Irrigation is said to be the oldest applied science of the world. Man, since the time he began to settle life, used to tap water resources by bundhing the source of water stream. In India, historical records bear testimony to the existence of number of old works in different parts of the country. Expansion of irrigation from large as well as small projects is an essential condition for diversifying agriculture and increasing crop yield. It has been among the most significant field of development since the beginning of the First Plan. To be more precise, from 1st to 8th Five Year Plans of India and the State of Gujarat, prime importance is given to irrigation. Irrigation has a leading role in establishing new level of economic and social well being in the region and helps to rebuild agricultural economy and paves way for the rapidly increasing living standard of people in the region benefitted by it. River valley projects like D.V.C. Bhakra Nangal, Hirakund, Tungbhadra and Nagarjun Sagar
which had all programmes of development along with a leading role in increasing primary and secondary benefits to the region served by them.

The present study deals with the Mahi Right Bank Canal (MRBC) which is one of the major projects of the State. The analysis and evaluation done with cost benefit analysis will have its own importance while the financial analysis made on the project will help understand the financial return on the irrigation project in the state, the cost benefit study will provide guidance to the authority, the feasibility of the project in the State, where large section of population depends upon agriculture. An attempt has, therefore, been made in the present study to deal with the financial analysis and the cost benefit analysis keeping the above mentioned facts in mind.

OBJECTIVES OF THE STUDY:

The present study is based on three objectives. They are as follows:

(1) To find out the benefit cost ratio of the project with the help of direct primary benefits accruing to the society as well as the direct primary costs the society has to pay for it.

(2) To find out the indirect primary benefits and the indirect primary costs i.e., resultant advantages to the landless labourers and the artisans and increased generation of income of family labourers in the command area, and
(3) To trace out the economic impact of canal irrigation in the command area in terms of crop pattern, operational holdings, land utilisation pattern, infra-structural facilities etc.

HYPOTHESES:

(1) The project may be running in loss from financial point of view but may be beneficial to the farmers of the command area and thus be feasible from economic point of view.

(2) Irrigation facilities help change the crop pattern, land intensity, operation holdings etc., in favour of farmers of the command area. Due to such facilities direct effects on change in the crop pattern, production etc., subsequently lead to an increase in the income of farmers of the command area.

METHODOLOGY:

Two types of data have been used. They are primary and secondary. Secondary data have been collected from the District Census Hand Book, 1981, document of Five Year Plans of India and the State, the Mahi Circle Office, Nádiad, Division Office, Thasra, and the Bureau of Economics and Statistics of Gujarat, while primary data have collected through field work and personal meetings with the farmers.
Three out of the seven talukas of the Mahi Command Area have hundred per cent irrigation facility. They are Anand, Khambhat and Petlad. Thus, no comparison of 'With-Without' situation in these three talukas is possible. Also, the facility of well irrigation is significantly high in these talukas. They have, therefore, not been taken into account in the present study. In the rest of the talukas of the command area stratified purposive random sampling has been used for the selection of sample villages. The talukas which have been taken for the purpose of this study are Thasra, Nadiad, Matar and Borsad. From among these four talukas, twelve villages of the command area and eight villages from the controlled area have been randomly selected, from each taluka. The villages of the controlled area, which have more or less the same social condition and population as that of command area have been chosen. The only difference between the two areas, Command and Controlled, is that irrigation facility is available in the former and unavailable in the latter.

96 households from the command area and 64 households from the controlled area have been selected. The selection of households has been based on the size of land holdings. Eight households have been selected for detail investigation from each of the villages. Out of eight, 2 each belong to big, medium, small and marginal size group of holdings. The same procedure has been followed in the selection of households of controlled area. While selecting the households, both in
command and controlled area, stratified purposive random sampling has been used since well irrigation facilities are available in some areas of both the regions, and in order to avoid the household that have well irrigation facilities.

Landless labourers and Artisans have also been chosen in the present study to assess the indirect benefits of the project. In all 24 sample households each for landless labourers and Artisans have been taken for study purpose, from the command area. While 16 sample households each of landless labourers and Artisans have been chosen from the controlled area.

CHAPTER ANALYSIS:

Chapter I confines itself to pointing out the importance of the study and discusses the research design adopted in the pursuit of the study. A mention has also been made in this chapter about the relevant existing literature.

Chapter II discusses the theory of benefit cost analysis adopted in the present study. This chapter discusses various concepts and factors involved in the cost benefit in detail. Government policies of irrigation during different Five Year Plans of Gujarat and the Centre have been discussed in Chapter III which also evaluates the irrigation policies. Chapter IV has taken stock of general background of Kheda district and Mahi project so as to present a broader view of
Kheda and the project areas. This is done in order to understand the specificities of the concerned study within the given frame work. Chapter V is confined to financial analysis of the project where rate of return criterion is used. An attempt has also been made to analyse the indirect primary benefits of the project. The overall impact of irrigation project on farmers and village is the focus of attention in Chapter VI, whereas in Chapter VII the direct primary benefits and direct primary costs borne by the farmers during the year due to irrigation are analysed. Benefit-cost ratio has been obtained with the help of direct primary benefits and direct primary costs. Chapter VIII sums up the entire study and discusses the policy implications.

REVIEW OF LITERATURE:

In this section review is made on the related literature which is based on the cost benefit theory. In the literature of cost benefit analysis two types of situations are possible i.e., Ex-ante situation and Ex-post situation. First, an attempt is made to view the studies based on Ex-ante situation, followed by Ex-post situation.

EX-ANTE SITUATION:

Only recently in India, ex-ante criterion, for ascertaining the feasibility of irrigation, have been formulated by the Committee of Direction for Evaluation Studies on benefits of irrigation projects. This committee was sponsored by
Research Programme Committee of the Planning Commission, Government of India. The result of the two medium type of irrigation projects are as follows:

**TABLE 1.1**

<table>
<thead>
<tr>
<th>PROJECT</th>
<th>CAPITAL COST (crores)</th>
<th>B/C RATIO at 5% rate of interest</th>
<th>B/C RATIO at 10% rate of interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAR PROJECT</td>
<td>2.20</td>
<td>1.84</td>
<td>0.87</td>
</tr>
<tr>
<td>NAL GANGA</td>
<td>2.09</td>
<td>1.24</td>
<td>0.85</td>
</tr>
</tbody>
</table>

From the above table, it is clear that as the rate of interest increases, cost benefit ratio decreases. A 5% rate of interest is indicated as favourable rate of interest and with higher rate of interest (10%) the ratio is less than unity.

About two rates of interest i.e., 10% and 5%, no clarification has been made by the committee as to which rate of interest is to be considered for the final calculation. While calculating output, the committee has omitted the by-product of the main crops whereas irrigation commission II recommends to take by-product into account while calculating output.5

The committee has not taken into account indirect benefits and other regional benefits that might have been designed at the time of the formulation of the scheme.
The important work in this field was done by Sovani and Rath in their study "Economics of multi-purpose river dam" on Hirakund project. This is a multi-purpose project for irrigation, generation of hydro power, flood control, and navigation. This study deals with only irrigation and hydro power, separately. Benefits from navigation have not been calculated. Allocation of cost for each purpose has been added separately viz., Annual cost and associated cost. The former cost included interest on capital investment of the project and its break up into investment for irrigation and generation of hydro power according to financial allocation made by the Rath Committee. While allocating such cost, it is not clear whether cost allocation principle was adopted or not.

For irrigation and hydro-power different rates of interest have been taken. (Though no justification for adopting different rates of interest is given). The rate was 3.15% for irrigation and 4.25% for hydro-power.

In this study, cost of production has been worked out on an assumption that the per acre value of input material used in production, would remain constant, though with the provision of irrigation facility the per acre yield would go up. This assumption does not seem proper because as yield would go up, the value of input material used would also increase. Benefits arising out of the flood control as a result of completion of
above mentioned project, have been added to benefits from irrigation. For administrative reason no separate allocation of capital cost has been made for flood control. Benefits accruing from navigation have not been calculated in this study. On total benefits and total costs for all purpose, ratio of 1.20 has been worked out while ratio of 2.18 and 1.12 have been worked out for irrigation and hydro power respectively.

Only direct primary benefits and direct secondary benefits have been considered in the Hirakund project. In the case of irrigation, as direct primary benefits, only net increase in the output of agriculture has been taken into account and the direct secondary benefits have been considered only for value added to the proposed sugar factory in the region. In the study the indirect primary benefits and indirect secondary benefits have not been calculated and the cause of not calculating the benefits is lack of data availability as per Sovani and Rath.

Sardar Sarovar Project (SSP):

An appraisal of Sardar Sarovar project (Multi-purpose project) has been done by TCS for Narmada Planning Group. For the comparative analysis of the project, 1981-82 has been chosen as the reference year. A study has been made on direct and indirect benefits and costs, employment generation (i) during the construction and, (ii) after the completion of the project, and financial return with a view to giving better
justification of the project. In the calculation of costs, all the project related costs such as cost of submergence, rehabilitation, projective plantation, command area development, drainage and conjuctive use of ground water, repairing and maintenance and operating cost have been included. Similarly on benefits side those arising from irrigation, use of water for non-agricultural purpose and hydro power have been taken into account. All the above mentioned benefits and costs related to project are considered without any regard to the State boundaries and with the help of "With and Without" situation. The benefits and costs derived from the project have been used in calculation of B/C ratio of the project. Benefit - Cost Ratio has been carried out first by evaluating costs and benefits at market prices and then by valuing all the resources at economic prices. The latter B/C ratio is broadly based on Little and Mirless method which is 1.84 : 1 while B/C ratio, achieved through Market price is 1.39 : 1. Along with B/C ratio, financial analysis of the project has also been done. In the financial analysis internal rate of return of the project is calculated to be as high as 18.30 per cent and when additional feature of Saurashtra Link Canal (SLC) and Lower Level Canal (LLC) is taken into account, the rate is 22 per cent. The SSP's life is expected to be 51 years and 12 per cent rate of discount is taken into consideration.

It will be useful to note here that project points out to be quite beneficial even if all calculations are based on market prices. Thus, one can say from the above analysis that
the proposed project is economically viable. Intangible benefits of the projects, that cannot be fixed into monetary terms, have been studied separately to prove the importance of the project especially for Gujarat - where scarcity of natural resources exist.

EX-POST STUDY:

The Research Programme Committee of Planning Commission sponsored a series of studies to workout the benefits and costs of number of projects spreaded all over the country. Most of these studies done by Planning Commission are on Ex-post basis. Since our study is also based on this criterion the review of Ex-post evaluation is of added importance. In the following paragraphs, a brief review is attempted on six irrigation projects which are reported in the report entitled "Criteria for appraising the feasibility of irrigation project." The list of R.P.C. studies which reviewed here, are as follows:

<table>
<thead>
<tr>
<th>Name of the Projects</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarda Canal</td>
<td>Uttar Pradesh</td>
</tr>
<tr>
<td>Ganga Canal</td>
<td>Rajasthan</td>
</tr>
<tr>
<td>Tribeni Canal</td>
<td>Bihar</td>
</tr>
<tr>
<td>Damodar Canal</td>
<td>Orissa</td>
</tr>
<tr>
<td>Caveri Mattur</td>
<td>Madras (Tamil Nadu)</td>
</tr>
<tr>
<td>Nizam Sagar</td>
<td>Andhra Pradesh</td>
</tr>
</tbody>
</table>

Nizam Sagar study does not provide comparative data. Evaluation of project has been attempted twenty years (or more) after the completion of the project. The reference period for
all the studies was 1958-59, in the case of Damodar Canal the reference period was 1959. For evaluation and assessment of all the projects, single year has been taken into account. The annual benefit cost ratio have been calculated in respect of all the studies. There is a possibility of over estimation or under estimation of cost since single year has been taken into account for all the studies.

Another limitation of these studies is that, in most of the cases definition of costs and benefits have not been stated clearly. They have also not followed uniform definition. For example, in the case of Sarda Canal, increased agricultural production, increase in employment, fillip to economic activities and increase in income from non-farm production are treated as indirect secondary benefits. In the case of Tribeni Canal benefit accruing from agricultural production was calculated as follows. Under the head of direct benefits of irrigation, net farm income from livestock produce, return from human labour and appreciation of value of land have been studied. While for indirect benefits, effect on agricultural labour, rural industries, transport, urban development and urban industries, have been taken into consideration.

In the study of Damodar Canal, direct primary benefits were limited to increased production of Aman Paddy, which offers employment opportunities and expansion of trade due to increased agricultural production. The development of processing industries and increase in trade due to processing
of paddy have been taken as direct secondary benefits. In indirect secondary benefits rise in income of workers engaged in industry and trades and increase in economic activity due to additional amount spent by these workers have been taken into consideration. It is clear from above examples, that benefits have become less specific in the methodology of R.P.C. studies.

Calculation of Cost Benefit Ratio:

Among all these studies, calculation of benefit cost ratio has been made only in three studies. These ratios are presented in Table No. 1.2.

In the case of Sarda Canal benefit cost ratio was calculated on total command area of 1930 (on irrigable area instead of irrigated area). According to Sovani, taking total command area for calculating benefit-cost ratio is not correct, because it is quite clear from all available technical and other informations in the report itself that area commanded by canal will never be irrigated. Even estimation of irrigable area will be wrong because of technical drawbacks which have been noted in Chapter III of the report. Sovani has suggested that "we can, therefore, only take the largest area irrigated on an average during a quinquennium as the basis for such calculation. Three benefit cost ratios are calculated 2.67 on the basis of actual outlay, 2.03 on the basis of repayment (3 times of actual outlay) and 1.09. Economic life of the project is more than usually stated in the literature. The
### TABLE: 1.2
BENEFIT-COST RATIO OF DIFFERENT PROJECTS REVIEWED HERE

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of the Project</th>
<th>B/C Ratio</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Sarda Canal Project</td>
<td>2.67</td>
<td>On the basis of actual outlay.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.03</td>
<td>On the basis of repayment. (3 times of actual outlay).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.09</td>
<td>Calculated by Sovani N.V. on actual. (outlay).</td>
</tr>
<tr>
<td>B.</td>
<td>Damodar Project(Old)</td>
<td>3.98</td>
<td>Calculated on the basis of total capital outlay including accumulated interest.</td>
</tr>
<tr>
<td></td>
<td>(New)</td>
<td>1.36</td>
<td>-do-</td>
</tr>
<tr>
<td>C.</td>
<td>Caveri Mattur</td>
<td>1.77</td>
<td>Calculated on the basis of annualities (Average annual benefit have been derived by annualities for amortisation and sinking fund).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.63</td>
<td>Calculated on the formula suggested by Kambhu M.E. [ B / \left(1+P+D\right) ]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>( B = ) Benefit, ( i = ) Interest, ( P = ) Capital, ( D = ) Depreciation</td>
</tr>
<tr>
<td>D.</td>
<td>Ganga Canal</td>
<td>1.40</td>
<td>On the basis of Bureau of reclamation in USA.</td>
</tr>
</tbody>
</table>

**REFERENCE:**

   (2) Sovani N.V. p. 61.
D. R.P.C. p. 113.
rate of interest has been estimated lower than usually suggested. Author has not given reason for accepting lower interest rate and higher economic life of the project. Benefit cost ratio of the Sarda Canal would be lower if the rate of interest and rate of depreciation have been taken higher than it is adopted in the study.

For Damodar Canal, interest has been calculated on total capital outlay including accumulative interest and economic life estimated is less than that in other projects. In this case, benefit-cost ratio of project may be overestimated or underestimated. In the case of Damodar Canal, rate of interest and the rate of depreciation have been given combined. No economic reason for adopting combined rate of interest and rate of depreciation have been given by the author.¹³

In the Caveri Mattur Project direct primary benefit and cost estimation have been derived by two different approaches i.e., (I) Average annual benefits have been divided by annualities for amortisation of sinking funds. Annualities are calculated for remaining period of 21 years so that they fully meet the amortisation charges and help in building up sinking fund equal to "sum at charges" at the end of 21st year. Economic life is assumed to be only 30 years of this project, 3 years have been left out as they are likely to be period of low yielding. Operational and maintenance cost have not been taken into account in this study and (iii) Second
method is as below:

\[
\text{B/C ratio} = \frac{B}{I + P + d}
\]

\[
\text{B/C ratio} = \text{Annual benefit} - \text{Cost ratio}
\]

\[
C = \text{Cost of project}
\]

\[
i = \text{interest in percentage of capital}
\]

\[
I = \text{Capital}
\]

\[
P = \text{Cost of maintenance and operation}
\]

\[
D = \text{Depreciation } \left( \frac{1}{1 + \frac{i}{1}} \right) ^{n-1}
\]

**OTHER EX-POST STUDY:**

**Dantiwada Project:**

In the case of Dantiwada Project, 1979-80 is taken as base year for calculation of cost benefit ratio. To find out cost-benefit ratio 3 different rates of interest have been chosen. They are 6%, 9% and 12%. While 70 years and 100 years have been taken as the project life. The benefit-cost ratio has been calculated with actual irrigated area of 1979-80 which is the reference year of the study. A total sum of Rs. 303.94 lakh has been taken as direct benefits from the project; of which 269.60 lakh were direct benefits accrued due to irrigation and 31.09 lakh from additional income from employment generation, and Rs. 2.00 lakh income from increased marketing work. All the above mentioned benefits have been taken into account for calculating benefit-cost ratio.
### TABLE: 1.3

**BENEFIT-COST RATIO OF DANTIWADA PROJECT**

<table>
<thead>
<tr>
<th>Particulars</th>
<th>B/C Ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td>B/C Ratio by considering depreciation at 1% and interest</td>
<td></td>
</tr>
<tr>
<td>6%</td>
<td>2.97</td>
</tr>
<tr>
<td>9%</td>
<td>2.25</td>
</tr>
<tr>
<td>12%</td>
<td>1.80</td>
</tr>
<tr>
<td>B/C Ratio by considering the depreciation at 1.43% and interest</td>
<td></td>
</tr>
<tr>
<td>6%</td>
<td>2.84</td>
</tr>
<tr>
<td>9%</td>
<td>2.18</td>
</tr>
<tr>
<td>12%</td>
<td>1.15</td>
</tr>
<tr>
<td>B/C Ratio for reference period 1979-80 with 1964-65 prices and depreciation 1% and interest</td>
<td></td>
</tr>
<tr>
<td>6%</td>
<td>1.65</td>
</tr>
<tr>
<td>9%</td>
<td>1.25</td>
</tr>
<tr>
<td>12%</td>
<td>0.95</td>
</tr>
<tr>
<td>B/C Ratio by considering Depreciation 1.43% and interest</td>
<td></td>
</tr>
<tr>
<td>6%</td>
<td>1.65</td>
</tr>
<tr>
<td>9%</td>
<td>1.16</td>
</tr>
<tr>
<td>12%</td>
<td>0.94</td>
</tr>
</tbody>
</table>
While calculating the direct effects of project, other than net increase in farm output, changes in operational holding, cropping pattern and employment opportunities have been considered. For indirect effects, family size, proportion of workers to total population, level and spread of education have been taken into account. Environmental effects like water logging, water table, moisture in soil, temperature and infra-structural changes have been considered.

**West Banas Project:**

West Banas Project\(^{15}\) is a single purpose project. The reference year of the project is 1968-69. Annual benefit-cost ratio has been calculated with direct primary benefits and direct primary costs on the line of the Research Programme Committee. Direct and indirect effects of primary, secondary and tertiary benefits and costs have been taken into account, but for the calculation of cost-benefit ratio, direct primary benefits and costs have been considered. This ratio is calculated on actual irrigated area of the study year and also with potential created area in order to show the likely benefit cost ratio the project will show when full potential utilised. The cost-benefit ratio of West Banas Project with actual irrigated area is 2.70 : 1 and with potential created is 4.02 : 1. Apart from primary, secondary and tertiary benefits, other direct effects also take place in the command area due to irrigation. These effects are changes in work force, occupational structure, occupational distribution, land
utilisation pattern, change in land holdings, tenancy, cropping pattern etc. The project life has been assumed to be 75 years and 4.5% of interest has been considered. The cost benefit study attempted on West Banas project is one of the important work in the field of irrigation study by Charan in his unpublished Ph.D. Thesis: "An economic evaluation of West Banas Project."

Auranga Reservoir Project:

In the case of Auranga Reservoir Project authors have put stress on detail social benefit cost analysis of an individual project. The benefit-cost analysis of the project is based on the valuation of benefits and costs at (1) Market prices, and (2) Economic prices. However, only economic prices for all the resources have been taken into account, to obtain B/C ratio of the project. The various B/C ratios obtained with economic prices are given below:

TABLE: 1.4

<table>
<thead>
<tr>
<th>Particulars</th>
<th>B/C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without premium on saving and without income distribution weight</td>
<td>3.29</td>
</tr>
<tr>
<td>With premium on saving and without income distribution weight</td>
<td>2.33</td>
</tr>
<tr>
<td>With adjustment for saving benefit and income distribution weight</td>
<td>2.51</td>
</tr>
<tr>
<td>B/C ratio at shadow prices with delay in construction by three years</td>
<td>2.03</td>
</tr>
<tr>
<td>B/C ratio at shadow prices with faster irrigation development in 5 years</td>
<td>2.90</td>
</tr>
</tbody>
</table>
The above mentioned B/C ratios have been estimated under 'With and Without' condition and discounted benefit and cost stream over a period of economic life of the Project. Economic life of the project has been estimated to be 52 years for discounting the stream of benefits and costs and social rate of discount has been taken 10 per cent. However, no justification has been made for using 52 years project life and 10 per cent rate of discount in the calculation of B/C ratio, also it doesn't provide a guideline whether which ratio is believed for the final conclusion. The study has also presented an economic appraisal of various technical alternatives relating to: (1) the size of dam, (2) extensive V/s intensive irrigation, (3) crop pattern and (4) lining of main canal etc. Authors have also discussed the various approaches of cost benefit analysis and used the L.M. Methodology on Auranga Reservoir project.

Bhadar Project:

In the case of Bhadar Project, direct and indirect effects have been clearly enumerated and stated. For the calculation of direct and indirect effects "with and without" and 'before and after' situations are analysed. While measuring income impact of the project a separate seasonwise analysis in respect of irrigated and unirrigated agriculture has been attempted, and seasonwise estimation of net income arising out of irrigation has been obtained. An attempt has also been made in the study to do the analysis of income impact and other
direct effects of the Bhadar Project in respect of the social impact of the command area. Besides, additional employment generation arising due to irrigation has been worked out for each season. Along with this, economical, social, political, environmental effects and water use practice have been derived.

For the calculation of all the benefits and costs, 1986-87 agricultural year is chosen as reference year. In the calculation of B/C ratio two rates of interest (6\% and 9\%) and two economic life of the project (75 years and 100 years) have been taken into consideration, and no clear explanation for taking the two rates of interest and two economic life of project has been given and also it is not clear which ratio should be considered for final conclusion.

B/C ratio calculated with different rate of interest and project life is as follow:

<table>
<thead>
<tr>
<th>Particulars</th>
<th>B/C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>By considering depreciation 1%</td>
<td></td>
</tr>
<tr>
<td>and interest at 6%</td>
<td>1.01</td>
</tr>
<tr>
<td>and 9%</td>
<td>0.75</td>
</tr>
<tr>
<td>By considering depreciation 1.43%</td>
<td></td>
</tr>
<tr>
<td>and interest at 6%</td>
<td>0.92</td>
</tr>
<tr>
<td>and 9%</td>
<td>0.73</td>
</tr>
<tr>
<td>B/C ratio put forth by project authority</td>
<td>0.98</td>
</tr>
</tbody>
</table>
It is clear from above table that B/C ratio is less than unity in all except at 6% rate of interest and 100 years project life have been taken into account. It is also to be noted here that calculated B/C ratio is less than expected by the project authority. However, project is situated in drought prone area, tribal area and semi arid area of the Gujarat and the study also made only after two years of project working in the command area, it will be hopeful to believe that after maturity period the project would provide all economic benefits which have been expected by project authority.

Rajasthan Canal Project:

The research on RCP is attempted on more than one factor. The study pertains to B/C ratio and utilisation of capacity with regard to the field channels but it does not provide an integrated attempt on cost benefit estimation. Only some piecemeal aspects such as the construction of field channels, and labour V/s capital intensity in the construction of canals have been examined. Some direct effects of irrigation have also been examined. They are, change in crop pattern, change in agricultural practice, use of chemical, fertiliser and improved variety of seeds. The other important aspects examined in the study are, use of higher inputs, higher labour in irrigated area, effects of improved crop pattern and agricultural practice and net return from agriculture. Along with economical effects, useful factors like socio-environmental and political effects and demographic effects of the RCP have
also been studied. For all these studies 'with and without' situation has been used keeping 1978-79 as reference year.

**Tungbhadra Project:**

The study of Tungbhadra irrigation project is an ex-post assessment of economic benefits of irrigation of left Bank Canal in Raichur district. The study has been done with different size groups of holding with particular emphasis on crop pattern, input use, production and productivity. While studying the above aspects the analysis has been compared with controlled area and with-without situation is used. Reference year of the study is, agricultural year of 1982-83. Some direct impacts have been also analysed in the study. They are, land utilisation pattern, cropping practice in different seasons, input utilisation in command area due to irrigation, replacement of traditional varieties of crop by the new varieties recommended and actual dosages of seeds and fertilizer, labour used, crop yields per hectare etc. For the analysis of the above mentioned aspects four out of six talukas have been selected and 10 villages each from command and controlled areas have been chosen. Besides above mentioned economic effects attempts have been also made in the study to throw lights on cost benefit analysis. B/C ratios have been calculated in terms of: (i) total cost, and for individual crops, (ii) total cost for kharif and rabi season separately, and (iii) total irrigable area for kharif and rabi crops. However,
the main focus of the study was the direct effects of the project in the command area rather than that of cost benefit analysis of the project.

Mulla Irrigation Project:

The study of Mulla Irrigation Project\textsuperscript{20} is undertaken by Ashok Mitra. For the purpose of study, benefits and costs were derived by field work. On the cost side administrative cost and additional input costs have been taken into account. Interest charges have been calculated at 2 per cent and depreciation has been calculated at 2 per cent assuming the project life as 50 years. However, as part of annual project cost, M & O cost, interest charges, and depreciation have not taken into account but 'capital recovery factor'\textsuperscript{21} was used for arriving at annual project cost. Similarly on benefit side increased agricultural production due to irrigation has been considered. These benefits and costs have been used to derive B/C ratio of the project and average annual B/C ratio have been calculated to find out the feasibility of the irrigation project. Two types of B/C ratio were obtained in the study: (1) 1.14 on the basis of actual crop pattern. For the calculation of this B/C ratio actual gross irrigated hectares have been taken into account. (2) Using second method B/C ratio calculated was 2.15 which is possible only if the crop pattern suggested in 1977 project report (with some modification as suggested by author with fieldwork) is followed. Gross irrigable hectares have been used for this B/C ratio, which was planned to be irrigated according to the project report.
Along with cost-benefit ratio, proposed crop pattern, actual crop pattern that has taken place with the introduction of irrigation, and mixed crop have been analysed. Under utilisation of potential created, cause of under-utilisation, and actual use of water, water utilisation pattern and management system have been studied in detail. However, B/C ratio is given less importance and more focus was laid on the above mentioned aspects.

Alexander in his study which was conducted in a comparative framework of both irrigated and non-irrigated part of Ganganagar district of Rajasthan, observed that economically, irrigation facilitated intensification of agricultural activity through larger use of labour, fertiliser, insecticides and other inputs, enabled farmers to use improved tools and machines, led to increase in the amount of per hectare production and productivity and gross income, enhance amount of saving etc. Socially it has resulted in change in religious beliefs. Further, there is also sharp differences in the incidence of sickness and mortality rates in the irrigated and non-irrigated area. Besides, it has paved the way for modernisation of occupational values and their specialisation. For this study, author has collected the data by interviewing 900 respondents from different Tehsil of U.P., 600 respondents from irrigated area (Ganganagar) Karanpur, Padampur Tehsil and 300 respondents from non-irrigated area (Naubar and Bhadra Tehsils).
OTHER WORK ON MAHI PROJECT:

'An economic profile of Mahi Kadana Project' has been undertaken by Agro Economic Research Centre, Vidyanagar. The study highlights two aspects: (1) It provides economic profile of the selected region and contains a fairly comprehensive review of the Agricultural support programme envisaged for this project. (2) It also contains the benchmark data relating to the broad socio-economic condition prevailing in the region at the time of survey.

Some of the important conclusions which have been derived by the study may be mentioned here: (i) There are certain basic issues concerned with availability of canal irrigation in the command area. The construction of cheap and durable field channels and their maintenance are very necessary in order to secure an adequate and timely flow of water. The existing system of water management has also been analysed and farmers' opinion about water rates and present water management system have been gathered. Besides, social condition, demographic features and direct effects of the irrigation facility have been analysed. For the study 1973-74 agricultural year was selected.

Another important work for the Mahi Kadana was done by A.S. Patel and Brahmbhatt D.M. which is entitled as 'Action Research Programme on Interim Evaluation'. The
Study was to evaluate the performance of the pilot project, which was initiated by WALMI in 1984-85. This study is basically a baseline socio-economic survey with a reference year 1989-90.

One more study was done by Himmat Patel in 1990. This study aims at examining various aspects of financial working of the four major projects of Gujarat. Apart from Mahi project, Dantiwada project, Kakrapar project, and Shetrunji project were studied. The study also attempted to examine various aspects of revenue and operating and maintenance expenses of the four projects. A review and suggestion were made to improve the financial working of the projects. This study reviewed that in Gujarat major projects are running in loss and they hardly earn enough to cover M & O charges of the projects when interest charges and depreciation are taken into account project sustain heavy loss.

**METHOD FOLLOWED IN THE PRESENT STUDY:**

Only direct and indirect primary benefits are calculated in the present study. For this calculation definition followed is taken from the book called "GREEN BOOK" for most of the present studies.

**Direct Primary Benefit:**

An increase in net agricultural output of a farmer due to irrigation.
Direct Primary Cost and Associated Cost:

Cost incurred by a farmer to make immediate product or service changes of project.

Indirect Primary Benefit:

Increased employment opportunity at farm level both for family members and for landless labourers have been treated as indirect primary benefits.

In the present study rate of interest is taken as 4.5% and calculated on the original capital outlay of the project. Project life is assumed to be 50 years and depreciation is calculated at 2% with straight line method. This rate of interest and depreciation on project life are taken from the Mahi Irrigation Circle Office, Nadiad. The above rate of interest and depreciation was accepted by the office when it calculated financial performance of MRBC Project.

Comparison of the study is attempted on "WITH" and "WITHOUT" project situation since data regarding "BEFORE" project was not available, "BEFORE" and "AFTER" project situation is not taken into account. Thus calculation of benefit-cost ratio is done on the line of Research Programme Committee Planning Commission. Two types of benefit-cost ratio have been calculated. They are:

(1) With actual irrigated area,
(2) With potential created area for the reference period of 1988-89.
The present study is an ex-post situation and only direct primary benefits and costs are taken for the calculating B/C ratio.

NOTES AND REFERENCES

1. Dr. Anjeneya G. Agricultural Entrepreneurship in India. Ghush Publication, Allahabad, India, 1988, p. 44.

2. For detail see Chapter III. Intensive study is done on the development policy of Five Year Plans of Centre and the State.

3. Finding of following authors have also shown this:

4. For detail please see bibliography cited at the end of the thesis.

5. Farm business data, appropriate allowance can be made about fodder produced in a way similar to the adopted to estimate as dung receipt. There is another way. fodder expense from input side can be omitted with the assumption that these products are exclusively used by the farmers as cattle feed for own animal.

7. Because of canal irrigation per acre yield would go up and due to change in crop pattern, use of high yielding varieties, use of fertilizer etc., per acre input would also go up. Study up till done by with - without situation shows that, in the command area over controlled area. See bibliography cited at the end of the study.


13. It was calculated from the table that depreciation was 5.5 per cent and interest was 4.5 per cent.


17. Patel A.S. Socio-economic Evaluation of an Irrigation Project (P), Gujarat, Dept. of Economics, S.P. Univ. V.V.Nagar (Mimeo), 1990.


21. In capital recovery factor is the annual payment that will repay Rs.01 loan in X year with compound interest on the unpaid balance. Ibid, see 405-406.


