waterings. Hence those farmers who had an assured water source could only take wheat. After PIM because of assured canal water to more number of farmers, the cropping area of wheat increased. It was found to be remarkable, in case of Rangpur and Thalota, which ranged from 20% - 35%. However, Kiyadar did not show much difference in the cropping pattern. Generally, farmers consume wheat for home use and the remaining they sell in the market. They grow mustard and cotton as cash crops. As per the farmers' opinion, it would some more years before they can think of crop diversification.

Table-2.1: Change in cropping pattern in % (Rangpur)

Crop	Head		Middle		Tail		Average		
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Diff
Wheat	27.5	+48.5	23	46.5	29	47	30	49.5	19.5
Mustard	27.5	-16.5	34	17.5	23	15.5	28	16.5	-11.5
Castor	5.5	+7	10.5	14.5	7.5	5.5	9.5	9	-0.5
Cotton	17.5	+20	17.5	7.5	29.5	22.5	21.5	16.5	-5
Fodder	18.5	-9.5	6	5.5	8.5	10	11	8.5	-2.5

Source: Primary data collected

Table-2.2: Change in cropping pattern in % (Kiyadar)

Crop	Head		Middle		Tail		Average		
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Diff
Wheat	46	49	20	34	35	40	33	45	8
Mustard	12	19	26	16	25	22	27	19	-8
Cotton	2	8	6	22	0	2	6	11	5
Castor	13	18	21	8	24	23	21	16	-5
Fodder	20	9	9	3	9	14	13	9	-4

Source: Primary data collected

Table-2.3: Change in cropping pattern in % (Thalota)

Crop	Head		Middle		Tail		Average		
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Diff
Wheat	9	48	26	59	23	54	19	54	35
Mustard	43	14	42	19	19	9	35	14	-21
Cotton	9	6	15	7	15	9	13	7	-6
Castor	22	22	14	7	35	22	24	17	-7
Grass	17	10	3	8	8	6	9	8	-1

Source: Primary data collected

Increase in irrigated area

Table-2.4 shows an average percentage increase in the land cultivated by a farmer in the Rabi season, Pre and post PIM in a normal year. This is the average of all the three ICs taken together. Increase in irrigated area was found to be least in case of tail reach. It was found from the field survey that there are still areas in the tail reach, mainly in case of Kiyadar; where rehabilitation work is still not done, due to lack of fund, and water does not reach farmers there. Hence, other limited ground water sources also could not be recharged. In the head reach, average increase is 25% and in the middle, it is 9%. When discussed with the villagers, it was found that in case of the head reach there was the problem of water logging, because of which considerable land was damaged and could not be irrigated, which after PIM and following repairing could be covered under irrigation. As being in the head reach, there was no water crisis, so the average increase per farmer was good. Besides, other sources like well and tube well also gets recharged when canal water is flowing.

Table-2.4: Average change in irrigated area per farmer (in %)

Reach	Big			Small			Marginal			Average		
	Pre PIM	Post PIM	Benefit	Pre PIM	Post PIM	Benefit	Pre PIM	Post PIM	Benefit	Pre PIM	Post PIM	Benefit
Head	50	68.5	18.5	65.5	90	24.5	47	79.5	32.5	54	79.25	25
Middle	74.5	78.5	4	69	84.5	15.5	83.5	91.5	8	75.5	84.75	9
Tail	75	75	0	61	68.5	7.5	61	66	5	65.5	69.75	4
Average	66.5	74	7.5	65	81	15.75	63.75	79	15	65	78	12.75

Source: Primary calculation

A landholding-wise on average increase in area irrigated was found to be more in case of small (15.75%) and marginal (15%) farmers than big (7.5%) farmers. Big farmers anyway had the other sources of irrigation before PIM. Small and marginal farmers, who mainly faced water crisis earlier and were mostly dependent on rainfed agriculture as in Rabi season tube well exorbitantly expensive water was not affordable, they could not irrigate their whole area. Hence when canal water was made available to them after PIM there was noticeable increase in their irrigated area.

Reach-wise increase in irrigated area was found to be maximum in head (25%) and minimum in tail (4%). This head reach increase is mainly as they get assured canal water and the canal rehabilitation also mainly takes from head to reach. Some part of tail end still do not get water because of broken canal or water not flowing till the end.

Increase in canal water availability

Table-2.5 show the percentage of ground and canal water source used for irrigation pre and post PIM. It was found from the farmers' discussion that canal water availability was not more than 30%, 10% and 30% of the designed command area of Rangpur, Kiyadar and Thalota respectively before PIM; which increased to 85%, 50% and 60% in after PIM. Irrigation through ground water source was found to be 50%, 70% and 60%, of total water used for irrigation in Rangpur, Kiyadar and Thalota respectively before PIM; which was reduced to 5%, 30% and 40% after PIM. Thus, once the canal water was made available to more and more farmers their dependency on ground water was reduced. Farmers were of the opinion that if water distribution had continued as before they would have faced severe water crisis, as the remaining wells/tube wells would also have become defunct and canal water distribution status would have remained the same pathetic situation. Now, because of canal water availability, ground water also gets recharged apart from farmers shifting to canal water. The uncultivated land was also reduced by 10% to 15%.

Table-2.5: Change in irrigation through different source (in %)

Irrigation Cooperative	Only well		Only bore well		Well +borewell		Canal		Uncultivated	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Rangpur	0	0	50	10	0	0	30	85	20	5
Kiyadar	0	0	0	0	70	40	10	50	20	10
Thalota	0	0	10	5	50	35	30	60	10	0

Source: Group discussion

Water Expense

As seen from the Table-2.5, increase in canal irrigation area was 55%, 30% and 40% in Rangpur, Thalota and Kiyadar respectively. On account of canal water, farmers saved considerable amount of water expense, which is shown in Table-2.7. It shows the average expenditure of water incurred before and after PIM for the whole command area depending upon the areas of each IC irrigated from various other, sources as per the figures shown in Table-2.6.

Table-2.6: Average area irrigated through various sources of water (in ha)

Irrigation Coop.	Only Well		Only Bore well		Well +borewell		Canal		Uncultivated	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Rangpur (616)	0	0	308 ³	61.6	0	0	184.8	523.6	123.2	30.8
Kiyadar (315)	0	0	0	0	220.5	126	31.5	157.5	63	31.5
Thalota (327)	0	0	32.7	16.35	163.5	114.45	98.1	196.2	32.7	0

Source: Calculated

As discussed with the group of farmers, the cost of water per hectare from individual sources of well bore well and canal came o be Rs 4000, Rs 6000 and Rs 680 respectively. On average reduction in water expense per hectare were Rs 2026, Rs 1228 and Rs 846 in case of Rangpur, Kiyadar and Thalota respectively.

Table 2.7: Average water expense/ ha (in Rs)

Irrigation Coop.	1.Well (@Rs4000/ha)		2.Bore well (@Rs 6000/ha)		3.Well +borewell (@ Rs 5000/ha)		4.Canal (@ Rs 680/ha)		Total			Diff/ha
	1.aPre	1.bPost	2.a Pre	2.b Post	3.a Pre	3.b Post	4.a Pre	4.b Post	5.aPre (1a+2a+3a+4a)	5bPost (1b+2b+3b+4b)	Diff (5b-5a)	
Rangpur (616)	0	0	1848000 ⁴	369600	0	0	125664	356048	193664	725648	-1248016	(-) ⁵ 2026
Kiyadar (315)	0	0	0	0	1102500	630000	21420	107100	1123920	737100	-386820	(-)1228
Thalota (327)	0	0	196200	98100	817500	572250	66708	133416	1080408	803766	-276642	(-) 846

Source: calculated

From the table above it can be that gradually the shift is there from ground source to canal source. Actually farmers prefer canal water, as it is cost effective. They go for tube well water only in special case.⁶ This decrease in ground water dependency would also result in rise in water table. Rangpur shows the maximum benefit that is mainly because canal coverage is 100% and usage of ground water has also decreased considerably. In case of Thalota coverage is 100%, but percentage of ground water usage is comparatively more than Rangpur. Kiyadar shows the least benefit as here canal water coverage has reached 60% and is in progress; hence ground water dependency is slightly higher.

Crop productivity

As informed by the farmers, crop productivity has increased due to the timely water availability, increase in number of watering and additional area under irrigation after PIM. Table-2.8 shows the net income per crop per hectare. As discussed with the farmers they opined that 50% to 75% increase in crop yield is due to PIM.

³ 50 (percentage of bore well for Rangpur pre PIM from Table-2.5) X 616 (command area of Rangpur IC) ÷ 100. Accordingly area and percentage will change as per three ICs

⁴ Rangpur area (from Table 2.6) X 6000. Similarly other cells are calculated.

⁵ (-) sign shows the decrease in water expense per hectare

⁶ some farmers prefer last water for wheat to be from ground water as it is warm and gives more productivity as per their perception.

Table-2.8: Average crop yield (Kg/ha)

Crop	Production (kg)/ha		Col 3. % Increase [(Col2- /Col1) Col1] X 100	Col 4. Market Price (Rs/Kg)	Col 6. Gross Income (Rs/ha)		Cost of cultivation (Rs/ha) ⁷		Net income = Gross income-cost of cultivation	
	Col 1. Pre	Col 2. Post			Pre (Col 1 X Col 4)	Pre (Col 2 X Col 4)	Pre	Post	Pre	Post
Wheat	2000	3200	60	7.5	15000	24000	11812	7847	3188	16153
Mustard	900	1200	33	15.5	13950	18600	5562	3822	8388	14778
Cotton	1100	1350	23	25	27500	33750	12668	10668	14832	23082
Castor	1525	1800	18	15	22875	27000	7862	5284	15013	21716
Grass	1800	2400	33	5	9000	12000	8662	6142	338	5858

Source: Calculated

On account of assured and timely water availability, the crop yield has improved. The net income per hectare, for each IC, was calculated from their cropping pattern. Table-2.9 shows the average percentage of crop taken by the farmers. Weighted mean of the cropping pattern is calculated in Table-2.10. Thus, net income as per the cropping pattern before and after PIM is shown in Table-2.11. On an average, it comes out to be Rs 8500/ha.

Table 2.9: Average cropping pattern (in %)

Crop	Rangpur		Kiyadar		Thalota	
	Pre	Post	Pre	Post	Pre	Post
Wheat	26	49.5	33	45	19	54
Mustard	31	16.5	27	19	35	14
Castor	9.5	9	6	11	13	7
Cotton	22.5	16.5	21	16	24	17
Fodder	11	8.5	13	9	9	8

Source: calculated

Table 2.10: weighted mean of percentages of cropping pattern

Crop	Rangpur			Kiyadar			Thalota		
	Pre	Post	Diff	Pre	Post	Diff	Pre	Post	Diff
Wheat	0.26	0.495	0.235	0.33	0.45	0.12	0.19	0.54	0.35
Mustard	0.31	0.165	-0.145	0.27	0.19	-0.08	0.35	0.14	-0.21
Castor	0.095	0.09	-0.005	0.06	0.11	0.05	0.13	0.07	-0.06
Cotton	0.225	0.165	-0.06	0.21	0.16	-0.05	0.24	0.17	-0.07
Fodder	0.11	0.085	-0.025	0.13	0.09	-0.04	0.09	0.08	-0.01

⁷ Calculation shown in annexure

Table-2.11: Average net income (Rs/Ha/year)

Crop	Rangpur			Kiyadar			Thalota		
	Pre	Post	Diff	Pre	Post	Diff	Pre	Post	Diff
Wheat	828.88	7995.735	7166.855	1052.04	7268.85	6216.81	605.72	8722.62	8116.9
Mustard	2600.28	2438.37	-161.91	2264.76	2807.82	543.06	2935.8	2068.92	-866.88
Castor	1409.04	2077.38	668.34	889.92	2539.02	1649.1	1928.16	1615.74	-312.42
Cotton	3377.925	3583.14	205.215	3152.73	3474.56	321.83	3603.12	3691.72	88.6
Fodder	37.18	497.93	460.75	43.94	527.22	483.28	30.42	468.64	438.22
Total	8253.305	16592.56	8339.25	7403.39	16617.47	9214.08	9103.22	16567.64	7464.42

Source: Calculated

Overall average benefit in net income = $(8339+9214+7464)/3 = \text{Rs } 8340^8$

Employment generation

Increase in employment has been observed after the PIM. There have been 4 reasons of employment generation, directly or indirectly attributed to PIM;

- i) Employment due to rehabilitation work of the canal.
- ii) Employment due operation and maintenance of the structures.
- iii) Employment due to administration of Irrigation cooperatives
- iv) Employment due to increase in area irrigated. Here, employment increase due to increase in irrigated area is considered.

Table-2.12, shows that the overall increase in mandays are 4.75/ha. If seen in monetary terms, the benefit is of on an average of Rs 250/ha. Small and marginal farmers, in most of the cases, work as an agricultural labour in other farmers' fields. Like in case of Kiyadar, there are about 25-30 families working in 50% partnership. Thus, irrespective of head, middle and tail, overall employment generation is observed.

Table-2.12: Average additional employment generation

Reach	Rangpur			Kiyadar			Thalota		
	Pre	Post	Diff	Pre	Post	Diff	Pre	Post	Diff
Head	29.28	31.5	2.22	19.61	30.71	11.1	20.3	31.82	11.52
Middle	14.96	31.5	16.54	28.49	34.04	5.55	23.45	25.9	2.45
Tail	0	31.5	31.5	28	25.2	-2.8	18.72	19	0.28
Average (Total of Diff/3)	16.75			4.67			4.75		

Thus overall average employment generation is 4.75/ha

Considering the daily wage to be Rs 50 additional income will be Rs237.5/ha

Source: Calculated

⁸ To remain on conservative side, for calculation of BCR net income taken is Rs 8000/ha

Employment status for landless labour

Table-2.13 shows the additional mandays/ labour generated for landless in all the three ICs. Kiyadar showed the maximum increase in the mandays/labour created in the village. In case of Thalota, some people go to Gujarat Industrial Development Corporation estates for work. Still, increase in mandays is observed. This also supports the previous finding of increase in mandays due to increase in irrigated area and crop productivity.

Table-2.13: Change in employment availability for landless (in the village)

Reach	Agri (days/labour)			Non-Agri(days/labour)		
	Pre PIM	Post PIM	Diff	Pre PIM	Post PIM	Diff
Rangpur	76	84	8	10	10	0
Kiyadar	73	98	25	0	0	0
Thalota	50	55	5	0	42.5	42.5

Source: Primary data collection from the farmers

Table-2.14 shows the reduction in forced migration⁹. In Kiyadar it was encouraging to see that it reduced substantially. In case of Thalota, too, also reduction was observed, which shows positive sign in employment generation per labour in the village.

Table-2.14: Reduction in net migration

Name of the IC	Agri(days/labour)			Non-Agri(days/labour)		
	Pre PIM	Post PIM	Diff	Pre PIM	Post PIM	Diff
Rangpur	0	0	0	0	0	0
Kiyadar	35	13	-22	0	0	0
Thalota	0	0	0	20	18	-2

Source: Primary data collection

Milk Production

From the Table-2.15, it can be seen that an increase in number of animals was found in all the three ICs. This ranged from 75 to 200 after PIM. It can be said that farmers showed interest in pursuing dairy business in the normal years when they were assured of water availability.

Table-2.15: Average number of milch animal

Milch animal	Rangpur			Kiyadar			Thalota		
	Pre	Post	Diff	Pre	Post	Diff	Pre	Post	Diff
Cow	350	500	150	331	497	166	9	35	26
Buffalo	400	600	200	944	1021	77	134	314	180

⁹ Forced migration is when somebody is compelled to leave his or her place and go to some other place to earn livelihood. In villages, generally means of livelihood is agriculture, but due to certain circumstances like lack of water, availability farmers are forced to leave their village and move to city for earning.

Table-2.16: Average milk production (litres/day)/per animal?

Milch animal	Rangpur		Kiyadar		Thalota		Average	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Cow	10	15	10	11	9	11	10	12
Buffalo	4	6	7	9	5	7	5	7

As seen from *Table-2.16*, overall increase in milk production per milch animal was found to be more or less same. Hence, increase in milk production per household was observed, which was mainly due to increase in number of animals per household. Per hectare increase in average milk production was found to be 853 lit/ha/year. Increase in income per hectare was found to be on an average Rs 7677/ha/year as shown in *Table-2.17*.

Table-2.17: Impact on milk yield (Lit/year/ha)

Reach	Big			Small			Marginal		
	Pre	Post	Diff	Pre	Post	Diff	Pre	Post	Diff
Head	898	1065	167	352	405	53	618	706	88
Middle	2725	3462	737	2907	4502	1595	2448	3936	1488
Tail	1444	1787	343	3258	5508	2250	4485	5439	954
Average (Total of Diff/3)			416			1299			843
Average milk production (Lit/year/ha)								853	
Therefore overall average additional Income due to increase in milk yield (lit/ha/year) (@Rs 9 /litre)									7677

Source: Primary data collected

Impact on ground water

In all the three villages, there is a well-maintained drinking water supply pipeline and for domestic use tube well water is available whenever necessary.

The details of other sources in the command areas are given below in *Table-2.18*. It can be seen that about 50% of the wells have become defunct. In the remaining wells, water is available only for half an hour per day, which and that is not suitable for agricultural purpose.

Table- 2.18: Details of sources other than canal

IC	Well	Tube Well
Rangpur	55(37 in use)	4 (3 in head 1 in middle)
Kiyadar	40 (20 in use)	3
Thalota	22 (12 in use)	8

In these villages, canal water is available since 1990, but before that, wells were constructed having a depth of 200 to 400 ft, which in the long run have been defunct due to clogging & rusting. Farmers said that there is an increase in ground water level after the canal water has been used. After PIM this increase is felt widespread, even in some of the wells located at the tail reach.

Benefit due to time saved in watering

From the discussion with farmers it was found that there is saving of, on an average, 3 hours/watering/hectare, due to timely availability of canal water, as compared to water distribution before PIM. Table-2.19 shows the days saved per hectare. In case of small and marginal farmers, it is less obvious because of small landholding size. On an average, the days saved are 15 per hectare and in monetary terms, Rs 750/ha considering daily wage to be Rs 50.

Table-2.19: Days saved/hectare/year for watering

Location	Days saved/ha			
	Big	Small	Marginal	Total
Head	7	4.38	1.62	13
Middle	15.5	5	2.3	23
Tail	6	1.75	1.63	9.38
				45.56
Average days saved/ha (45/3) 15				

Source: Calculated

Benefit of conflict resolution

It is observed that farmers have become disciplined now, as they have confidence that they will be provided water in turn. If somebody is caught stealing or misusing water, he is punished and is made to pay a heavy penalty. As in case of Rangpur, in 2004-05, IC collected penalty of about Rs 4000 from four farmers, which is equivalent to the cost that they would have borne when irrigated by a through tube well. Given below are some instances of penalty from the three ICs:

Table-2.20: Instances of penalty in Rangpur IC in 2004–05

S.No.	Name of farmer	Penalty	Description of incidences
1.	Kantibhai (Sarpanch)	1704	Two times irrigation in single rotation
2.	Becharbhai Patel and 8 other farmers (Rs.150 each)	1200	Irrigating without the permission of operator
3.	Pursottambhai	451	Two times irrigation in single rotation
4.	Ishwarbhai Patel	251	Irrigating more land than what he had indicated in demand form

Source: Secretary of the IC

Table-2.21: Instances of penalty in Kiyadar IC in 2004 – 05

S.No.	Name of farmer	Penalty	Description of incidences
1.	Ganeshji Lavji Thakor	500	Two times irrigation in single rotation
2.	Abheraj Bhembhai Chaudhary	200	Took irrigation out of turn
3.	Thakor Chehrajji	300	Had put obstruction in the canal

Source: Secretary of the IC

Instance of penalty in Thalota in 2004 - 05

No such instances have been reported in Thalota in 2004 - 05. The most rampant violation is of not applying for water demands before the due date with the advance fee. Many farmers apply after the due date and therefore, IC charges them at 1.5 times the normal rate, 50% being the penalty. The secretary of the IC was of the view that over the years farmers have learnt that there are no gains in breaking the rules and therefore, no such cases have been reported.

Benefit Cost Ratio

The Benefit Cost Ratio (BCR) has been calculated for Rangpur, Kiyadar and Thalota. A time series statement is prepared from the year 1997-98 to 2003-04, for both, the cost incurred and benefits achieved during the same period. They are then summed up and the BCR is calculated as per the formula given below.

$$BCR = \text{Total benefit} / \text{Total cost}$$

Cost includes

- Irrigation Cooperative cost

- Cost of administration, operation, maintenance and water charges by Irrigation Cooperatives.
- Rehabilitation cost by Irrigation Dept (80%) and IC (20%).

- Organization cost of facilitating agency (DSC)

- 4) Field office- Salary, travel
- 5) Centre office- Salary, travel
- 6) Communication- Exposure visits, training materials and training, street shows, video shows, flyers etc.

Benefits taken into consideration are:

- Increase in income due to increase in crop productivity. This is inclusive of the additional area under agriculture. It was informed by the farmers that the yield of the new area is comparatively higher than the old area already under irrigation.
- Increase in income due to additional employment generation
- Increase in income due to milk production
- Opportunity cost of time saved due to timely water availability and water surety.

Table- 3.1: Benefit Cost Ratio

Name of the IC	Total Cost	Total Benefit	Benefit Cost Ratio (BCR)
Rangpur	25,49,292	1,17,79,875	4.5
Kiyadar	25,01,560	48,14,190	2.8
Thalota	25,64,292	34,87,344	1.3

Source: Calculated

The Benefit cost ratio is shown in Table-3.1, which is quite encouraging. The detailed calculation of this is shown further in this chapter from Table-3.2 to Table-3.7. Rangpur shows relatively good results possibly on account of its canal being in better condition. Second, as seen in Table-2.18, the number of other sources of water is also higher in case of Rangpur. Thalota's BC ratio is less, as a rehabilitation work undergone was more and other sources of water were comparatively less.

Table- 3.2- Cost detail and Calculation in Rs (Rangpur)

S.No.	Cost	Year							
		C1	C2	C3	C4	C5	C6	C7	
		1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	
R1	Rehabilitation cost	1050000							
	Administration cost								
	IC cost								
	Area Irrigated	138	120	0	0	174	0	110	
	Water rate (Rs/ha)	420	250	0	0	536	0	680	
	Govt. water rate (Rs/ha)	130	130	0	0	270	0	357	
	Water charges paid to government (area irrigated X Govt. water rate)	17940	15600	0	0	46980	0	39270	
	Salary of secretary (Rs 6000/year)	3000	6000	3000	6000	6000	3000	3000	
	Salary of operator (Rs 60 for 4 months for 4 operators for a year)	0	28800	0	28800	28800	0	28800	
	Stationery (Rs 5/month for a year)	60	60	60	60	60	60	60	
	Vehicle (Rs 200/month for 6 months)	1200	1200	1200	1200	1200	1200	1200	
	Guest exp (Rs 100/month for 6 months)	600	600	600	600	600	600	600	
	Canal cleaning (Rs 2.5/running mt on average of 9km canal)	0	22500	0	22500	22500	0	22500	
R2	Sub total	22800	74760	4860	59160	106140	4860	95430	
	DSC cost Field								
	Administration	11952	14442	10956	11952	17864	20944	22176	
	Travel	8217	8217	8217	8217	20328	20328	20328	
	Others	31125	31125	31125	31125	77000	77000	77000	
R3	Sub total	51294	53784	50298	51294	115192	118272	119504	
	DSC cost Head office								
	Salary	39840	39840	39840	39840	98560	98560	98560	
	Travel	10209	10209	10209	10209	25256	25256	25256	
R4	Sub total	50049	50049	50049	50049	123816	123816	123816	
R5	TOTAL (R5 = R2+R3+R4)	124143	178593	105207	160503	345148	246948	338750	
	Total for 7 years (R5 of C1 to C7)								14,99,292
	Grand total = Admin cost + Rehab cost (R5 + R1)								25,49,292

Table- 3.3:Benefit detail and calculation in Rs (Rangpur)

	BENEFIT	YEAR						
		C1	C2	C3	C4	C5	C6	C7
		1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04
	No. of Watering	5	3	0	0	5	0	2
R1	Area irrigated (in hectares)	301	278	0	0	320	0	227.38
R2	Benefit due to increase in crop productivity (@ Rs 9600/ha) (R1 X 9600)	2889600	2668800	0	0	3072000	0	2182848
R3	Income due to additional employment generation (@ Rs250/ha) (R1 X 250)	75250	41700	0	0	80000	0	22738
R4	Income due to increase in milk production (@Rs 850/ha) (R1 X 850)	255850	141780	0	0	272000	0	77309.2
R5	Total Benefit (R5 = R2 + R3 + R4)	3220700	2852280	0	0	3424000	0	2282895
	Total benefit for theseven years (in Rs)							11779875

Thus BCR = 11779875/2549292 = 4.5

Table- 3.4: Cost detail and calculation in Rs (Kiyadar)

S.No.	COST	Year							
		C1	C2	C3	C4	C5	C6	C7	
		1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	
R1	Rehabilitation cost	1260000							
	Administration cost								
	IC cost								
	Area Irrigated	0	52	0	0	141	0	160	
	Water rate (Rs/ha)	420	250	0	0	536	0	680	
	Govt. water rate (Rs/ha)	130	130	0	0	270	0	357	
	Water charges paid to government (area irrigated X Govt. water rate)	6240	6760	0	0	38070	0	57120	
	Salary of secretary (Rs 6000/year)	3000	6000	3000	6000	6000	3000	3000	
	Salary of operator (Rs 60 for 4 months for 4 operators for a year)	0	28800	0	28800	28800	0	28800	
	Stationery (Rs 5/month for a year)	60	60	60	60	60	60	60	
	Vehicle (Rs 200/month for 6 months)	1200	1200	1200	1200	1200	1200	1200	
	Guest exp (Rs 100/month for 6 months)	600	600	600	600	600	600	600	
	Canal cleaning (Rs 2.5/running mt on average of 9km canal)	0	22500	0	22500	22500	0	22500	
R2	Sub total	11100	65920	4860	59160	97230	4860	113280	
	DSC cost_ Field								
	Administration	15120	18270	13860	15120	9135	10710	11340	
	Travel	10395	10395	10395	10395	10395	10395	10395	
	Others	39375	39375	39375	39375	39375	39375	39375	
R3	Sub total	64890	68040	63630	64890	58905	60480	61110	
	DSC cost_ Head office								
	Salary	50400	50400	50400	50400	50400	50400	50400	
	Travel	12915	12915	12915	12915	12915	12915	12915	
R4	Sub total	63315	63315	63315	63315	63315	63315	63315	
R5	Total Administration cost(R2+R3+R4)	139305	197275	131805	187365	219450	128655	237705	
	Total admin cost for 7 years (in Rs) (R5 of C1 to C7)								1241560
	Total admin cost +Rehab cost (R5 + R1)								2501560

Table-3.5: Benefit detail and calculation in Rs (Kiyadar)

	Year	C1	C2	C3	C4	C5	C6	C7
		1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04
	No. of Watering	5	3	0	0	5	0	2
R1	Area irrigated (in hectares)	110	160	0	0	140	0	60
	Benefits (in Rs)							
R2	Benefit due to increase in crop productivity (@ Rs 9377/ha) (R1 X 9377)	1031470	1500320	0	0	1312780	0	562620
R3	Benefit from income due to additional employment generation (@ Rs250/ha) (R1 X 250)	27500	24000	0	0	35000	0	6000
R4	Benefit from income due to increase in milk production (@Rs 850/ha) (R1 X 850)	93500	81600	0	0	119000	0	20400
R5	Total Benefit (R5 = R2+R3+R4)	1152470	1605920	0	0	1466780	0	589020
	Total Benefit from all the 7 years (sum of col 1 to 7 of R5)							4814190

Thus BCR = 4814190/2501560 = 2.8

Table- 3.6: -Cost detail and calculation in Rs (Thalota)

	Year	C1	C2	C3	C4	C5	C6	C7	
S.No.	COST	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	
R1	Rehabilitation cost	1065000							
	IC cost								
	Area Irrigated	138	120	0	0	174	0	110	
	Water rate (Rs/ha)	420	250	0	0	536	0	680	
	Govt. water rate (Rs/ha)	130	130	0	0	270	0	357	
	Water charges paid to government (area irrigated X Govt. water rate)	17940	15600	0	0	46980	0	39270	
	Salary of secretary (Rs 6000/year)	3000	6000	3000	6000	6000	3000	3000	
	Salary of operator (Rs 60 for 4 months for 4 operators for a year)	0	28800	0	28800	28800	0	28800	
	Stationery (Rs 5/month for a year)	60	60	60	60	60	60	60	
	Vehicle(Rs 200/month for 6 months)	1200	1200	1200	1200	1200	1200	1200	
	Guest exp (Rs 100/month for 6 months)	600	600	600	600	600	600	600	
	Canal cleaning (Rs 2.5/running mt on average of 9km canal)	0	22500	0	22500	22500	0	22500	
R2	Sub total	22800	74760	4860	59160	106140	4860	95430	
	DSC cost_ Field								
	Administration	11952	14442	10956	11952	17864	20944	22176	
	Travel	8217	8217	8217	8217	20328	20328	20328	
	Others	31125	31125	31125	31125	77000	77000	77000	
R3	Sub total 2	51294	53784	50298	51294	115192	118272	119504	
	DSC cost Head_ office								
	Salary	39840	39840	39840	39840	98560	98560	98560	
	Travel	10209	10209	10209	10209	25256	25256	25256	
R4	Sub total 3	50049	50049	50049	50049	123816	123816	123816	
R5	Total Administration cost (R2+R3+R4)	124143	178593	105207	160503	345148	246948	338750	
	Therefore total cost throughout the years for 7 years (In Rs)								1499292
	Total (admin + rehab cost) (R5 + R1)								2564292

Table- 3.7: Benefit detail and calculation in Rs (Thalota)

	Benefit	Year							
		1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	
	No. of Watering	5	3	0	0	5	0	2	
R1	Area irrigated (in hectares) Benefit (in Rs.)	138	120	0	0	174	0	110	
R2	Benefit due to increase in crop productivity (@ Rs 7048/ha)(R1 X 7048)	972624	507456	0	0	1226352	0	310112	
R3	Income due to additional employment generation (@ Rs250/ha)(R1 X 250)	34500	18000	0	0	43500	0	11000	
R4	Income due to increase in milk production (@Rs 850/ha) (R1 X 850)	117300	61200	0	0	147900	0	37400	
R5	Total (R5 = R2 + R3 + R4)	1124424	586656	0	0	1417752	0	358512	
	Total Benefit from all the 7 years (sum of col 1 to 7 of R5)								3487344

Thus BCR = 3487344/2564292 = 1.3

DSC total Area

DSC's total area, including Dharoi, Mazum and Guhai irrigation systems in Gujarat is 56800 hectares. It is proposed that by the end of year 2008, the rehabilitation work and software work would be completed. The government would be providing 80% of the rehabilitation cost and farmers would contribute 20%. For software support National Dairy Development Board (NDDDB) would be providing 80% and 20% by DSC and other sources. Thus the total cost (Rehabilitation + software cost of DSC + Admin cost of IC) was estimated to be Rs 20 crores¹⁰

Table-3.8: total estimated cost of DSC area of 56800ha

Year	Col-1 % of the area to be covered	Col-2 Area in ha	Col-3 Total area covered (will include 5100ha already rehabilitated)	Col-4 Rehabilitation expenditure	Col-5 Software cost_DSC	IC administration cost ¹¹	Col-6 Area irrigated in ha (assuming 50% irrigated as per design norms)	Col-7 No of watering
2005-06	21	10857	15957	27142500	5428500	7950602	4787.1	3
2006-07	40	20680	25780	51700000	10340000	10340000	0	0
2007-08	39	20163	25263	50407500	10081500	17663060	12631.5	5
2008-09	100	51700	56800	0	0	11709510	17040	3
Total (in Rs)				12,92,50,000	2,58,50,000	4,76,63,172		

¹⁰ Rehabilitation = 129250000
Software cost = 25850000
IC administration cost = 43330574

¹¹ Calculation shown separately

Table-3.9: IC administration cost

Year	Govt. water rate (Rs/ha)	Water charges paid to government (area irrigated X ovt. water rate)	IC's contribution for rehabilitation	Salary of Secretary (Rs. 1200/ month)	Salary of operator (Rs. 60 / day for four months, on average 4 operators in normal watering)	Stationery (Rs. 5/month)	Vehical / Travel (Rs. 200 /month)	Guest exp. (Rs.100/ month)	Canal cleaning (Rs. 2 / Rmt for 8.5 kms	Total
2005-06	517.65	2478042	5428500	8640	17280	60	720	360	17000	7950602
2006-07	0	0	10340000	0	0	0	0	0	0	10340000
2007-08	595.2975	7519500	10081500	14400	28800	60	1200	600	17000	17663060
2008-09	684.5921	11665450	0	8640	17280	60	720	360	17000	11709510
TOTAL(in Rs)										43330574

Benefits are calculated taking into considerations the three factors;

i) Agricultural benefit;

ii) benefit due to additional employment generation;

iii) benefit due to increase in milk production. Hence, the total benefit after the total DSC's area of 56800 ha is completed is calculated to be Rs 25 crores.

Table-3.10: Benefit out of total DSC area once the project is completed

Year	Col1-Due to increase in crop productivity (@ Rs 8000/ha/year)	Col-2 Due to income from additional employment (@Rs250/ha/year)	Co-3 Income due to increase in milk production (@ Rs 850/ha/year)
2005-06	38296800	1196775	4069035
2006-07	0	0	0
2007-08	101052000	3157875	10736775
2008-09	136320000	4260000	14484000
Total (in Rs)	22,05,35,040	68,91,720	2,34,31,848
Grand Total (Col-1 +Col-2 + Col-3) 25,08,58,608			

The BCR ratio thus calculated is 1.26¹², considering all the three benefits and 1.1¹³, considering only agricultural benefits.

¹² BCR = 250858608/198430574 = 1.26

¹³ BCR = 220535040/198430574 = 1.11

From the findings it can be seen that PIM ultimately over a period of time, gives positive results.

Most of the time timely water is made available to farmers, due to effective and efficient water distribution system by the IC. This has led to increase in irrigated area and consequently to increase in income per hectare. The irrigation dept. is also benefited, as farmers are now able to pay timely water charges and also 100%. The IC in turn gets 50% rebate on water charge collection.

From the favourable benefit-cost ratio of the three ICs studied, it is evident that the investment in PIM has yielded high returns to the villagers. Thus, investment in promoting PIM can be regarded as a worthwhile investment opportunity. The investment agency in this case is the Irrigation Department, as well as a non-government organization with significant contribution from the villagers. The benefits have largely accrued to the farmers as well as agriculture labour (In terms of higher employment opportunities), while some benefits are also gained by the Irrigation Department (reduced cost and man power requirement). The cost has been largely borne by the implementation agency (DSC) and the government jointly.

This social welfare investment has proved beneficial for the target farming community as well as the labour community and hence, should be taken for large-scale implementation.

ANNEXURE

I Sample of calculation of impact on crop production

Pre PIM (Head/Big)

II Sample of water expense calculated

Pre PIM (Head/small)

Crop	Area	Source of watering		Expenditure			Total	Cost/ha	% Irrigated	Weighted %	Mean exp
		Canal	Well	Tube well	Canal	Well					
Wheat	5.75	0	0	6	0	0	62100	10800	41.07143	0.41	4428
Mustard	3.75	0	0	4	0	0	27000	7200	26.78571	0.27	1944
Cotton	0	0	0	0	0	0	0	0	0	0	0
Castor	3.25	0	0	4	0	0	19500	6000	23.21429	0.23	1380
Grass	1.25	0	0	4	0	0	7500	6000	8.928571	0.09	540
	14						116100	8292.857			
											8292

Pre PIM (Head/small)

Crop	Area	Source of watering		Expenditure			Total	Cost/ha	% Irrigated	Weighted %	Mean exp
		Canal	Well	Tube well	Canal	Well					
Wheat	4.25	5	1	1	5100	7500	20250	4764.706	32.69231	0.33	1572.353
Mustard	2.5	4	0	0	2400	0	2400	960	19.23077	0.19	182.4
Cotton	1	5	0	0	1200	0	1200	1200	7.692308	0.08	96
Castor	3.5	4	1	1	3360	4800	13410	3831.429	26.92308	0.27	1034.486
Grass	1.75	4	2	1	1680	5250	9555	1820	13.46154	0.13	236.6
	13						46815	3601.154			
											3121.839

III Sample of calculation for time saved (Hours)

Head/big

Crop	1. Area	2. Area (in percentage)	3. Weightage derived from % area	4. No.of watering by canal	5.Time saved(in hrs) 3 hrs/hectare 5=1*4*3hrs	6. Weighted time saved (in hrs) 6=5*3
Wheat	5.75	42	0.42	5	86.25	36.225
Mustard	3.25	24	0.24	4	39	9.36
Cotton	3.25	24	0.24	4	39	9.36
Castor	1.5	10	0.1	5	22.5	2.25
Grass	13.75					
Therefore time saved/ha as per the cropping pattern						57.195

Note: On discussion with the farmers 3hrs/ha was approximately the time saved on every watering.

Overall time saved in terms of ??? mandays and opportunity cost

Reach	Big	Small	Marginal	Total
Head	57	35	13	105
Middle	125	41	18.5	184.5
Tail	48	14	13	75
Total	230	90	44.5	364.5
Location	Opportunity cost Rs/hec			
	Big	Small	Marginal	Total
Head	2850	1750	650	5250
Middle	6250	2050	925	9225
Tail	2400	700	650	3750
Total	11500	4500	2225	18225
Therefore money saved/ha due to time saved 18225				

Note: Assuming the wage Rs 50/day

IV Sample of employment generation

Post PIM	1. Area (in Percentage)	2. Man days required for harvesting in 1 Ha	3. Weight-age (derived from 1)	4 == 2*3
Wheat	60	30.25	.60	18.15
Mustard	22	17.5	.22	3.85
Castor	10	47.5	.10	4.75
Cotton	5	95	.05	4.75
Fodder	3	0	.03	0
Water				
Logged	0	0	0	0
				31.50

Note : Fodder is harvested by the family members and usually no labour is hired for such purpose and hence 0 man-days have been used for it.

V Sample of the calculation for milk production and fodder

Pre PIM	1. Area (in Percentage)	2. Man days required for harvesting in 1 Ha	3. Weight-age (derived from 1)	4 == 2*3
Wheat	58	30.25	.58	17.54
Mustard	21	17.5	.21	3.67
Castor	9	47.5	.09	4.27
Cotton	4	95	.04	3.8
Fodder	3	0	.03	0
Water Logged	5	0	.05	0
				29.28

V Sample of calculation for milk and fodder production

Post PIM

Animal	No	1.Milk production	2. Wet	3. Dry	4. Cake	5. Prod/lit	6. Wet/unit	7. Dry/unit	8. Cake/unit
Cow	4	8700	7300	21900	5840	2175	1825	5475	1460
Buffalo	7	12060	14600	43800	17520	1722.857	2085.714	6257.143	2502.857
Bullock	6	0	13870	27010	0				
Other	3	0	3285	7300	0				
Total	20		39055	100010	23360	1948.929	1955.357	5866.071	1981.429

Note: Wet is the green fodder

Post PIM

Animal	No	1.Milk production	2. Wet	3. Dry	4. Cake	5. Prod/lit	6. Wet/unit	7. Dry/unit	8. Cake/unit
Cow	3	6000	5475	16425	4015	2000	1825	5475	1338.333
Buffalo	7	11520	12775	38325	7300	1645.714	1825	5475	1042.857
Bullock	6	0	13870	27740	0				
Other	2	1981.429	2190	4745	23360				
Total	18		34310	87235	34675	1822.857	1825	5475	1190.595

Note: Wet is the green fodder

Note: Post PIM per unit consumption of fodder (Wet, dry and cake) has increased and hence the milk production. Similarly calculation is done for each reach and L/H, and for all three ICs, Rangpur, Kiyadar and Thalota. Then the average of all the three is taken out to convert to the monetary benefit.

VI Cost of Cultivation of the Rabi crops

Crop	Wheat	Mustard	Castor	Cotton	Grass
Ploughing	800	800	800	1000	1200
Sowing	400	400	500	500	400
Seeds	1200	150	200	1800	750
Inter-culture	0	0	400	600	0
Urea	320	320	320	320	480
DAP	500	250	400	500	0
Bunding	100	80	100	100	90
Pesticides	200	200	100	200	0
Harvesting	500	400	500	600	400
Bundle making	0	0	0	0	50
Threshing	400	400	200	0	0
Carting	100	100	100	150	50
Weeding	300	200	100	100	0
Total	4820	3300	3720	5870	3420

Source: Group discussion

ABOUT DSC...

Development Support Centre (DSC) was established in 1994 in Ahmedabad under the leadership of Founder Chairman, a Retired IAS Officer Mr. Anil C Shah in response to the need felt, from various non-governmental organizations. The DSC provides support to NGOs, government agencies and other administrative bodies, which are involved in participatory management of natural resources in Gujarat. DSC's multi-disciplinary professional team helps in capacity building of key functionaries, performs hand holding operations in the field when required, takes initiatives for appropriate policy changes and carries out field studies related to policy issues.

DSC offers the following portfolio of services:

- Field Support Services
- Research and Monitoring Activities
- Training
- Policy Advocacy
- Communications and Publications
- Networking
- Field Units

DSC's main focus presently is on the following four programs;

Participatory Irrigation Management

DSC is playing pivotal role in promoting the PIM in Gujarat in close cooperation with the state irrigation department and strives to promote the program at state and national levels. The DSC directly implements the program in 66 villages in three projects covering 56,000 hectares of command area.

Watershed Development

DSC has made a significant contribution in the formulation of the National Watershed Development Guidelines and has sustained its involvement in the program. The emphasis is to ensure that the key functionaries appreciate and build necessary skills, attitudes and behaviour to translate the rhetoric of participation into practice.

Agricultural Productivity Enhancement and Improving Livelihoods

To enhance agricultural productivity and improve livelihoods, the DSC has promoted Sajjata Sangh, a network of NGOs, bringing together agricultural scientists; the NGOs and the farmers on a common platform so that the scientists understand the problems and the needs of the farmers, take them into account in their research. The farmers are provided with expert advice in turn.

Joint Forest Management

Gujarat was one of the first states in the country to introduce JFM. However, despite enabling policies and tentative initiatives of the state government, the program has not picked up the desired momentum. The DSC is striving to remedy the situation by advocating changes in the implementation of the program at state and national levels.