As is clear from the previous chapter that in most of the cases, the benefit cost analysis has been used in the form of ex-ante analysis. The methodology adopted for ex-ante calculations has already been discussed in a previous chapter. In short, in the case of irrigation project for such calculations information is needed on the area irrigated, crop pattern before and after irrigation, yield of crops, intensity of irrigation, output and inputs, of agriculture etc. Besides, proper assumption about the life of the project, depreciation rate, interest rate, constructional, operational and maintenance charges, etc., have to be made.

Ex-Ante Examination:

In India, only recently ex-ante criteria for ascertaining the feasibility of irrigation projects have been formulated by the Committee of Directions for Evaluation Studies on Benefits of Irrigation Projects, sponsored by Research Programme Committee of Planning Commission, Government of India. In this case also, efforts have been confined to the measurement of primary direct benefits and costs. The results of the benefit cost calculations applied to two medium type of irrigation projects are given below.1

1 R.P.C. op.cit. p. 65.
Benefit Cost Ratios of Bor and Nal Ganga Projects

<table>
<thead>
<tr>
<th>Project</th>
<th>Capital cost (Rs.) in crores</th>
<th>Benefit cost ratio at 10% rest charge</th>
<th>Benefit cost ratio at 5% interest rest charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bor 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>0.75</td>
</tr>
</tbody>
</table>

It appears from the table that at the rate of 5% interest rate (which is taken as the productivity rate) favourable benefit cost ratio is indicated, while with the adoption of higher interest rate (which is nearer to the private interest rate) the ratio is less than unity. It is not made clear in the analysis as to which rate is considered appropriate for arriving at the final decision. Moreover, assumptions made about outputs also need to be revised.

Similarly, the Committee has not taken into account the indirect benefits and other important regional advantages that the scheme might be designed to promote.

---

2 For example, by-products of main crops have been omitted from calculation by the Committee. With the help of farm business data, appropriate allowance can be made about fodder produced in a way similar to that adopted to estimate as dung receipts. There is another way out, namely, fodder expenses from input side can be omitted with the assumption that these by-products are exclusively used by the farmer as cattle feed for own animals.
For this, they have stated that "to bring together some information regarding the selected projects has, however, demonstrated the difficulty in gathering even such data as should be available relatively easily in project statements, and other official records. Even with these limitations the criteria formulated by them can serve the purpose of project selection in the absence of availability of more detailed information. Such benefit cost criterion is superior to the financial criterion."

**Bhakra Nangal Study:**

In India two major projects have been appraised when they were nearing completion. Prof. Raj in his study, which in his own view, is "very general and explorative" in nature, appraised some economic aspects of the Bhakra Nangal Project. As the project is highly capital intensive, the norms applied in this study may not be very useful for the medium or minor schemes. However, the theoretical framework provided by Raj is quite relevant for a developing country like India.

---

3 R.P.C. *op.cit.*, p. 65
4 Baljitsingh and Mishra also concluded that both financial and economic feasibilities should be taken into account before a project is selected for execution and when two are in conflict it may be desirable to give the greater weightage to the latter, See, Baljit Singh and S. Mishra, *op.cit.*, p. 152.
The other important study in this field is Sovani and Rath's study of Hirkud Dam. Hirkud dam is a multipurpose project (for irrigation, generation of power, flood control, and navigation). The Sovani and Rath study deals with irrigation and hydro-power aspects separately. The benefits arising out of flood prevention as a result of completion of project have been added to irrigation. Since administratively no separate allocation has been made in the project costs for the flood control. Navigation benefits have not been measured at all. Aggregating the total benefits and costs for all purposes a ratio of 1:20 : 1.00 has been worked out while the ratios of 2.18 : 1.00 and 1.12 : 1.00 have been given for the irrigation and hydro-power parts respectively.

The allocation of costs for each purpose has been done separately and two distinct costs viz., the annual cost of the project (which includes 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) and the associated costs. It has not been made explicit whether the cost allocation principles have been taken into account while making such allocations. The different rates of

---

6 Singh and Mishra, S. op. cit., p. 4.
interest have been taken for allocated investment for irrigation (3.75%) and for hydel-power (4.25%), though no economic justification has been given for these differential rates.

In calculating the benefits, no attempt has been made to measure benefits beyond the secondary degree. For this, it has been pointed out that calculations have been done for a period of 10 years after the project. In this respect it may be pointed out that tertiary and further range of benefits may not begin within 10 years. However, these benefits arise before 25 years (which has been assumed to be the maturity period) are completed. No attempt has been made about long run projection of the benefits of maturity.

In reality, only direct primary benefits have been calculated in both the cases. In the case of irrigation, these benefits are net increase in agricultural production. Indirect secondary benefits have not been calculated as data was not available. The secondary direct benefits have been considered only for the value added to the proposed sugar factory. The indirect secondary benefits have also been left out, although they have been enumerated. Tertiary benefits, whether direct or indirect, have not been calculated. For calculating the value of additional crop production due to irrigation, farm business surveys
were conducted in the project area and also in certain places of known concentration of irrigation. The results of survey of crop patterns and rotations in existing irrigated area have been used to project the crop pattern of the canal area for next ten years. Assumption underlying such calculation i.e., use of constant price (prevailing in the year of inquiry) for valuation of likely annual agricultural output, assumption of constant cost of production per acre, etc., rather over simplify the issues. However, this study was the pioneering study of its kind and has provided a base for further inquiry. 7

Ex-Post Studies:

The most widely used form of benefit cost analysis in this country is, however, ex-post one. For this type of analysis two approaches have been suggested. One way is that if the data pertaining to the economic conditions before irrigation was introduced are available, these data can be compared with the effects which have resulted after the introduction of the irrigation in that area. However, one has to be very cautious while comparing 'before' and 'after' situations, since it is very essential to make appropriate allowance for likely economic changes, especially the technological and the institutional changes, in the intervening period. Generally, in a developing country like India it is very difficult

7 In fact, this study has provided base for studies done under R.P.C.
to get adequate data to satisfy the above mentioned conditions. Therefore, second type of approach has been accepted for project evaluation. This approach may be termed as 'with' and 'without' analysis. It involves making a comparative study of the command and non-command areas which are having identical economic conditions, except the availability of irrigation water.

R.P.C. Studies:

The Research Programme Committee of the Planning Commission sponsored a series of studies to work out, on ex-post basis, the benefits and costs of a number of projects spread all over the country. In the following paragraphs brief comments will be made on six projects taken up for such study. These are:

1. Sarda Canal (Uttar Pradesh)
2. Garg Canal (Rajasthan)
3. Tribeni Canal (Bihar)
4. Damodar Canal (Orissa)
5. Cauvery Mettur Project (Madras)
6. Nizam Sagar Project (Andhra Pradesh)

Of the above studies, Nizam Sagar study did not provide comparative data. The findings and conclusions of these

8 Tolani, N.P., op.cit., p. 2.
studies have been studied by the Committee of Direction for Evaluation Studies on Benefits of Irrigation Projects and are reported in the report entitled "Criteria for Appraising the Feasibility of Irrigation Project".

Evaluation of all these projects has been attempted after 20 years or more. The reference year for these studies was the agricultural year (July-June) 1958-59, except in respect of Damodar Canal project where the data related to the calendar year 1959. In all the studies single year has been kept in view for the assessment of annual benefits and costs. The limitation of having this single year study period is that there is possibility of under-estimating or over-estimating benefits, as it has actually happened in some of these studies.

Another limitation of these studies is that they have not followed uniform definitions of benefits accruing from an irrigation project. In fact, in most of the

9 It has been stated in R.P.C. study that in the case of Mann Gang canal, in the year of enquiry there was marked favourable September rains which led to an unusual increase in the acreage under rabi crop. This improved the performance of non-irrigated area as compared to irrigated area. Further, the cotton crop in the irrigated area suffered substantial damage, Conclusions drawn from data for the year of enquiry, are, therefore, subject to the limitation that they underestimate the magnitude of benefits from irrigation. In the case of Cavery-Mettur Project the fact has been brought to the notice that in the year of enquiry, there was crop failure in the non-command zone and this has widened the gap in output in favour of the irrigated area. The year of enquiry was good in the case of Tribal canal area, and the figures naturally reflected over estimation. See, R.P.C. op.cit., pp. 8-12.

10 This may be because directors of the Institutions to whom these studies were sponsored were not asked to do it in particular form; it was left to them to decide about the methodology and content.
studies these definitions have not been stated clearly. For example, in the case of Tribeni Canal Study, benefits accruing from agricultural production (which includes net farm output, income from livestock, returns from human labour in farm business, appreciation of the value of land etc.) have been studied under the head of direct benefits of irrigation, while effects on agricultural labour, rural industries, transport, urban development and urban industries have been treated as indirect benefits\(^\text{11}\). In the Sarda Canal Study in the chapter 'Origin and Scope' it has been stated that a decision has to be taken about the exact benefits that are to be considered as direct and primary benefits such as increased agricultural production. Increase in employment filip to economic activities and, increase in income from non-farm population are treated as indirect, secondary benefits\(^\text{12}\). Similarly, in the case of Damodar canal study, direct primary benefits have been limited to increased production of Aman paddy only which is the major crop in the region. Increase in employment opportunities and expansion of trade because of increased

\(^{11}\) Jha Divakar, *Evaluation of Benefits of Irrigation* 

\(^{12}\) Singh, B. & Mishra, S. *op.cit.*, pp. 18-19.
production have been treated as indirect primary benefits. The development of processing industries and increase in the trade of processed paddy have been taken as direct secondary benefits. Rise in the income of workers engaged in these industries and trade and the increase in economic activities because of the additional amount spread by these workers have been dealt with under indirect secondary benefits. It is clear from these various explanations that at every stage the benefits become more diffused and less specific.

Coming to the methodology adopted in these studies, while calculating associated costs (input costs) farm management concepts of cost (cost A, B, C) have been used which involve imputation of value on many items. But for all practical purposes, it is the estimation of the paid out cost which has been taken into final calculations. To include in these items the imputed value of family labour is not appropriate since there is sizeable degree of underemployment of labour. Therefore, the impact of the projects on the employment generation should be studied separately under the heading of indirect primary benefits.

It has been found in these studies that estimation of the secondary and tertiary benefits is a much more complicated. They, however, have made no attempt from

\[13 \text{ R.P.C.}^\dagger \text{ op.cit., p. 7.}\]
the data gathered to build up overall values or figures of the benefits or to establish direct relationship between the primary effects of irrigation and those which are extended in sequence and space. The quantification of secondary benefits was rendered difficult also by the very nature of the benefits; the benefits are complementary in nature, i.e. benefits of irrigation cannot be isolated easily from the effects of other factors influencing development in a given area. It has also not been possible to evaluate the adverse effects arising from irrigation as social cost.

The Benefit Cost Calculation:

Among all these studies, calculation regarding benefit cost ratios have been attempted only in three studies. These ratios have been given in the adjoining table. (See Table No.III-1).

The authors of Sarda Canal, instead of calculating the benefit cost ratio with reference to the actually irrigated area, or even estimated irrigable area, have calculated it with reference to total area commanded by the Sarda Canal system in 1930. This is not correct, as pointed out by Sovani, because it is quite clear from all available technical and other information in the report itself that total area commanded by the canal will never be
<table>
<thead>
<tr>
<th>Name of the Project</th>
<th>Benefit Cost Ratio</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarda Canal Project</td>
<td>(i) 2.67:1 *</td>
<td>Calculated in the study of the basis of actual outlay.</td>
</tr>
<tr>
<td></td>
<td>(ii) 2.03:1 *</td>
<td>Calculated in the study on the basis of repayment (three times of actual outlay)</td>
</tr>
<tr>
<td></td>
<td>(iii) 1.09:1 **</td>
<td>Calculated by Sovani N.V. on actual outlay.</td>
</tr>
<tr>
<td>Damodar Canal Project (Old)</td>
<td>3.98:1 ***</td>
<td>Calculated on the basis of total capital outlay including accumulated interest.</td>
</tr>
<tr>
<td>Damodar Canal Project (New)</td>
<td>1.36:1 ***</td>
<td>-do-</td>
</tr>
<tr>
<td>Cavery-Mettur Project</td>
<td>(i) 1.77:1 ****</td>
<td>Calculated on the basis of annuities (average annual benefits have been divided by annuities for amortisation and sinking fund).</td>
</tr>
<tr>
<td></td>
<td>(ii) 2.63:1 ****</td>
<td>Calculated on the basis of formula suggested by Kambhu, M.L. ( \frac{B}{(I + P + D)} ) where ( B ) stands for Benefit, ( i ) for interest, ( P ) for percentage of capital, and ( D ) for depreciation.</td>
</tr>
<tr>
<td>Gang Canal</td>
<td>1.4:1 ****</td>
<td>Calculated on the basis of method followed by Bureau of Reclamation in U.S.A.</td>
</tr>
</tbody>
</table>

wholly irrigated. Even estimates for irrigable area will be wrong because of various technical drawbacks which have been noted in Chapter VII 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 calculations. As can be easily seen the benefit cost ratio drops in the more realistic calculation to just 1.09 from 2.51 arrived at by the authors". Sovani keeping these points in view has calculated the ratios more realistically as shown in the table.

Even in his case it seems that the economic life assumed is also more than what is usually envisaged in the literature in this field. Any way, reasons for assuming the span of life have not been given by the authors. The interest rate used in this study is also less than what usually have been suggested. If rates of depreciation and interest are raised, even by a small fraction, the Sarda Canal could not economically pass muster. It is not, and never was, an economic proposition.

Further, one can scrutinise the estimates of farm output and input. If one is interested in making exact calculations about direct primary benefits, the input and output calculations should be done only with respect to production. The economics of livestock product should be studied separately.

In the case of Damodar canal system it is interesting to note that in total annual cost of the project, annual interest has been calculated on total capital outlay including accumulated interest. It is clearly an overestimation. Moreover, no economic reasoning has been given for adopting 10 per cent rate depreciation and interest combined.15

Besides, economic life assumed is far less than that of other such projects with the result that a high rate of 5.5 per cent of depreciation is assumed. The logic behind, acceptance of 10 per cent rate in the cost of new D.V. Canal system is also not made clear by the authors. This may lead to underestimation of ratio.

In the case of the Cavery Mettur Project, the direct primary benefits and cost estimation have been arrived at by two approaches.

In the first case, average annual benefits have been divided by annuities for amortisation of sinking funds. Annuities are calculated for the remaining period of 21 years so that they fully meet the amortisation charge and help in building up sinking fund equal to the "sum-at-charget" at the end of 21 years. Economic life has been

---

15 It is concluded here from the table that the depreciation rate is 5.5 per cent and the interest rate is 4.5 per cent.
assumed to be of 30 years; 9 years have been left out as they are likely to be periods of low yields. As it has been stated by the author himself, operating and maintenance costs are not taken into account in this study. This reduces the validity of the conclusion.

The second method is based on the formula as follows:

$$\frac{B}{C} \text{ ratio } = \frac{B}{iI + PtD}$$

- $B = \text{Annual benefit}$
- $C = \text{Cost}$
- $i = \text{Interest in percentage of capital}$
- $I = \text{Capital}$
- $P = \text{Cost of maintenance and operation}$
- $D = \text{Depreciation } = \left(\frac{i}{(1+i)^n - 1}\right) I$

However, these investigations have helped to provide a framework of reference and set of indices for the economic appraisal of major irrigation projects and for the verification of some of the assumptions regarding their potential benefits.

Other studies: Several other studies\textsuperscript{16} have also

contribution in the economic appraisal of irrigation projects. Since these studies were not primarily aimed at calculating benefit cost analysis of minor or major irrigation projects, they are not examined here.

The Approach followed in this Study:

This study aims at ex-post evaluation of a medium sized irrigation project. On the line of Research Programme Committee studies, benefits and costs are evaluated at primary, secondary and tertiary (both direct and indirect) levels. Wherever intangible benefits exist, they have also been cited.

The definitions of benefits and costs accepted in our study are as follows:

By direct primary benefits, we mean, the increase in agricultural output of the farmers because of the availability of canal irrigation facilities.

The project costs and associated costs, viz., the costs incurred by farmers to make the immediate products or services of the project available for use at the level, are the direct primary costs.

The increase in employment opportunities at farm level both for the family members of the farmers and for the landless agricultural labourers have been treated as net indirect primary benefits. The sacrifice made for
accepting these opportunities are treated as cost of it. It was found difficult to take account of such costs, since there is a high degree of underemployment in this region.

Besides the increase in the income of the farmers and landless labourers via the farm enterprise, the increase in the income earning opportunities of village professional and functionaries in the terms of larger employment and higher incomes are also treated as indirect primary benefits.

The increase in the income of the traders, transport operators, processors and input suppliers has been taken as direct secondary benefits. The costs involved in generating these incomes have been treated as direct secondary costs. Regional development in the form of town development and marketing centres development, availability of infrastructures, improvement in water table and corresponding expansion in well irrigation etc., are taken as indirect secondary, tertiary and intangible benefits.

Since data pertaining to the economic conditions before irrigation were not available sufficiently, 'before' and 'after' study approach was not found possible. Instead we have adopted 'with' and 'without' approach for the evaluation of benefits and costs. In ex-post calculations,
this can be done by making comparative study of the economy of the command and non-command region.

For conducting this study, firstly, from command area four representative villages were selected on the basis of PPS (Probability Proportional to Size) method and intensity of irrigation has been taken as the prime factor. Similarly, two villages were selected from the non-command region for comparative study. For the non-command region, the selection of the villages was based on their similarities in physical and social conditions to those of the villages of the command region except that the latter had canal irrigation facilities. One important similarity considered in this context was the availability of well irrigation. It was found that intensity of well irrigation was more or less the same in both the areas. Thereafter, from these selected villages, selection of the farmers was made on random basis.

In all 60 farmers in the case of command villages and 30 farmers in the case of non-command villages is 15 farmers from each selected village were selected for intensive study. As project has area under bed cultivation also, 10 bed cultivating farmer was also selected from the villages having bed cultivation.

In the present study scientific sampling is done only for the selection of the villages and the farmers. Since the reference period taken for the field inquiry
is 1968-69 and supply of irrigation facilities was made available only after 1962-63, it is assumed that it is not possible to ascertain after this time lag, the extent of the benefits other than direct primary benefit in a complete manner. For other beneficiaries the selection of respondents has been done from the selected villages. A nearby market centre Sarupganj was selected to sample out and study different types of functionaries in the market. This selection was also purposive. The data on the agricultural aspects have also been collected for the year 1967-68 and 1969-70. They have been given in respective chapters of the study in the form of supplementary information.

However, data for these two years i.e., 1967-68 and 1969-70 have not been analysed in our analysis in detail. As field survey was carried out in 1970, it was felt that data collected for the year 1967-68 might not present a true picture (due to memory lapses on the part of the respondents). Similarly, the year 1969-70, was an year of acute famine, hence the data for this year were excluded from the analysis as the year was not a normal year. Most of the findings are based on the data for 1968-69.

An extensive field survey was carried out for data collection from primary and secondary sources for the period of three months in the middle of 1970. Firstly,
different schedules pertaining to various beneficiaries and non-beneficiaries in the case of 'control' villages were canvassed in all the selected villages. Thereafter all relevant technical, administrative and economic information was collected from the project office at Sumerpur, Rajasthan, as well as from other government departments located at the district headquarters and at the state capital.

The benefits cost ratio has been calculated only for annual direct primary benefits and costs. The assumptions in deriving the ratio and various calculations with respect to the benefits and costs are stated at the appropriate places.

It has been emphasised in the literature on economic development that for sustaining continuous economic growth there is a need for increasing revenue from existing projects, without making adverse effect on output. This suggests the importance of the financial returns and, therefore, it is desirable that the projects should be appraised from the point of view of financial potentiality also. This has been attempted with the help of the financial results available from the project authorities.
With this broad approach, the study is aimed at making benefits-cost analysis, and includes evaluation of primary benefits and costs in detail, and evaluation of other type of effects in the form of supplementary information.

* * *