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IRRIGATION, DRAINAGE AND
FLOOD CONTROL WORKS

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NOTE :

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FOREWORD

The irrigation, drainage and flood control projects in India continue to be formed on the old concept of direct revenue return while in most cases the long-term investment projects, at present are not remunerative. The projects cost tends to be high in view of the rising prices, as well as their being more complicated. The major lacuna is that indirect benefits accruing to the community as a result of the project are not accounted for and thinking is gaining ground that these factors must be considered so that a project is accepted on the basis of benefit-cost ratio.

The Central Board of Irrigation and Power at its 34th Annual Session held at New Delhi in November 1961, organised a Symposium on 'Economics and Financing of Irrigation, Drainage and Flood Control Works' and discussions were continued at the 32nd Annual Research Session held at Ooty in May 1962. Seven papers were presented on the various aspects of the subject by irrigation engineers from all over the country. The Symposium was largely attended by representatives from State Irrigation Departments, Planning Commission, Ministry of Irrigation and Power, Ministry of Food and Agriculture, T.C.M. and Central Water and Power Commission.

A Sub-Committee consisting of Sarvashri D. B. Anand, A. R. Venkataraman, Baleshwar Nath, J. P. Mital, K. V. Ekambaram and J. P. Naegamvala examined the various issues that came up as a result of discussions and brought out recommendations for implementation by State Irrigation Departments.

The recommendations of the Sub-Committee, Symposium papers and discussions have been compiled in the present publication for use by irrigation officers. The Board is grateful to the authors of the papers and the participants who largely contributed to the success of Symposium and Sub-Committee Members in finalising the recommendations.

S. N. GUPTA

Secretary,

Central Board of Irrigation & Power

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CONTENTS

	PAGE
FOREWORD	(i)
RECOMMENDATIONS BY THE SUB-COMMITTEE	1
GENERAL REPORT	5
PAPERS	
1. Economics and Financing of Irrigation, Drainage and Flood Control Works—by <i>P. R. Ahuja and K. S. Misra</i>	10
2. Economics and Financing of Irrigation, Drainage and Flood Control Works—by <i>Jatindra Singh and Madan Lal</i>	21
3. Economics and Financing of Water Resources Development Project—by <i>D. Mookerjee</i>	45
4. Economics and Financing of Irrigation Projects in India—by <i>Kanwar Sain</i>	49
5. Economics and Financing of Irrigation, Drainage and Flood Control Works—by <i>N. S. Chohan</i>	57
6. Economics and Financing of Irrigation, Drainage and Flood Control Works—by <i>G. P. Gupta</i>	76
7. Economics of Irrigation Projects : Criteria for Justification—by <i>R. Rangachari</i>	80
DISCUSSIONS :	
November 1961 Session	89
May 1962, Session	104
LIST OF BOARD PUBLICATIONS	115

RECOMMENDATIONS BY THE SUB-COMMITTEE*

A lot of general ground was also covered in the Symposium and the discussions on the above subject held at Ooty in May 1962. The following, however, appear to be the general recommendations which emerge out of the Symposium and the discussions:

- (1) The projects should be constructed as economically as possible, for which purpose proper investigations, planning and construction should be assured. The field channels (as defined in Planning Commission's letter No. 6(1)/63-I&P of 23rd September, 1963, to all State Governments—Appendix I), should be constructed by the beneficiaries at their own cost and the project cost should not be loaded with this item.
- (2) The water rates in most of the States are significantly low, and should be raised as far as possible. It might be advisable to suggest some norms for the fixation of water rates which could be in relation to the benefits and the market conditions. Rates should normally be revised every 5 years or earlier, if market conditions so warrant.
- (3) The projects should be constructed multi-purpose as far as possible, so as to reduce the costs for individual utilisations. There should be distinct categorisation of the projects and allocation of costs for the different purposes so that economics for each use may be properly assessed.
- (4) It is felt that the old concept of direct revenue returns from irrigation, drainage and flood control works are no longer suitable in the present-day concept of a socialist state. Since on account of

*This Sub-Committee was formed to study the recommendations made at the Symposium on the subject held at Ooty in May 1962.

the projects being now more complicated, and, the rise in prices, the project costs tend to be quite high, it is considered desirable to view the projects from an over-all angle of the direct and indirect benefits accruing to the community as a result of the project. For this purpose, it is suggested that a method may be devised to assess the acceptability of projects on the basis of benefit-cost ratio, which would take into account the over-all impact on the economy of the community served by the project.

There would still be projects in exceptional situations like scarcity areas, etc., which would have to be considered acceptable on such other merits.

- (5) It is suggested that socio-economical surveys should be periodically made of the irrigated project areas in order to assess the over-all picture in the context of the increase in the indirect benefits, and national wealth, which benefits take long time to develop.
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APPENDIX I

Copy of letter No. 6(1)/63-I&P dated 23rd September, 1963 from the Secretary, Planning Commission, Government of India, Yojna Bhavan, Parliament Street, New Delhi to the Secretary, Public Works/Irrigation Departments of all State Governments.

SUB: Water-courses and field Channels

In Planning Commission letter No. NR-6(1)/59 dated 19 May 1959 addressed to the Secretary, Public Works/Irrigation Departments of all State Governments, water-courses and field channels have been defined in the following terms:

"A water-course in a channel, built at Government expense, to convey water from an outlet to a 100-acre (40.47 ha.) block or as may be prescribed.

A field channel is a channel built by cultivators beyond the water-course to serve the various fields within the block.

Note.—Where the block is small, water-course may not be necessary and field channels take water directly from the outlet."

2. In certain States, the size of some of the outlets is kept so large that the water flowing from the outlet into the water-course becomes unmanageable for the cultivators. This matter had been receiving consideration of the Ministry of Irrigation and Power and Planning Commission, and it is considered that there should be an upper limit for the discharge from an outlet into a water-course. This upper limit may be fixed at 2 to 3 cusec (0.06 to 0.08 cusec) depending upon the type of soil and crop. Paragraph 1(1) of the letter of 19 May 1959 referred to earlier, may therefore, be modified to read as under:

"Project authorities should be responsible for the construction of water-courses at Government cost for *chaks* or blocks up to 100 acres (40.47 ha.) in area.

This limit may, however, be varied in different States according to local conditions relating to topography, crop pattern, etc. The upper limit for the discharge from an outlet into a water-course may be fixed at 2 to 3 cusec (0.06 to 0.08 cusec) depending upon the type of soil and crop. The authorities concerned should consult local opinion in fixing the alignment of these water-courses."

3. Cases have come to notice where outlets have been designed for much higher discharges. In such cases, the command may be split up and served by two or more outlets from the parent channel or the outlet converted into or replaced by a minor/sub-minor with suitable number of outlets, constructed at Government expense to facilitate serving the command by easily manageable discharges. It is considered that this arrangement should improve the distribution of water among the cultivators and would also avoid wastage of water. It is suggested that in the case of projects under construction, where outlets of larger size have been provided in the original project estimates, these estimates may be revised to incorporate the improvements suggested above.

This letter may kindly be acknowledged.

GENERAL REPORT*

In order to facilitate deliberations of the Symposium for which so far 5 papers have been received from the various authors, this report has been prepared. No attempt has been made to prepare exhaustive summaries of the papers as it might be desirable that the authors of the papers may have to elaborate or explain some of the salient points they would like to lay stress.

The present scope of the Symposium is "how to evaluate the economic efficiency of the different aspects of Irrigation, Drainage and Flood Control schemes and also from where should the financial resources be met".

Economic efficiency has been defined by some authors as a situation in which productive resources are so allocated amongst alternative uses that any reshuffling from the pattern cannot improve any individual position and still leave any other individual as well as before. For ideal conditions, any change in the pattern of resources employment may improve the conditions of some people but if this is done at the expense of others, it may only result in a redistribution of income. One of the authors stresses the importance of initiating a careful economic analysis before the project is initiated. He points out that the present tendency is only to take into account the direct benefits from irrigation and he stresses upon the various indirect benefits which accrue from the irrigation projects such as settlement opportunities, etc.

But, most of the activities today of the Government are devoted to satisfying collective wants, wants which cannot be met through goods and services sold in the market place. Many of the goods by public investments are valued qualitatively precluding computations of the rates

*In all seven papers were received for discussion—six at the November 1961 session and one at the May 1962 session. Only five papers have been included in this General Report and two papers by Sarvashri Ahuja and Rangachari could not be included.

of return which underline private investment decisions. The resources employed in a public undertaking have alternative uses in the production of marketable commodities and will, therefore, have a price which measures their opportunity costs. Therefore, the task of discovering the true social cost of capital devoted to water resources development and the actual conditions is much more difficult than a mere hypothetical criteria. Further, with the Government imposing taxes in order to finance public investments it levies a compulsory loan and forced saving on the community which releases the resources for the undertaking. The taxes lead in turn to a reduction of consumption of households resulting in decline of investments or both. It is argued that with such an interconnected economic balance the social cost is equal to the foregone rate of return on the private investment.

In regard to financing the projects, one of the authors has drawn attention to Dr. Penman's recent researches about the economics of irrigation projects, wherein it is stated that irrigating a given area at a given time of the year will use up some amount of water almost irrespective of the crop which is being grown; *irrigators, therefore, should always be growing the crop which at that time of the year and at that price at that time prevailing, yields the highest economic return per unit of area and per unit of time.*

The author has further pointed out that prior to 1867, the works in India were undertaken by a few companies and did not prove successful. As a result, the Select Committee of the Indian Public Works in 1879 recommended certain stipulated tests, enumerated below, fixing the 10-year period test for financial soundness, for taking up irrigation projects:

- (1) By considering the capital cost of any work to be simply the sum actually spent on its construction.
- (2) By debiting the revenue account yearly with:
 - (a) the simple interest on the capital cost of the works at the commencement of the year, and
 - (b) working expenses of the year.

(3) By crediting revenue account yearly with:

- (a) direct receipts, and
- (b) indirect receipts.

With such a basis the minimum returns varied for different periods from 4 per cent to 6 per cent up to the partition of India. After this it has been scaled down to 4 per cent. The projects adhering to such criteria were mostly from the run of the river or less costly and they have all been tapped. As such, the criteria which were based to safeguard the investment interests and security of loans raised in England, he suggests, require radical change as the present longterm investment projects cannot be expected to be remunerative in the short run. Further, a project is not merely an irrigation or an independent flood control project and usually in most of the cases it being a multi-purpose one, it yields several products under the different purposes of irrigation, generation of power, flood control, etc. He, therefore, has summed up that the criteria for the projects should allow the assessment of their overall contribution to the growth of the region and the best test for undertaking a new irrigation project is whether there is a further demand for the agricultural wealth that the project will produce and not the financial return of 4 per cent or so.

In Punjab, as one of the authors has pointed out, water-logging and irrigation are closely connected aspects and unless adequate drainage facility is provided, the present water-logged area of 30 lakh acres (12,14,060 ha.) would go up. As an example he has said that under cotton in 1954, the acreage was of 1,26,653 acres (51,254 ha.) whereas in 1959 it has been reduced to 71,000 acres (28,733 ha.) in a period of 5 years due to water-logging. Therefore, he expresses that an outlay of 100 crores in 4 or 5 Plan periods on anti-water-logging including flood control and reclamation works is justifiable. Further, he has suggested that the flood control drainage and anti-water-logging schemes should form a part and parcel of the capital outlay on irrigation schemes.

Another author has raised a point in regard to the use of water by canal systems that well irrigation becomes extinct as it would be costlier compared to flow system. He

suggests for a balanced programme of canal and well irrigation which would check up water-logging and directly saving capital outlays on anti-water-logging measures and further adds that a rigid policy should be framed imposing tubewell irrigation in the canal tracts.

However, it may be said that the financing of irrigation would in part depend on the security of repayment contracts and in part on the likelihood that the settlers would realise the projected benefits. Non-reimbursible purposes such as flood control for which there are no comparable private industries, are subject to the risk that benefit will not be fully realised. To impute risk premiums for these purposes, we could need to take into account the fact that in some instances, particularly in the case of flood control, the projects also serve to reduce risks—a factor which should lower the interest rate. It may be the desire to redistribute the income towards future generations can provide some rationale for continued use of a low interest rate but this has limitations. In so far as a low interest rate leads to the justification of some projects at the expense of others which can produce a better return, the rate will result in a social loss even within resource fields. Therefore, it is desirable that the relevant social gains and costs should be used as an aid in budgeting public revenues for development of water resources. Further, the bargaining position enjoyed by the irrigation farmers *vis-a-vis* the irrigation enterprise is a practical importance.

The difficulties arising from the ability of water used to wait out the water supplier in some cases and to buy out the bankrupt facilities on their own terms are important considerations. Reliance, during an agricultural depression, on the political process to scale down repayment obligations and water charges further affect the financial returns to investment for the provision of irrigation water. In addition, an estimation of the value of collective goods principally flood protection within the context of multi-purpose river development needs to reflect the sum which beneficiaries would be willing to pay for such protection if they were given a choice. Further, quick colonization is essential for the success of irrigation projects. More good projects have failed through lack of

quick colonization than from all other causes. And, a project simply cannot stand years of accumulating interest charges and operation and maintenance costs. The future success of irrigation, therefore, depends on the measures adopted to overcome this obstacle.

From a review, it is seen that some of the important aspects require immediate consideration and definite policies:—

- (1) The evaluation of economics of the present irrigation projects may not be simple as it becomes an involved development of various aspects—drainage, flood control and other multi-purposes for which it is being used.
- (2) The evaluation should be the total benefits to the nation than the direct revenues the projects fetch, such as improvement in communications, colonization and stabilisation of living conditions to the community, etc.
- (3) Financing of irrigation, drainage and flood control works should be based on the relevant social gains and costs and not on the financial percentage return yard-stick.
- (4) Financing of irrigation projects should include aids to water users to develop quick agricultural operations and colonization.

Any other point that has been raised in the general report and papers may be discussed and suitable recommendations formulated.

Economics and Financing of Irrigation, Drainage and Flood Control Works

by

P. R. Ahuja*

&

K. S. Misra**

Introduction

The object in view is to ensure that a project, which has been thoroughly prepared as far as its technical aspects are concerned, is also sound economically. In other words, the investment towards the execution of the project is to be justified from the point of view of benefits which will accrue after expenditure on the concerned works.

This criterion of economical soundness of projects has been in vogue since long time. The yard-stick applied, however, has not changed all these years and has remained in the form of a percentage return on the capital outlay. This method was adopted during pre-independence period, when the Government had in view, foremost, the security of money invested, in the sense that the project would earn at least the interest on the capital which was possible by bank deposit.

Originally the interest rates for productive projects were as follows :—

Period	Rate (per cent after 10 years of construction)
(i) Before 1919	4
(ii) Between 1919 to 1921	5
(iii) Between 1921 to 1937	6

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For schemes approved after 1 April 1937, different percentages were adopted in different States. However, from April 1949 the Government of India fixed 3.75 per cent as the productivity yard-stick for projects financed by the Central Government. The present rate is 4.5 per cent.

Now as an independent country, it is necessary to have a different outlook. In all directions, development is taking place, for example communications by road, rail and air have been enormously improved without consideration that they may be economically remunerative to a high extent. On the same lines, development of the country regarding its agricultural potential with the help of irrigation, flood control, drainage projects and development of electric power cannot be restricted on the basis of percentage returns. Without these projects, the country would not be able to maintain its population. It may not always be possible to obtain foodgrain from other countries in spite of the fact that foreign exchange could be spared. This would happen if and when the relations with the countries supplying foodgrain happen to become strained for political reasons. In a country like ours with immense agriculture and water potential remaining unexploited, such a situation would be most unpardonable.

New Criteria for Financing River Valley Projects

Since the above criteria of percentage returns were fixed, conditions have changed basically. Due to improvement in the technique of design and construction, it has become possible to execute bigger schemes which require more than 10 years for full development. Secondly, the earlier projects were constructed mostly to take advantage of run-off of a river and as such were obviously less costly and at the same time provided greater benefits. Most of such profitable schemes have already been tapped. As against these, the present schemes are mostly storage schemes and are thus costlier.

Another consideration commanding importance in the formulation of economic analysis is the 'indirect benefit' extended to the nation by the execution of a project. Apart from the direct returns in the shape of land revenue, water rates, betterment levy, receipts from plantations, lease of

the land along the canal banks, etc., there are innumerable indirect benefits flowing from these projects.

Conception of Benefit Cost Analysis

A new aspect of economic evaluation, known as the benefit-cost technique has been developed lately, particularly in the U.S.A. The benefit cost calculation requires that for a project to be economically justified, its estimated total annual benefits should exceed the estimated total annual expenditure. The computed benefit cost ratio is used as the yard-stick.

The computation of benefit cost ratio requires very careful assessment of different factors and reliability of statistical data. Any error in the statistical data of various patterns of benefits, social as well as private and direct as well as indirect, would mitigate its utility.

Direct and Indirect Benefits

A broad indication of the benefits, direct and indirect, resulting from different types of projects such as irrigation, drainage and flood control, may be indicated as below:—

(A) IRRIGATION

(a) Direct Benefits :

- (i) Water rates, water cess and betterment levy.
- (ii) Reclamation of lands not cultivated before due to lack of water and increase in land revenue.
- (iii) Year-round cultivation of land, introduction of new crops, double cropping of land, etc.
- (iv) Miscellaneous receipts from plantations, lease of land along the canal banks, etc.

(b) Indirect Benefits :

- (i) Increase in land and property value, employment, living standard, livestock production, duty, taxes due to influx of more population, postal revenue, excise duty, etc.

- (ii) Stimulation of business.
- (iii) Reduction in the cost of pumping water due to rise in the water-table by the introduction of irrigation canals.
- (iv) Saving in famine and flood expenditure.
- (v) Saving of precious foreign exchange now spent in importing food due to food deficit.

(B) DRAINAGE

(a) Direct Benefits :

- (i) Reclamation of land and land revenue.
- (ii) Betterment levy.
- (iii) Increase in food production.
- (iv) Saving in anti-malarial control expenses.

(b) Indirect Benefits :

- (i) Increase in land and property value.
- (ii) Saving in foreign exchange now spent in importing food.

(C) FLOOD CONTROL

(a) Direct Benefits :

- (i) Saving from inundation of agricultural crops, properties, interruption of services, suspension of business, deposition of gravel and sand thus changing the fertility of soil, etc.
- (ii) Saving in cost of evacuation and relief measures.
- (iii) Saving in cost of anti-malarial and other health control expenses.
- (iv) Saving in increased cost of transportation charges due to circuitous routings and damage to roads, bridges and railways.

(b) Indirect Benefits :

- (i) Better social security of the people and saving of miseries to the nation.

Evaluation of Benefit Cost Ratio

It is necessary to conduct economic surveys in the project areas to assess their direct and indirect benefits. Such surveys have been undertaken by the Gokhale Institute of Economics and also at the instance of Planning Commission which has realised the need for a realistic assessment of full benefits that accrue from an irrigation project rather than merely applying the yard-stick of direct financial return to gauge the productivity of a project. From Table I it may be seen that 77 per cent of projects included in the Second Plan have been approved by the Planning Commission which were below the orthodox standard of productivity test.

This fact bears a testimony to the new trend for financing river valley schemes which are aimed at the integrated and overall developments of water resources, as well as for enhancing production of food and raising the per capita standard of the people.

TABLE I

Projects of Second Plan including projects continuing from First Plan to Second Plan approved by the Planning Commission below the productivity test of 4.5 per cent return.

Sl. No.	Name of State	Approved by the Planning Commission		Projects approved by the Planning Commission below the productive criteria	
		No.	Cost Rs. lakhs	No.	Cost Rs. lakhs
1	2	3	4	5	6
1.	Andhra Pradesh	11	236.61	8	184.62
2.	Assam	..	..	..	..
3.	Bihar	8	2,648.58	4	496.09
4.	Gujarat	22	10,214.72	18	2,325.92
5.	Jammu and Kashmir	1	66.00	..	..
6.	Kerala	3	455.34	3	455.34

TABLE I—Contd.

1	2	3	4	5	6
7.	Madhya Pradesh	12	3,028·76	11	3,004·49
8.	Madras	3	341·27	3	341·27
9.	Maharashtra	24	6,308·58	21	3,989·97
10.	Mysore	9	586·88	7	517·74
11.	Orissa	7	782·06	5	263·61
12.	Punjab . . . . .	..	..	..	..
13.	Rajasthan	8	657·71	4	199·38
14.	Uttar Pradesh	4	2,600·93	3	360·32
15.	West Bengal	2	67·02	1	46·38
16.	Delhi . . . . .	..	..	..	..
17.	Himachal Pradesh . . . . .	..	..	..	..
18.	Manipur . . . . .	..	..	..	..
19.	N.E.F.A. . . . .	..	..	..	..
20.	Tripura . . . . .	..	..	..	..
21.	Andaman & Nicobar . . . . .	..	..	..	..
22.	Amindive and Laccadive Islands . . . . .	..	..	..	..
		114	27,994·46	88	12,185·13

For purposes of illustration, Table II shows results of economic survey of the Godavari and the Pravara Canal area in the State of Bombay and establishes clearly the magnitude of indirect benefits and helps in assessing a realistic view in understanding to finance these so-called unproductive schemes.

TABLE II

Sl. No.	Name of Receipt	Increased Annual Income (Rs. lakhs)	Percentage return on capital outlay of Rs. 257 lakhs
CENTRAL GOVERNMENT			
1.	Excise duties	15.0	
2.	Railway earnings	7.9	
3.	Income-tax	3.0	
4.	Petrol and other duties	0.58	
	TOTAL FOR CENTRAL GOVERNMENT	26.48	10.3
5.	Miscellaneous canal receipts	0.13	
6.	Increased land tax	0.90	
7.	Motor vehicles tax, fees, etc.	0.18	
8.	Savings in financial expenditure	0.50	
		1.71	0.7
	GRAND TOTAL OF RETURN		11.0

It is significant that the net direct return on this project over the total capital outlay was only 2.3 per cent but the indirect benefits accrued were 10.3 per cent to the Central Government and 0.7 per cent to the State Government. Even on the total Government sum at charge, i.e., capital outlay + arrears of interest amounting to Rs. 430 lakhs (257+173), the indirect revenue adds to 6.5 per cent to the meagre direct revenue of 1.4 per cent.

In December 1958, the Planning Commission sponsored an intensive study for evaluating the benefits that accrue from irrigation projects for obtaining a correct perspective of direct and indirect benefits in quantitative terms. The following projects were accordingly selected for intensive studies:—

- (1) Gang Canal
- (2) Sarda Canal
- (3) Tribeni Canal
- (4) Damodar Canal
- (5) Cauvery Mettur Project.

To obtain a basis for assessing the benefits of irrigation, investigations were carried out in the commanded area of an irrigation project and in a comparable area outside the project.

The fact that the canal irrigation has led to a general expansion of secondary and tertiary activities in the area affected by it, has been well brought out in the studies of Cauvery Mettur, Sarda Canal and Tribeni Canal Projects. Benefits have accrued to establishments which are processing agricultural products or are engaged in trade in them.

The expansion of industry and trade in the command zones has resulted in greater work, opportunities and employment of both family and hired labour. This is evident from the figures of higher employment in industrial and trading establishments in the project areas.

It has been observed that in general the value of product per industrial unit has been higher in the project area. Similarly, turnover of business establishments has been higher in the project areas in comparison to those in the non-project areas (Table III).

TABLE III

*Impact of Irrigation—Primary or Direct Benefits.**

Sl. No.	Project	% of cultivated area to total area		Farm Labour input Rs. per acre		Farm input Rs. per acre		Farm output Rs. per acre		Farm Business income Rs. per acre		Family Labour income Rs. per acre	
		Project	Non-Project	Project	Non-Project	Project	Non-Project	Project	Non-Project	Project	Non-Project	Project	Non-Project
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Gang Canal	92	58	35.2	21.8	148.5	58.8	165.94	57.26	44.71	19.46	35.07	17.16
2.	Sarda Canal	80	67	57.7	55.51	156.91	61.35	251.74	230.09	135.02	129.07	130.24	123.08
3.	Cauvery Mettur	95	68	78.2	46.83	317.49	120.42	327.74	81.06	160.84	12.00	31.26	—13.24
4.	Tribeni Canal	94	98	64.3	48.99	285.06	205.06	732.00	268.00	591.27	148.62	456.50	76.57
5.	Damodar Canal I	99	92	113.1	71.05	342.08	221.93	311.54	202.98	126.13	93.59	16.01	16.55
	—do—do—	II		87.76		279.44		276.36		137.21		34.97	

Conclusion

It has been clearly brought out that the projects which are likely to be undertaken in the near future, would have rather low percentage return from the direct benefits, as all attractive run-off the river projects have since been completed. Nevertheless, if the secondary and tertiary benefits are also taken into account, these projects would qualify for approval.

It has already been emphatically pointed out that whether the returns are low or high, this agricultural country with tremendous resources of water potential for irrigation, cannot be allowed to remain deficit in foodgrains and be permitted to meet its requirements from foreign countries. Apart from the drain on foreign exchange, which can be utilised for other development enterprises, foreign countries may not be able to supply food, in case of hostility, bad relations, *etc.*

At the same time, it cannot be overlooked that our financial resources are limited to take up all the projects simultaneously. Again, the necessity of irrigation schemes in different parts of the country varies, depending on the extent to which an individual area has already been developed in the past. Keeping all factors in view, priority would have to be drawn up in accordance with which the different projects have got to be taken up for construction. For a long time to come, until we are in a position to evaluate the indirect benefits, it would be evident that we continue selecting projects in the order of percentage of direct returns.

In this context, it must be remembered that preference should be given to those projects which are best located, so as to economise on transport charges. The main criterion in locating these projects should be that water resources are not a property of any one State and we should not be bound by State and food boundaries. In this manner alone, we will be able to achieve the welfare of the nation.

Nothing special can be said about the financing of the river valley projects. These form major sectors of the national development plan and money has to be found from

revenue surpluses, earnings of public undertakings, loans raised within the country, foreign aid, etc. Under the present constitutional set-up loans are being advanced by the Central Government to States for specific projects included in the Plan as the responsibility for the execution and maintenance of these projects rests mostly with the different States.

While construction costs of projects are mounting, the State Governments are usually very shy in the matter of levying proportionately higher water rates, etc. Further, it is not likely that the various States would ever be in a position to repay the large loans advanced to them. The present pattern of responsibility has also often resulted in very fissiparous tendencies and inter-State disputes. In view of these factors and in order to promote emotional integration it is a matter for serious consideration whether Irrigation and Power Sector in the country should be a direct responsibility of the Centre.

Economics and Financing of Irrigation, Drainage and Flood Control Works

by

Jatindra Singh*

&

Madan Lal**

[Suggestions for raising revenue made in this paper are not necessarily those of the Irrigation Branch and the Punjab Government. They have been made to elicit discussion at the Symposium.]

Introduction

Irrigation, drainage and flood control are closely inter-related and are required for full utilisation of land and maximum production of crops. Irrigation, as is obvious, meets the needs of land for water, be this from canals, tubewells or drains. Again, drainage is required for carrying away surplus waters from land so that the land does not get damaged by standing water or by rise of the sub-soil water-table resulting from high rainfall and the application of intensive irrigation.

Flood control is necessary to ensure that arable land is made safe against inundations. This enables raising of cash crops besides foodgrains where nothing may grow. Flood control works may be required in plains along rivers and rivulets where they can be taken as part and parcel of an irrigation system or they may be built in mountainous or sub-mountainous regions for keeping back flood waters from rushing down to plains during the period of the rainstorm. These flood control works in the form of dams, gully plugging works, etc., may also be taken as

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a part and parcel of an irrigation system. This paper deals with the economic and financing of drainage-cum-flood control schemes in Punjab which is one of the best irrigated States in India.

Extent of Drainage Problem

(A) CANAL IRRIGATED AREA

Punjab (India) lies between River Ravi on one end and River Yamuna on the other and has got Beas, Sutlej and Ghaggar Rivers flowing inbetween. Punjab is conveniently divided into four tracts namely: (i) Upper Bari Doab Tract between Ravi and Beas, (ii) Bist Doab Tract between Beas and Sutlej, (iii) Sirhind Tract between Sutlej and Ghaggar, (iv) Yamuna Tract between Ghaggar and Yamuna. Ghaggar alone amongst these rivers is a seasonal river carrying substantial supplies during monsoons only and ends into two canals, namely, the northern and the southern Ghaggar Canal, taking off from the Otu Lake. Any surplus supplies flow down to Rajasthan and are absorbed in the desert area. Again Sarswati, at one time, a tributary of the Ghaggar ends in Sarswati Canal taking off from the Bibipur Lake and only the surplus is sent down to the Ghaggar through an artificial drain. The Western Yamuna Canal off-taking from the Yamuna River, Sirhind Canal off-taking from Sutlej and the Upper Bari Doab Canal off-taking from Ravi, are old perennial canals of the Punjab (India). These canals were constructed during the second half of the 19th century. Some of these canals have run for nearly a century.

Total approximate C.C.A. under these old canals up to date is as under:—

	<i>Lakh acres</i>
1. Western Yamuna Canal	30·4
2. Sirhind Canal	38·9
3. Upper Bari Doab Canal	11·4
4. Master Canal and Grey Canal	9·3
TOTAL	90 0

Sarswati and Ghaggar Canals, now form part of the Bhakra Canal system as their sources have been connected with the main system by suitable links. Total C.C.A. of the Bhakra Canals is nearly 40 lakh acres (16·187 lakh ha.). Total C.C.A. receiving irrigation from various canal systems is nearly 123 lakh acres (49·776 lakh ha.). Various schemes are under implementation and some are to be implemented during the Third Five-Year Plan and later Plans. These schemes will add about 37 lakh acres (14·973 lakh ha.) bringing the total canal irrigation area to about 150 lakh acres (60·703 lakh ha.). State tubewells are providing irrigation to 9·25 lakh acres (3·743 lakh ha.). 13 lakh acres (5·261 lakh ha.) in Punjab are already being provided irrigation from percolation wells, private tubewells and *kuhls* and other irrigation sources. Nearly an area of 172 lakh acres (69·606 lakh ha.) will be covered by irrigation schemes by the end of Third Five-Year Plan or sometime thereafter. The total arable area in the State is nearly 216 lakh acres (87·412 lakh ha.). 44 lakh acres (17·806 lakh ha.) in Punjab area has still to be provided with additional irrigation supplies in Fourth and later Plans. Nearly 14 lakh acres (5·666 lakh ha.) will be covered by high lift schemes. Some further area of about 6 lakh acres (2·428 lakh ha.) may be covered by tubewells. It will be an area of about 24 lakh acres (9·713 lakh ha.) which may be difficult to irrigate on account of their location partly in the hilly tracts and partly in sand dunes of Hissar Mohindergarh District. Development of irrigation in the Punjab has been as under:—

Period	Actual irrigated area
Pre-partition, 1946-47	44,33,105 acres
Pre-First Plan period 1950-51	49,61,919 acres
End of the First Five-Year Plan 1955-56	60,21,073 acres
End of the Second Five-Year Plan 1960-61	72,00,000 acres (nearly)
Expectation by the end of Third Five-Year Plan	85,00,000 acres (Approx.)

1 acre=0·4047 hectare.

This development of irrigation, *viz.*, 85 lakh acres (34·398 lakh ha.) which may go up in about 10 years' time up to 100 lakh acres (40·469 lakh ha.) against total C.C.A. of nearly 130 lakh acres (52·609 lakh ha.) receiving canal

irrigation is not the best that can be achieved with the available means of irrigation. 100 per cent intensity of irrigation is the least that should be obtained and the same should still go higher up provided adequate drainage facility is provided for lands covered by these various irrigation schemes. Taking into consideration the total full supply discharge of nearly 50,000 cusec (1,416 cumec) of all the canals in Punjab and a mean capacity factor of 0.7 the depth of water for 130 lakh acres (52,609 lakh ha.) works out to 24 in. (60.96 cm.). A part of this water percolates into the soil, a part is utilised by the crops and a part gets evaporated. As against this, monsoon rainfall as shown in Figure 1 varies from 10 to 40 in. (25.4 to 101.60 cm.) and in water-logged areas it is about 25 to 30 in. (63.50 to 76.20 cm.). Unfortunately Punjab has had high rainfall every other year as will be apparent from the rainfalls in various tracts before the partition and later as given below:—

Main monsoon rainfall at some central stations

Before 1947

1. Upper Bari Doab Tract	23 in.
2. Sirhind Tract	21 in.
3. Ghaggar Tract	23 in.
4. Yamuna Tract	23 in.

After 1947

1. Upper Bari Doab Tract	34 in.
2. Sirhind Tract	22 in.
3. Ghaggar Tract	20 in.
4. Yamuna Tract	31 in.

1 in. = 2.54 cm. = 25.4 mm.

It will thus be seen that the monsoon rainfall which occurs in about 3 months of the year, i.e., July to September, creates water-logging problems for lands unless these waters get carried away by the storm rains of adequate capacity.

(B) AREAS ALREADY WATER-LOGGED

Area with sub-soil water-table within 10 ft. (3.05 m.) of the natural surface for all purposes may be taken as water-logged. Table I gives extent of these areas, with the sub-soil water depth 5 and 10 ft. (1.52 and 3.05 m.)

below natural surface in different parts of the State on the basis of observations made in June before the monsoons and in October, after the monsoons.

TABLE I

Area in acres with sub-soil water-table under 10 ft. (3.05m.) depth.

	Observations made in June			Observations made in October		
	0—5	5—10	Total	0—5	5—10	Total
1951	164656	2619806	2784462	923458	2477149	3400607
1952	45077	1824158	1869235	872038	2285557	3157595
1953	38094	1454079	1492173	752025	3096569	1061594
1954	70315	1185225	125540	1205042	2088691	3293733
1955	111627	1742284	1853911	2469616	2314289	4783905
1956	379954	3228794	3608748	2513838	2187334	4701172
1957	521011	3021619	3542630	2462253	2190950	4653203
1958	285085	2790606	3095691	3520007	2484573	6004580

Figure 1 shows that the water-logging is confined mostly to areas lying North-East of Ferozepore-Jakhal line. Areas lying South-West of Ferozepore-Jakhal line are semi-arid and the development of irrigation in these areas is also small at present.

Bhakra Canals will provide perennial supplies to these areas from now onwards and it is quite likely that the water-table in these areas would also go up unless adequate drainage facility is provided. At present the area water-logged is nearly 30 lakh acres (12.141 lakh ha.) which may go up in any particular year if the incidence of rainfall is abnormally heavy. This area forms nearly 25 per cent of the C.C.A. receiving irrigation and quite about 40 per cent of the area receiving canal irrigation in the tract lying North-East of Ferozepore-Jakhal line.

The water-logging in the old canals has been caused due to inadequate drainage facility. Drainage crossings under roads, railways and canals were not provided with adequate waterway and in some depressions no drainage crossings were built. No proper drains were excavated in irrigated tracts to begin with and some drains

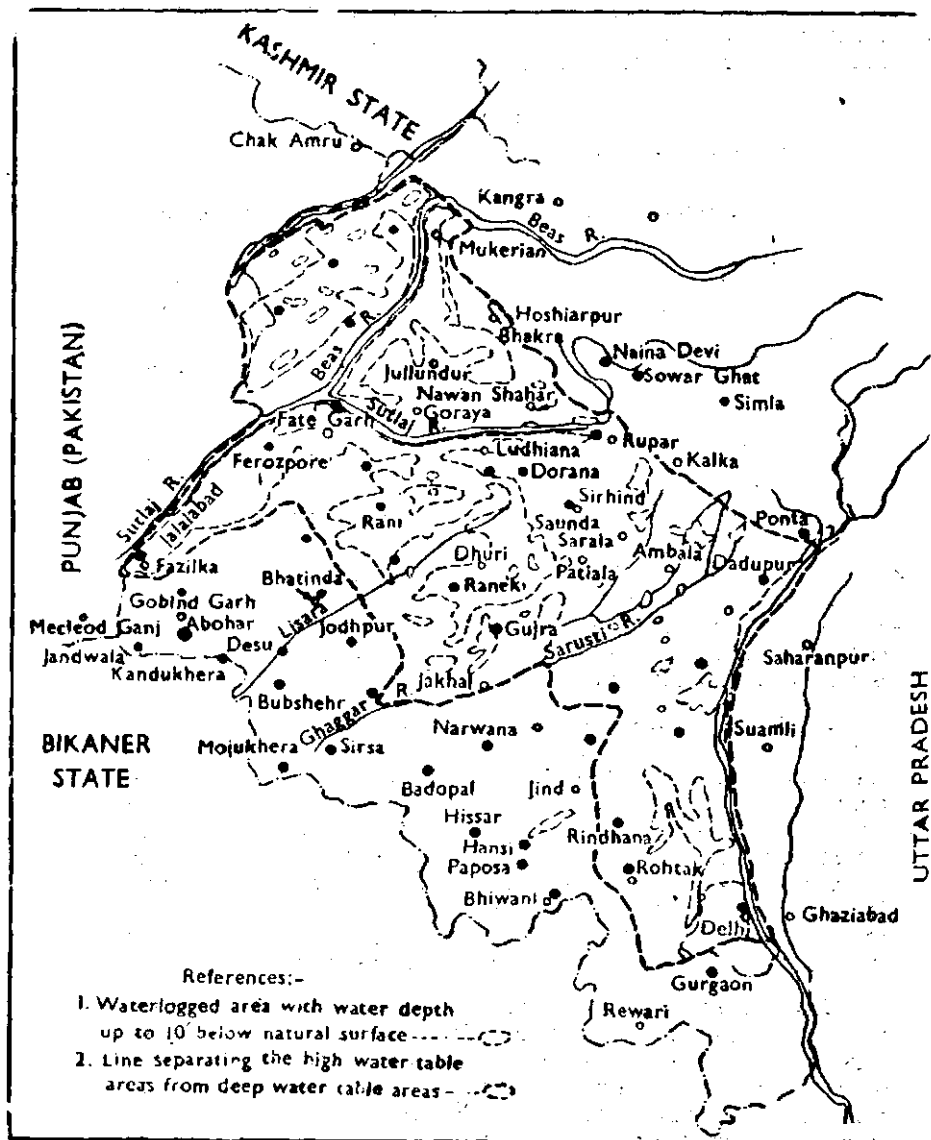


Figure 1.

in Yamuna tract came to be constructed when the problem of water-logging in the area became manifest. In similar situation some drains were excavated in the Upper Bari Doab Canal Tract and in belt area along the Sirhind Canal. Total length of drains in the pre-independence era was 370 miles (595.46 km.).

The necessity for adequate surface drainage was realised only in the post independence era. The total mileage of new drains in various stages of construction is 2,104 miles (3,386 km.). Additional mileage of new drains planned to be started in Third Plan and later on is approximately 3,076 miles (49.53 km.).

Presently, drains are being excavated to function as storm-water drains. At a later stage when more funds would become available as also the necessary machinery such as dragline and dredgers, seepage cunettes will be excavated in the bed of drains so that such open drains may also serve as seepage drains.

Presently, the capacity of drains under excavation is being provided on the basis of 2 cusec per square mile (0.019 cumec per sq. km.) of the catchment area. Subsequently on availability of more funds, the deepening and widening would be taken up. Whereas drains are being excavated for nominal discharge on account of shortage of funds, works under roads, railways and canals are being built to permit passage of maximum discharge without excessive heading up. Appendix 'A' gives the basis of arriving at the discharge for which works across drains should be designed.

Surface-cum-seepage drains, as planned, when completed, would provide a considerable relief to water-logged areas. The productivity of lands will also go up considerably. As it is, the productivity of water-logged lands has gone down very low. Yield of wheat per acre has gone down from 14-15 maunds per acre (1291-1383 kg. per ha.) to practically nothing in badly water-logged areas. Similarly cultivation of cotton is being given up in the water-logged area. Table II gives cotton sown in acres in Upper Bari Doab Canal from 1948 to 1959. It will be seen that fall in cotton acreage occurred due to water-logging conditions and inadequacy of drainage facility.

TABLE II

Year	Area sown under cotton on U.B.D. Canal in acres	Area in which the crop was damaged completely in acres	Balance
1948	25,890	N.A.	
1949	45,161	N.A.	
1950	57,415	N.A.	
1951	61,390	2,617	58,773
1952	75,307	2,901	72,406
1953	93,661	1,377	94,284
1954	1,26,653	2,551	1,23,102
1955	1,08,076	1,08,076	Nil
1956	1,06,371	7,561	98,810
1957	74,438	1,805	72,603
1958	80,677	25,112	55,565
1959	70,685	3,816	66,869

100 acres=40·47ha.

(C) ANTI-WATER-LOGGING MEASURES

The launching of anti-water-logging measures as indicated above on extensive scale would require considerable sums as discussed thereafter and for the present, these measures are being implemented on experimental basis in pilot areas each covering about 60-70 square miles (155.34-181.30 sq. km.) in the vicinity of Hansi, Suman, Sangrur, Zira, Fazalka and Amritsar.

In areas with the water-table within 5 ft. (1.52 m.) of the natural surface, surface and seepage drain alone might not eradicate the water-logging menace, and it would be necessary to take up other measures such as lining of channels, sinking of tubewells, digging of ditch drains parallel to roads, canals and railways for draining away borrow pits.

Cost of Schemes

Approximate outlay on drainage-cum-flood control and anti-water-logging schemes.

	Flood control and surface drains works	Ant - water-logging schemes
II Plan and earlier	5.15	0.17
III Plan	12.08	2.93
Subsequent Plans	11.21	57.90
	28.44	61 crores)
	say 29 crores	

Break-up of anti-water-logging schemes other than surface drains.

	in Rupees
(1) Seepage Cutnettes	3.33 crores
(2) Ditch Drains	Expenditure to be charged to annual maintenance and repairs estimate.
(3) Tubewells	
(a) Shallow	6.24 crores
(b) Deep	0.40 crores
(4) Lining of Canals	44 crores
(5) Reclamation of thur and investigations	6.76 crores
TOTAL	<u>60.73 say 61 crores</u>

Total financial outlay of nearly Rs. 90 crores during the course of 5 or 6 plans is based on present estimates. These estimates may go up with the rise in general price index in course of time.

Lining of canals may be done partly as part of anti-water-logging projects and partly as part of irrigation projects since waters saved can be utilised in the same canal system or elsewhere.

Measures indicated above are as a result of the first thoughts on the removal of water-logging. Further thing is being done on the same and it may be possible for the State to evolve cheaper measures for eradication of water-logging through further research.

Anticipated Benefits

The reclamation of water-logged and thur affected areas in old canals area will pay many times over the cost of anti-water-logging measures including flood control and reclamation works. With the implementation of these schemes, the production of crop per acre of reclaimed land would go up by about 5 to 6 *maunds* (186.62-223.95 kg.) of wheat on an average. Allowing for additional financial outlay operation and service charges, the benefit to a farmer would be to an extent of nearly Rs. 50 per acre every year. Taking water-logged area as 30 *lakh* acres (12.141 *lakh* ha.) the additional annual income of the people of the State would be $3 \times 10^6 \times 50 = \text{Rs. } 15 \text{ crores}$.

By carrying out anti-water-logging measures, additional irrigation supplies will be made available as indicated below:—

	<i>Million acre-ft.</i>
Water saved due to lining of channels	1.69
Seepage drains	2.08
Tubewells sunk from anti-water-logging consideration	0.68
	4.45

Punjab Engineers believe that nearly 2.2 million acre-ft. (2,713.66 million cu. m.) will be utilised and the same would bring additional revenue of Rs. 57 *lakhs* to the State every year.

The utilisation of these waters in Punjab or elsewhere would produce about 3 *maunds* (111.96 kg.) wheat per acre-ft. of water utilised and may add to the annual income of farmers to an extent of nearly $30 \times 2.2 \times 10^6$ or Rs. 6.6 *crores*

Flood damages in some past years are described in Appendix 'B'. On an average flood damage suffered by the people evaluated in terms of money works out to be about Rs. 10 *crores* every year.

Again the State suffers loss of revenue at the present scale of charges as under :—

(1) Remission of water rates	Rs. 8 2 <i>lakhs</i>
(2) Remission of land revenue	Rs. 7 8 <i>lakhs</i>
	<hr/>
	Rs. 16 <i>lakhs</i> .

Should the annual income of the people of the State go up by about 15 plus 6.6=Rs. 21.6 *crores* annually, it would be quite in order to spend over Rs. 300 *crores* on anti-water-logging measures from considerations of the Cost Benefit Ratio.

Financial Considerations

An outlay of Rs. 100 *crores* in Fourth or Fifth Plan period on anti-water-logging measures including flood control and reclamation works is justifiable, as discussed above. Besides direct benefits resulting from anti-water-logging measures and flood control works, indirect benefits such as employment of people, establishment of factories, cultivation of higher rate crops, elimination of flood damages, dislocation of communication, etc., if evaluated would mean adding several *crores* to the wealth of the State. The people will get annually direct benefits to an extent of over Rs. 30 *crores* in the shape of increased production of crops from lands which are presently producing little crop and are going out of use on account of deteriorated conditions. The question that crops up is as to how the State should finance these essential anti-water-logging schemes. The obvious solution would appear to be to levy drainage cess *vis-a-vis* betterment fee on lands that would get reclaimed.

Northern Indian Canal Act was amended some years ago and the relevant clauses regarding recovery of drainage cess are reproduced below:—

"57. Preparation of schemes for works of improvement.

Whenever it appears to the State Government that any drainage works are necessary for the improvement of any lands, or for the proper cultivation or irrigation thereof, or that protection from floods or other accumulations of water, or from erosion by a river, is required for any lands, the State Government may cause a scheme for such drainage works to be drawn up and published, together with an estimate of its cost and a statement of the proportion of such cost which the State Government proposes to defray, and a schedule of the lands which is proposed to make chargeable in respect of the scheme."

"59. Rate on lands benefited by works.

- (1) The proportion of the cost, other than that which is to be defrayed by Government, in respect of such scheme, may be charged from the owners of all lands made chargeable under Section 57 in accordance with rules made by the State Government in this behalf.
- (2) An owner shall be competent to contribute towards the charges payable by him either wholly or in part in terms of land, labour or cash in the manner prescribed by rules made in this behalf."

In the First Plan period, the Central Government was giving a loan for the implementation of drainage schemes on the basis of 12½ per cent contribution by the Central Government, 12½ per cent by the State Government and 75 per cent by the beneficiaries. Since beneficiaries on account of their poor financial status were not in a position to contribute substantial sum, the State Government agreed to contribute 31.25 per cent and beneficiaries were asked to give 56.2 per cent. Despite reduction in the share to be paid by them little or no contribution from beneficiaries materialised with the result that little or no work progressed on anti-water-logging schemes in the First Plan period.

The Government has now enacted for the acquisition of compulsory labour for the execution of anti-water-logging schemes. This Act has not yielded much results so far. But it is anticipated that an expenditure on anti-water-logging schemes to the extent of Rs. 3 crores or so may be saved due to the employment of *Zamindara* labour under this Act. Again, the Government has taken a decision that lands for drains may be taken out of the common pool in such villages where the consolidation of holdings has still to be done. This may also mean saving of Rs. 2.5 crores of expenditure.

It will be seen that measures such as Compulsory Labour Act and the utilisation of lands for drains from the common pool would help materially in raising funds for the anti-water-logging measures.

Again, it will be seen that the raising of drainage cess from the people with water-logged and damaged lands does not hold much promise, since their capacity to pay till such time their lands got fully reclaimed is indeed very low. It should be appreciated that these people have to spend a lot more on maintenance and operation charges for raising crops from damaged land and it would be unfair to levy tax on such people. Lands got damaged for no fault of their and they should be the last people to be taxed.

As pointed out in the introduction of this paper, flood control, drainage and anti-water-logging schemes are part and parcel of an irrigation system and the total outlay on such measures should be included in the capital outlay of the irrigation projects.

Statistics of capital outlay and revenue for irrigation projects, old and new, in 1946-47 and 1959-1960 are given below:—

Total area irrigated	4,433,105
Up to 1946-47	Rs. in crores
Capital outlay direct and indirect up to 1946-47	11.068
Interest charges to end of 1946-47	16.495
Net revenue to end of year	41.960
Accumulated profits	25.381

	Rs. in <i>crores</i>
During 1945-47	
Gross revenue	1.667
Working expenses	0.855
Net revenue	0.812
Percentage on capital	7.34
Up to 1959-60	
Capacity outlay	129.89
Interest	25.07
Net revenue	62.72
Accumulated profits	37.65
During 1959-60	
Gross revenue	5.82
Working expenses	2.31
Net revenue	3.50

The capital outlay on all irrigation projects, old and new, is Rs. 130 *crores* and may go up by another Rs. 30 *crores* or so, required for additional irrigation schemes to be taken up in the Third Five-Year Plan and subsequent plans and to this may be added the cost of anti-water-logging measures including flood control and reclamation works. The total outlay on irrigation system and drainage works as such would work out to be Rs. 130 + Rs. 30 + Rs. 90 = Rs. 250 *crores*.

As pointed out above from economic consideration, the outlay of over Rs. 300 *crores* is fully justifiable on reclamation of lands. The total outlay on irrigation schemes plus the anti-water-logging measures remains within that amount. For obtaining the return of 6 per cent on Rs. 300 *crores* it is necessary to collect revenue of nearly Rs. 18 *crores*. As already given earlier the annual irrigation in the State would easily go up to 150 *lakh* acres (60,703 *lakh* ha.) particularly when the areas get reclaimed on the implementation of anti-water-logging measures. Taking a return of Rs. 6 per acre as per current water charges and land revenue rate, the revenue from 150 *lakh* acres (60,703 *lakh* ha.) per year works out to be Rs. 9 *crores*. This means that the present water charges in the State on some crops particularly on cash crops and land revenue may necessitate raising to meet anti-water-logging costs.

Sources of Additional Revenues

To cover the gap of Rs. 9 crores between revenues at the present rates and the amount required to maintain works and pay back interest on capital outlay, the following methods of raising additional revenue would be suggested:—

- (i) Increase in water rates on all crops or some cash crops such as sugar-cane, cotton, chillies, etc., to meet the gap fully or partly.
- (ii) Levy of betterment fee on new lands being provided canal irrigation supply for the first time.
- (iii) Levy of drainage cess on reclaimed lands.
- (iv) Subsidising the gap from general revenues of the State and supplementing the income of the State by additional taxation:
 - (a) Agricultural income-tax.
 - (b) Sales tax on some agricultural produce such as cotton and wheat exported out of Punjab State.

(I) INCREASE IN WATER RATES

The gap is of nearly Rs. 12 crores as against anticipated annual revenue of nearly Rs. 9 crores. To meet this gap by increasing water rates and land revenue would mean an increase of nearly over 125 per cent whereas big landlords with huge land-holding may not be adversely affected. *Zamindars* with small and uneconomical land-holding may find this burden of additional water charges to be too heavy to bear in these days of high prices and wages. Unfortunately, Punjab has got small holdings as such there seems less chance of augmenting revenues by an increase in water rates and land revenue.

(II) BETTERMENT FEE ON NEW LANDS

Areas being provided canal irrigation supply particularly Bhakra areas where the additional canal supplies are being built up after constructing a dam at a cost of nearly Rs. 58 crores, the levy of betterment fee would appear to be reasonable. In fact the State has already passed necessary legislation in that regard and betterment fee is being

realised presently on an *ad hoc* basis as given in Appendix 'C'. Total betterment fee proposed to be levied in connection with Bhakra Canal irrigation is nearly 3.25 crores and the amount actually recovered is Rs. 2.56 crores. There was considerable agitation in the State against imposition of betterment fee on lands being provided with Bhakra irrigation supplies either for the first time or for increasing the capacity factor and water allowances. The levy of betterment fee on lands whose value goes up because of the introduction of irrigation supply is opposed on the ground that it is the State responsibility to provide means of irrigation to such lands and if the State failed to provide these means of irrigation in the earlier period, it is no fault of the people. Compared to people whose lands were provided means of irrigation in the last century, people whose lands are being provided irrigation have been hard hit in so much as these people did not derive income from land all these years. These people should be compensated instead of being punished with imposition of betterment fee.

It is more rational to have uniform taxation and levy of water charges on all the irrigated lands in the State instead. The imposition of any betterment levy on some lands for raising additional revenues is not equitable. This betterment levy of about Rs. 33 crores partly recovered to the extent of Rs. 2.56 crores does not find favour with the author of this paper.

(III) DRAINAGE CESS

The imposition of drainage cess under the provisions of the amended Canal Act, as referred to in the body of this paper, is also not reasonable since this cess is not leviable on all irrigated lands. This cess is to be levied on lands relieved of water-logging. People owning these lands who have been suffering for years past on account of low productivity resulting from water-logging caused by factors beyond their control, should be given relief and compensation rather than they should be taxed. Just as sanitation is provided by the Government in towns without taxing the people for this specific amenity, the State should provide drainage facilities for the irrigated lands financed out of the general revenues of the State.

(IV) SUBSIDY FROM GENERAL REVENUES

The expenditure on flood control works, drainage works and anti-water-logging measures is recommended to be charged to "Irrigation Projects", since the allocation of a part of this expenditure to other departments is a complicated matter. That the entire expenditure on flood control and drainage works is being met with from the budget of Irrigation Branch is only a matter of convenience and it has no special sanctity. In this connection it is submitted that the obstruction to the natural drainage was not caused by canals only but also by some roads built and maintained by the Buildings and Roads Branch of the State and some roads being maintained by Municipalities and *Panchayats*. The obstruction was caused by the Railways also. As we know, in case proper masonry works were constructed under railways, roads and canals along the drainage line, the acuteness of the problem with which we are faced today would have never occurred as the waters would have flowed down automatically. At the most some *Zamindara* help would have been obtained to cut down some obstruction in the natural drainage and make waters flow through openings of adequate capacity under these lines of communications. Even now our principal emphasis is on the construction of the masonry works rather than on the excavation of drains.

The allocation of expenditure to railways may, however, have to be done at some stage, and quite a few *crores* of rupees would be their share. However, the expenditure on the construction of bigger waterways under the roads which should strictly speaking be a charge on the road projects should be met from general revenues of the State.

The implementation of schemes such as irrigation-cum-drainage becomes necessary with a view to building up the prosperity of the State directly by stepping up production of agricultural crops and indirectly by providing large-scale employment, establishment of factories, building up of trade communications and many other gainful occupations of the people of the State. Such schemes can be built with funds raised from the public as loans. Again, funds are also necessary for maintaining and operating

these works. Some funds are recovered from the people in the form of direct charges such as land revenue and water rates. The additional funds for paying back interest on the loan and maintaining these works should come from the general revenues which should be augmented by the imposition of additional taxes. This is for the State Government to plan how to raise these revenues. One of the methods that suggests itself is the imposition of income-tax on the agricultural income. The subject is beyond the scope of the paper but if on an average 5 per cent of the agriculture is recovered from the people, the State would add to its general revenues annually an amount of nearly six *crores* or more *rupees*. The structure of the income-tax can be worked out by the experts.

In addition to the agricultural income-tax, it is a matter for the State to consider whether agricultural products such as foodgrains, cotton, oilseeds, exported out of the State should be levied a sales tax, which the State can levy. It is anticipated that foodgrains about 4 *crore maunds* (14,929 *lakh kg.*), oilseeds 40 *lakh maunds* (1492.92 *lakh kg.*) and cotton 43 *lakh maunds* (1,604.94 *lakh kg.*) would be exported out of the State. Levying a tax of three per cent on average, the State would get annually an additional revenue of nearly three *crores*.

Conclusions

(1) Anti-water-logging measures inclusive of flood control works are essential parts of irrigation system. Capital outlay on these schemes should be added to the capital outlay on irrigation schemes.

(2) On irrigated lands only one tax should be levied, may that be in the form of water rates or any other tax that the State Government may consider necessary for raising the revenues to pay back interest on the capital outlay and meeting maintenance and operation charges.

(3) The levy of betterment charges *vis-a-vis* drainage cess on lands denied irrigation facility for the decades past, is not a fair charge.

(4) Additional revenues required by the State may be obtained by levying tax on export of agriculture produce out of this State to other States of India and by the imposition of agricultural income-tax. The structure of this income-tax may be determined by the experts.

APPENDIX 'A'

RECOMMENDATIONS BY THE TECHNICAL COMMITTEE OF THE STATE FLOOD CONTROL BOARD FOR ESTIMATING DESIGN DISCHARGES

1. The design discharge should be worked out with the Boston Society Formula $Q = C\sqrt{A}$. The value of C should be kept as :
 - (a) For areas having rainfall less than 20 in. . . 200
 - (b) For areas having rainfall 20 to 30 in. . . 480
 - (c) For sub-mountainous areas having about 30 in. rainfall . . . 2,000
 - (d) For hilly areas having about 30 in. rainfall . . . Every case to be considered individually based on the actual study.

2. The works should be designed for full or part peak discharge as below :—
 - (i) For drainage works under Main Canal and Branches :
 - (a) Catchment areas less than one sq. mile . . . Full peak discharge worked out with the formula, $Q = C \times \sqrt{A}$.

 - (ii) For drainage works under distributaries of discharge 100 cusec and above :
 - (a) Catchment areas 10 or more than 10 sq. miles . . . Full peak discharge as arrived at with formula $Q = C\sqrt{A}$.
 - (b) Catchment areas less than 10 sq. miles . . . 75% of the peak discharge $Q = C\sqrt{A}$.

 - (iii) For drainage works under distributaries and minors of discharges less than 100 cusec . . . 50% of the peak discharge or designed discharge of the drain @ 4 cusec/sq. mile whichever is more.

- (iv) A.R. Bridges Full peak discharge
 $Q = CV\bar{A}$.
- (v) District Road Bridges Full peak discharge
 $Q = CV\bar{A}$.
- (vi) V.R. Bridges and Causeways 50% of the peak discharge, or designed discharge of the drain @ 4 cusec/sq. mile, whichever is more.
-

APPENDIX 'B'

FLOOD DAMAGES IN PUNJAB

Heavy damages have been experienced as and when there had been a heavy rainfall. As a result of floods of 1955, an area of about 49 lakh acres (19.83 lakh ha.) was submerged out of which an area of 27.86 lakh acres (11.27 lakh ha.) was under crops. The estimated loss to crops amounted to Rs. 18.93 crores. 7,26,897 houses were damaged and the damage to houses amounted to Rs. 17.33 crores.

508 human lives and 62,008 cattle heads were lost during the floods of 1955.

An area of about 39.00 lakh acres (15.78 lakh ha.) was inundated during the floods of 1958, out of which 18.96 lakh acres (7.66 lakh ha.) area was under crops. The damage to crops amounted to Rs. 30.32 crores. 1,65,992 houses were damaged and the damage to houses amounted to Rs. 5.08 crores. 67 human lives and 979 cattle heads were lost.

An area of 21.91 lakh acres (8.86 lakh ha.) was inundated during the floods of 1960, out of which an area of 16.92 lakh acres (6.84 lakh ha.) was under crops. Damage affected to crops was of the order of Rs. 17.11 crores. 1,24,962 houses were damaged and the damages amounted to Rs. 4.39 crores. 77 human lives and 561 cattle heads were lost.

APPENDIX C

BETTERMENT CHARGES ON BHAKRA CANALS (1959—KHARIF)

The rates of advance payment of betterment charges for Kharif 1959, in respect of the matured areas included in the Bhakra-Nangal Project and the Western Yamuna Canal remodelling project as fixed by the Government under Punjab Betterment Charges and Acreage Rates (amended) Act, 1959 are as under:

	RATE PER MATURED ACRE	
	Gravity flow irri- gation	Lift irri- gation maintained and oper- ated by landowners
	Rs. nP.	Rs. nP
1. Areas which will ultimately receive perennial irrigation	10-00	5-00
2. Areas which will ultimately receive non-perennial irrigation	5-00	2-50
3. Areas which will ultimately receive restricted perennial irrigation	7-50	3-75
4. Areas where water allowance is ultimately to be increased	2-50	1-25
5. Areas where non-perennial irrigation is ultimately to be converted into perennial irrigation	5-00	2-50
6. Areas where non-perennial irrigation is ultimately to be converted into restricted perennial irrigation	2-50	1-25

Provided that:

- (i) In the case of *chahi* lands in such areas, the rates of advance payment of betterment charges shall be half of the above rates;
- (ii) On areas under *sabqa-rauni*, where no crop is grown but occupier's rates are charged, advance payment of betterment charges shall not be levied;

- (iii) Where there has been a failure of crop in any area and occupier's rates have been remitted, the advance payment of betterment charges on such area shall be remitted proportionately; and
 - (iv) Advance payment of betterment charges shall not be levied on area under fodder crops, subject to a maximum of 10 per cent of the total matured area of each individual land owner.
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Economics and Financing of Water Resources Development Project

by

D. Mookerjee *

It is extremely important to initiate a careful economic analysis before a River Valley Project is initiated. In this analysis, the objectives, general perspective and setting up of the schemes should be brought out in detail. In schemes concerned with irrigation, the existing trend of land use, available cattle power, present farming methods, data about the yields, marketing outlet facilities should be clearly investigated. In case the irrigation is proposed to be carried out through the Co-operative Farming Societies—which should be the ideal agency for distribution of water—their general status and other organisational details should be investigated. Similarly, in the case of power projects, the existing trend in power use by various categories of consumers and all possible future market requirements should be carefully studied.

As in this country the River Valley Projects have to pay its return mainly from irrigation, a detailed study of the agricultural economy should be made. This study should deal with climatic condition, present economy without irrigation and anticipated economy with irrigation. It will be interesting to compare the anticipated agricultural economy with irrigation development with a future economy on the basis of price projection on a future date without the irrigation facilities.

Though the irrigation projects are being treated on a commercial basis, it has been seen that the payment capacity of the farmers has not been properly studied with the result that the method of repayment analysis which is usually assumed during the formulation of the

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project, completely changes. It is also incumbent on the project authorities or the State Government to make the water users familiar with the progressive education programme about the utility of irrigation water and consequent rise in their income. If the water users can be made interested in securing maximum returns from irrigation and information on technical assistance made available to them, the present problems involved in the transition from dry land to irrigated farming will be minimised and the problem of delay in the use of irrigation potential can be got over. This education programme should also be carried out through non-official agencies like Universities, Co-operative Farmers' Union and subsidised by the State. An economic study on repayment capacity of the water users would be very significant in deciding the water rates and other important levies usually imposed after irrigation project is sanctioned.

Soil survey as well as study of the detailed investigation of the land classification should be conducted for the specific purpose of establishing the extent and degree of suitability of the lands for sustained irrigation. This land use survey should also take into account the existing crop pattern, so that while planning a crop rotation programme, the present trend is not completely overlooked. As the problems of drainage as well as increase in salinity develop after a few years, not much importance is given initially to these factors while initiating a project.

While studying the cost benefit ratio, the present tendency is only to take into account the direct benefits from irrigation. It is, however, extremely important to lay equal emphasis on the various indirect benefits which accrue from an irrigation project. Some of these are enumerated below:—

- (i) Profits of local wholesalers and retailers from handling the increase in sales of farm products.
- (ii) Profits of all other enterprises between farm and the final consumers from handling processes and marketing the increase in sales of the additional yield in the farm products.

- (iii) Profits of all enterprises from supplying goods and services for the increase in farm purchase for family living and production expenses.
- (iv) Increase in the State revenue in the shape of agricultural income-tax, duty on petrol, diesel, etc.
- (v) Saving in foreign exchange which would otherwise be necessary to import foodgrains.

The benefits accrued by the general mass from an irrigation project in the shape of settlement opportunities, investment opportunities, stabilisation of local and regional economy should also be taken into account while assessing cost benefit ratio from an irrigation project.

It is not sufficient just to plan and execute a major irrigation project. It is simultaneously necessary to take effective steps to make irrigation schemes successful and attractive. The basic object of an irrigation scheme is to increase the yield of crops from the irrigated fields. To achieve this, it is necessary to plan a proper fertiliser activity programme along with the irrigation project. As soon as yield from the fields can be increased, which in any case has got to be done in case we intend to survive, the other subsidiary industries like proper storage of food crops, cold storage facilities, frozen food facilities, marketing and transport arrangements have got to be planned and initiated. Without these, the farmers will have no incentive to increase their productivity as otherwise the additional food will be wasted. The subsidiary industries will provide for much more employment to the rural people and thereby the living standard of common man can be raised. Sometimes it is not appreciated that as the projects are built, the expenditure on construction benefits, local industries, merchants, labourers and simultaneously create further employment facilities in the areas of manufacture from where manufactured goods are utilised in the construction of the projects.

In the case of flood control works, the indirect loss to the nation caused by the floods year after year is not taken into account while calculating the cost benefit ratio of a flood control project. The State Governments have

to find funds from their revenue resources for implementation of the flood control scheme. It seems that this subject requires careful thinking and it would, perhaps, be worthwhile following the practice followed in the United States where the cost of flood control and navigation is non-reimbursable. The Union Government should, therefore, bear the cost of all major flood control and navigation works. In the United States the irrigation water users do not have to bear the interest charges on the capital outlay. This special treatment has been made with a view to induce the farmers to go in for more production and indirectly help in the national economy. It is, therefore, suggested that such economic theories which have been established in the developed countries should also be introduced here as well.

Even after the completion of two Five-Year Plans, it has not yet been possible for us to make effective use of even 10 to 12 per cent of our water resources. How the effective conservation of the water resources can help to stabilise the economy of a nation will be evident from the following extract. In May 1954, President Eisenhower stated in forming a Cabinet Committee on Water Resources:—

“The conservation and use which we make of the water resources of our Nation may in large measure determine our future progress and the standard of living of our citizens. If we are to advance agriculturally and industrially, we must make the best use of every drop of water which falls on our soil or which can be extracted from the oceans. It is my desire that this Administration arrange effective and resourceful leadership in establishing national policies and improving the administrative organisation needed to conserve and best utilise the full potential of our water resources.”

Economics and Financing of Irrigation Projects in India

by

Kanwar Sain*

The financial aspect of any project may be considered firstly from the point of view of the financier, whether private or State, who has to incur the expenditure on the cost of construction and subsequently realises the cost incurred either by a system of repayment of the capital cost in a certain number of years (as in the case of U.S.A.) or by charging what is called the water-rate to meet the interest on the capital cost incurred and the annual charges on account of administration and maintenance.

Secondly, it may be considered from the point of view of the farmer, as the returns to the farmers must be commensurate with the costs he has to incur. The State construct the canal system to bring water to the boundary of each *chak*, but no further. The distribution system on the farm itself is to be put in by the farmer at his own expense. If irrigation is to be profitable to the farmer, it must give him sufficiently large returns to justify the costs of developing the land, constructing the distribution system and payment of water-rates to the State. The State may have to take special measures to ensure a reasonable margin to the farmer.

No irrigation project can strictly be said to be a financial success unless the returns both to the financier as well as to the farmer are reasonably adequate. As pointed out by Dr. Colin Clark in his recent paper on 'The Economics of Irrigation in Dry Climates', Dr. Penman's recent researches must necessarily lead to the drastic revision of all previous ideas about economics of irrigation projects. Irrigating a given area at a given time of the

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year, will use up the same amount of water almost irrespective of the crop which is being grown; irrigators, therefore, should always be growing the crop which at that time of the year and at the prices then prevailing, yields the highest economic return per unit of area and per unit of time. In general, this does not appear to have been the policy in the past. Charges for a given amount of water have often been differentiated in such a way as to encourage the growing of the less economic crops.

There is a third point of view which may be even more important than the first two. This is the national angle—an angle which can be brought to bear only by the Government of an independent sovereign country striving to make the country self-sufficient in food on a long-term basis. This angle has been to a great extent ignored in India in the past when considering the strategic and the economic as distinct from the narrow financial aspects of irrigation projects. The main reason for this attitude is perhaps linked with the history of a dependent India governed by an alien power.

Prior to 1854, all public works in India except railways were carried out by the Engineering Department of the Army under the superintendence of a Military Board. The expenditure was treated as ordinary and was charged against the revenue of the year. No capital or revenue accounts of the works were kept.

In 1858, great pressure was brought to bear upon the Government of India to promote irrigation under what was known as the guarantee system. A Madras Irrigation Company was formed with a Government guarantee of 5 per cent upon a capital of one million pounds (4,53,592 kg.). A few years later, another private company called the East India Irrigation Company undertook the construction of a system of canals in Orissa. The arrangements between the Secretary of State and the Irrigation Companies became so involved, that in 1867 the Government decided that irrigation works should be constructed by their own agency, which course was considered to be more economical and more amenable of control than the guarantee system. This involved raising a large capital in the United Kingdom by loans.

To safeguard that such loan capital was spent on projects which would ensure payment of interest on such loans, the Parliament of England appointed a Select Committee to suggest specific measures. In accordance with the recommendations of the Select Committee on Indian Public Works in 1879, it was decided by the Parliament that the results of irrigation works in India should be tested as below:—

- (i) By considering the capital cost of any work to be simply the sum actually spent on its construction.
- (ii) By debiting the revenue account yearly, with :
 - (a) the simple interest on the capital cost of the works at the commencement of the year;
 - (b) working expenses of the year.
- (iii) By crediting the revenue account yearly :
 - (a) with direct receipts;
 - (b) with indirect receipts.

The difference between (ii) and (iii) exhibited the profit or loss for that year. It was felt that irrigation works in India should be able to pay *within 10 years* of completion of opening the canal for irrigation and this was, therefore, the period fixed for testing the financial soundness of any project. The actual test prescribed was that the project should be able to earn sufficient revenue so as to *pay a certain minimum return* after deducting all working expenses *on the sum at charge in the tenth year of its opening*. The sum at charge was defined as the capital cost of construction plus the arrears of simple interest up to that year.

We have followed these criteria ever since. For works sanctioned before 1 April 1919, the 'minimum return' fixed was 4 per cent; for works sanctioned between 1 April 1919 to 1 August 1921, 5 per cent and for all works thereafter up to the partition of India 6 per cent. The limit has since been scaled down to 4 per cent.

Since the above criteria were fixed in 1879, conditions have changed very materially. Firstly, the country has become independent and has adopted a socialistic pattern as

its goal. Secondly, the production of food has not kept pace with the growth of population, resulting in a big deficit of food, which has to be imported from other countries, involving much foreign exchange. Thirdly, due to improvements in techniques of design and construction, it has become possible to undertake much bigger projects, requiring much longer period of development, as compared to 10 years laid down in 1879. Fourthly, the earlier irrigation works were constructed mostly to take advantage of the run-of-the river supplies and as such were less costly and yielded more and quicker profits. Indeed only such projects were undertaken as satisfied the test of productivity shown above. Most of such profitable schemes have since been tapped. The present schemes are mostly storage schemes which are more costly and all of them may not satisfy the productivity test devised by the Parliament of England in 1879 purely from the point of view of safe investment of capital raised by loans in England. Unless there is a change in the financial criterion fixed 80 years ago on capitalistic considerations, future development of this important resource of the country may be seriously jeopardised.

One of the most important points to which attention has not so far been paid in India is the actual wealth which the project creates. In Germany and France, it has been estimated that on navigation canal schemes, 45 and 47 per cent respectively of the capital cost is directly returned to Government in the form of taxes, duties, etc. This is not all. 31 per cent of even the operation charges are also returned to Government. There can be no reason to doubt that vast revenues are derived by the Central and Provincial Governments in India as a result of development of irrigation projects besides direct and indirect receipts.

It was for this reason that the Central Board of Irrigation and Power in November 1936, resolved:

"That an economic survey should be carried out with a view to estimate the direct and indirect financial benefits accruing to the Central and Local Governments from irrigation projects. If it is ascertained that the indirect revenues accruing to the Central Government are appreciable, the Government should see its

way to contribute towards the cost of future irrigation projects in order to encourage provincial Governments to extend irrigation facilities, which without such a subsidy would otherwise not be undertaken."

Projects for the development of water resources of an entire river valley are major capital investments. Their most important objective is to set in motion a cumulative process of growth by providing the region with the productive factors which are in short supply—water and power (in some instances navigation facilities and regulation of stream flow to avert losses caused by floods). Viewed in this manner, river valley projects have many characteristics in common with a general economic plan, of which indeed they are frequently an integral part. Like a general economic plan, a river basin development project must be understood to be much more than a simple decision to increase the rate of capital formation in a given area. It is a programme of strategy, of deliberate State interference with the price system in order to assure that the process of circular interactions really comes off and develops as planned, to use a recent formulation by Myrdal. It is important that the full implications of this formulation be clearly understood. In the first place a long-term investment project cannot be expected to be "remunerative" in the short run. Indeed, if it had been remunerative in the short run, it would already have been exploited by private enterprise. The heavy initial outlays required for a river valley project, the long-term and social character of its benefits, the uncertainty of its outcome and the fact that the emergence of even the tangible direct benefits depends upon a whole series of subsidiary organisational measures and joint investments—are factors hardly calculated to attract private enterprise. Secondly, whether we wish to refer to river basin projects as public works in the sense in which Adam Smith used the term, or as social overhead investments, or whether we emphasise their effects in terms of "External Economics", the planning authorities and the theoretical economists will have to find a rational conceptual framework in terms of which it is possible to describe the cumulative effects which are aimed at and which can be expected to accrue over their life span and not merely for a limited period of ten years or so.

Once a multipurpose project is completed, it yields several 'products' or produces many effects. These can be best visualised by classifying them under the different purposes for which the project is constructed. These purposes may be: (i) Irrigation, (ii) Generation of Power, (iii) Flood Control and (iv) Navigation.

The project affects the primary production in the area first through its effects on the total land surface and its use. It affects the total cultivated area in various ways. It increases it by making possible the reclaiming of certain lands that were not cultivated before because of lack of water; by making possible year round cultivation of lands heretofore liable to inundation by floods every year or by preventing the loss of land due to erosion. On the other hand, it reduces it by flooding some area under the lake, created by the dam, by water-logging, by preventing inundation of land whose cultivation depends upon it. Secondly, the dam makes it possible to utilise the available land for a longer period, leading to higher yields of existing crops, introduction of new crops, double cropping of land, etc., by making water available for irrigation over the area commanded by its canals. The primary direct benefits from irrigation would thus be : (i) increased agricultural production and (ii) saving in famine-relief and cognate expenditure to Government. In regard to (i) it should be noted, however, that its extent will depend, besides irrigation, upon other things, such as the availability of technical know-how and capital to farmers, appropriate system of land tenure, etc. Against gains from irrigation, however, must be off-set the costs incurred by the public authority in maintaining and operating the dam for irrigation purposes, and expenses incurred by it in settling new lands, building roads and other public works as also the investments necessary for irrigated farming.

Besides agriculture, the dam will also affect favourably or adversely forests and their produce, grass land, fish and wild life, and the balancing of both sides in these respects will also have to be done to estimate the benefits from them. The total increase in primary production in the area will also be affected by the good or bad effects produced by the dam on the level of sub-soil water and its effects on well irrigation. Losses or gains of scenic and

historical value because of the construction of the dam will have also to be similarly balanced. Any other losses like increased incidence of malaria in the irrigated area will have to be set off against the total benefits.

The extent of increase in agricultural production after irrigation will depend to a very significant extent on State policy in connection with land rights, land holdings, agricultural extension activity, public works programme, agricultural credit and marketing structure, etc. These will have to be carefully designed and planned beforehand. It is necessary to think ahead and with the aid of experts in their own fields to explore what would be the best crops and their combination and rotation that would give the highest increase in agricultural production. What types of land holdings will be the most beneficial? How and in what manner can farmers be initiated into the know-how of irrigated agriculture? What would be the most productive unit of cultivation?

Broadly speaking, we can roughly assume that in the short period (5 years after completion) chiefly the primary benefits will manifest themselves although even these will not reach their peak. In the long period (25 years after completion) the primary benefits will attain their peak. The secondary, tertiary and further benefits will also be flowing in and rising towards their own highest levels.

The criteria for evaluation of River Valley Projects must, therefore, allow the assessment of their overall contribution to the economic growth of the region. Such criteria of dynamic change cannot be measured by the traditional yard-stick of static efficiency in terms of marginal costs and marginal returns but only in terms of an indicator of the "progressive improvement in the economy of means", which the investment is likely to make from year to year. The best test for undertaking a new irrigation project is whether there is a further demand for the agricultural wealth that the project will produce, and not the financial return of 4 per cent or so. Shri G. L. Nanda, Union Minister during his visit to Jaipur in 1957 deplored the importance given to returns at a time when enormous sums in foreign exchange were being spent in importing food from outside India. A single acre of irrigated wheat would give an

average out-turn of 10 *maunds* (373.24 kg.) and would thus save Rs. 150 in foreign exchange in one year. It is, therefore, necessary that the irrigation projects should be considered from the overall economic consideration in creating additional National Wealth which they produce and not from the narrow financial yard-stick of percentage returns alone.

Economics and Financing of Irrigation, Drainage and Flood Control Works

by

N. S. Chohan*

The author, while preparing this paper, had in mind the following major objectives:—

(1) To emphasize the fact that the soil and water conservation is positively essential to India's progress and prosperity.

(2) To clarify the fact that great progress has been made towards soil and water conservation in the construction of large dams, reservoirs, diversion structures, canals and pumping plants for lifting surface and ground waters.

(3) To show that greater attention of the civil engineer to the prevention of soil water-logging salinity and alkali, by improving and lining the canals and reservoirs to reduce seepage losses is very important to progress.

(4) To show the fact that in many arid-regions of the country, more attention to adequate lands drainage and to efficiencies in the application of irrigation water is very essential; that in arid-regions, irrigation and drainage are separate and that both need the joint attention of the engineer to provide and perpetuate the soil and water conservation that are basically essential to country's progress.

(5) Engineering studies and data on which contemporary American Flood Control Projects are based.

(6) To spotlight the various technical, financial and other aspects of the schemes which should be adequately dealt with in project reports in order to justify a new project.

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(7) Consideration of other economical aspects :—

(a) Design

(b) Improvement in equipment for effecting economy

(c) Suggested criterion for financing irrigation, drainage and flood control works.

(8) *Conclusions* : The 27 hundred million people in the world of today have many urgent needs, the first in importance being adequate supply of food which can be produced only by efficient soil and water conservation in all the countries. In addition to its use for food production, water is essential to our world-wide welfare in many ways. Soil and water conservation are, therefore, vital necessities for the millions who live today and will be even more essential for a greater number of people of the days ahead. Soil conservation has come to mean proper land use, protecting land against all forms of soil deterioration, rebuilding eroded and depleted soil, improving grass lands, wood lands, wild life lands, conserving water for farm and ranch use, proper control and use of water to provide for drainage, irrigation and flood prevention, building up soil fertility and increasing yields and farms and ranch income.

We need to give increased attention to the improvement and reclamation of land in its broadest aspects, including soil productivity, irrigation, drainage and replenishing of ground water reserve if we are adequately to feed and clothe our people to continue to improve our standard of living. Conserving and improving our land and water resources should, therefore, be considered high priority business.

The engineering problems involved in soil and water conservation may be divided into the five following phases :

(a) Erosion Control

(b) Drainage

(c) Irrigation

(d) Flood Control

(e) Land Clearing.

In this paper, author has concentrated attention on almost all the above phases.

Land Drainage for Soil Conservation

ARID-REGION LAND DRAINAGE OBJECTIVES

Some of the major objectives of land drainage are to:

(1) Keep the water-table depth under complete control and deep enough to prevent upward flow and evaporation of soil water with resulting concentration of soluble salts in the root-zone soil.

(2) Maintain downward flow of water in saline and alkaline soils.

(3) Prevent the accumulation of excess soluble salts in the soil root-zone and on the surface of irrigated land.

(4) Obtain general and country-wide recognition of the fact that land drainage is essential to the permanence of arid-region agriculture and that the many benefits of drainage are greatly exceeding the costs.

DRAINAGE PROCEDURE TO OBTAIN THE OBJECTIVES

Source of the procedures and practices that are essential to attain the drainage objectives are:

(1) Reduce, whatever possible, the salt contents of irrigation water.

(2) Increase the permeability of soils in which the resistance to water flow is high and extend the practices of measuring the flow of water in soils.

(3) Design and construct drainage systems that are especially adopted to the physical condition of each area that needs drainage.

(4) Design and locate drainage pumping plants to get maximum water yield per foot of drawdown.

(5) Improve irrigation methods, measure irrigation waters and increase irrigation efficiency.

BENEFITS FROM DRAINAGE

Good drainage system provides economic benefit by:

(1) Increasing the productive land areas on the farm without extending its boundaries by bringing under cultivation pond areas, and marshy spots, the beds of which usually have great agricultural potentials.

(2) Improving the quality and increasing the yields of crops.

(3) Providing greater uniformity of fields thus making the farms more easily worked by removing the mud holes and wet spots.

(4) Preserving fertilizers.

(5) Reducing floods and consequent loss of crops.

(6) Decreasing of danger of drought by:

(a) Reducing evaporation from the soil surface and improving soil structures.

(b) Providing larger volume of available soil water for the plant roots by developing deeper root-zone soils.

(7) Improving the chemical conditions of the soil by:

(a) Removing excess of alkalis and acids.

(b) Aiding nitrification and decay of organic matters.

SOCIAL AND COMMUNITY BENEFITS OF DRAINAGE

Drainage system provides social and community benefits by:

(1) Improving sanitary conditions, thus making rural life more pleasant.

(2) Making the appearance of agricultural land better which results in increasing the market value and stimulating the pride and interest of the farmer in his work.

(3) Facilitating the construction and maintenance of good and permanent rural highways.

ARID-REGION DRAINAGE ESSENTIALS

The engineers and the owners and operators of irrigated farms in arid-regions and all farm advisers should know what they can and must do in irrigation and drainage to perpetuate soil and water conservation. The experience shows that:—

(1) Irrigation and drainage cannot be divorced in arid-regions. They must be considered as inseparable.

(2) Carelessness and inefficient irrigation of land is extremely expensive to the irrigator and to the owner of lower lands and drainage system; so must be prevented.

(3) Drainage alone is not enough to reclaim and make productive water-log, saline and alkaline lands. Improved irrigation practices and modern soil management methods are indispensable and must be developed.

(4) Adequate maintenance of drains is essential.

WATER STORAGE FACILITY

Very substantial world progress has been made towards water conservation by the use of water storage facility. This includes both surface reservoirs for irrigation and flood control and ground water reservoirs for which water is obtained by artesian flow of pumping.

WATER CONVEYANCE FACILITIES AND PROBLEMS

Efficient conveyance of water to field is a problem of great concern to the engineer as well as to the public. Excessive seepage losses are costly in many ways. One of the great disadvantages is water-logging. Water-logging, thus making millions of acres of land un-productive, lining of canals should, therefore, be considered.

WATER APPLICATION METHODS AND PROBLEMS

One of the major problems in soil and water conservation in arid-regions is to find how economically to apply adequate depths of irrigation water to the soil and also how to prevent the application of excessive depth of water which cause deep percolation, shallow water-tables and water-logging of root-zone, soil salinity and alkali problems and sterilization of soils. Irrigation water is applied

to the surface of soil by flooding, in furrows and by sprinkling. Major problems confronting the engineers are: how to best prepare the lands for the irrigation and to irrigate the land efficiently. Land levelling for irrigation, by hand method is very common, modern methods with modern machinery are, therefore, urgently needed. Engineers have not yet given enough attention to the irrigation of soils. The dominant factors which determine the appropriate depth of water to apply in each irrigation are soil texture, structure and root-zone depth. Only very few soils can retain more than $1\frac{1}{2}$ in. (3.8 cm.) depth of available soil water per foot depth of soil from one irrigation. Some soils retain less than even $\frac{3}{4}$ in. per foot depth of soil. In root-zone soils of 4 ft. (1.2 m.) depth, the maximum water depth in a single irrigation should, therefore, not exceed 6 to 7 in. (15.4 to 17.8 cm.). This can be determined, for example:

D = Depth of root-zone soil in inches,

pac = The percentage of available water on the dry weight basis,

As = The apparent specific gravity of soil, and

d = The depth of water in inches to fill the soil available water capacity.

Then $d = As \times Pac \times D$

For example, for a soil of 1.30 apparent specific gravity " As " having an available water capacity " Pac " of 5 per cent and depth ' D ' 60 in. (152.40 cm.) the depth of water needed, if spread uniformly, would be, from this equation:

$$d = 1.3 \times \frac{5}{100} \times 60 = 3.9 \text{ in.}$$

The above method makes it easy to compute depth of water applied which in this case is 3.90 per cent.

Engineering Studies and Data on which contemporary American Flood Control Projects are based

The flow of rivers is caused by water released on the earth's surface from rainfall or snow-melt. A portion of such water is disposed of by evaporation or other means,

and does not reach any stream. The remainder either percolates into the ground, most of it eventually emerging and entering a stream, or else enters the stream directly by surface run-off. Such run-off may occur promptly or be delayed, depending upon whether the precipitation is in the form of rain or snow.

Ordinarily, where there is an alluvial flood control problem the river lies in an alluvial plain limited by fluffs. For most of the time it confines itself to a well defined bed, bounded by the banks (or "high banks", as they are often called), which bed occupies only a fraction of the alluvial plain. If the surface run-off resulting from rainfall or snow-melt exceeds the capacity of the bed, the river overflows onto the alluvial plains. This is a flood. It becomes of economic importance if the plain has been settled and developed by man.

It is to be noted that there is nothing abnormal about a flood as such. The area between high banks, which we call "the river", is nature's device for handling ordinary flows. The alluvial plains is equally nature's device for handling exceptional flows. Strictly speaking, it is as much a part of the natural waterway as is the river bed proper. If we occupy the alluvial plains, we must expect to be flooded periodically, or else must interfere with the course of nature by keeping the excess water away from its destined course. Mankind has always settled upon the developed alluvial plains, and always will, since in many respects they are ideal for agriculture, cities and transportation routes. But in one way or the other by accepting flood damages or by building flood control works, the price of this occupation must invariably be paid.

Flooding of an alluvial plain may be prevented in principle by four means, alone or in combination:

- (a) Barring out the flood; i.e., by levees, river walls, or conduits.
- (b) Increasing the carrying capacity of the river proper; i.e., by channel improvement or channel rectification.
- (c) Decreasing the flow by diverting part of it; i.e., by diversion channels or floodways.

- (d) Decreasing the flow by temporarily holding back part of it; i.e., by reservoir or detention basins.

The basic purpose of flood control study is to decide what works of the above type shall be built, where, of what size and design and at what cost they shall be built. Associated with this should be an economic study to determine what potential damages will be averted by the works and whether this benefit justifies the cost.

Flood control is a measure of protection against an anticipated future occurrence. The normal and natural demand of those threatened by floods is protection against the *maximum probable flood*. In the present state of our knowledge, no exact quantitative value can be assigned to this entity but there are various methods of approximating it. Having done so, we may design our work either for this particular flood or a lesser one, determined as the result of economic study. To do so, we must know the characteristics of the flood against which we are designing, both in its natural stage and as it would be affected by the protective works themselves. Once the problem is solved, the essential dimensions and other features of the protective works are given and the planning of a project reduces to the structural design of these works.

In studying the characteristics of the expected floods, a series of questions arises in a logical order. Assume a river, a point P thereon, and a series of points Q , R , etc., downstream from P .

(i) Since precipitation causes floods we wish to estimate the maximum precipitation over the drainage areas above P and also on occasion the frequency with which lesser precipitation will occur.

(ii) We next wish to estimate how much of this precipitation will enter the river in time to contribute to the flood at P .

(iii) From this we wish to reduce the hydrograph of the resulting maximum floods at P , and also the hydrograph of lesser floods.

(iv) We also need to know the frequency of floods of various sites at A . This is sometimes used as an alternative means of attacking the problem stated in (iii), and

more often in connection with the economic study on which is based the justification of a flood control project.

(v) Given the hydrograph and frequency of any flood at P, we must know how its characteristics vary as it proceeds down the river to points Q, R, etc. This is known as 'routing' the flood in the open river. When this step is completed, we know the characteristics of any flood, along the entire length of the river, under the conditions now existing.

Assume next that a flood control project is being considered involving either levees, channel improvements, diversion channels, or combination thereof. We wish to know how these would affect the natural characteristics of the flood as for example; how high the surface would rise if confined between levees, how much it would be lowered by channel improvement, what would be the flow in a diversion channel, etc. Given the answers we can specify the height, capacity, etc., of the works of these classes needed to control the flood.

(vi) Alternatively, assume that a project is being considered involving a reservoir. We wish to know what relation exists between height of dam, capacity of reservoir, capacity of outlet and spillway, volume of waters in reservoir, and inflow and outflow of water before, during and after the flood. These factors are inter-related and from a study of them we may specify the height, reservoir capacity, spillway and outlet capacities and other characteristics of a dam needed to produce the desired effect on flood flow.

Technical and Financial Aspects of various Irrigation Drainage and Flood Control Projects which should invariably be dealt with while preparing the Project Report

IRRIGATION PROJECT

(A) Investigation required

(i) Existing irrigation facilities from different sources such as canals, tubewells, tanks, wells, etc., indicating gross commanded areas and culturable commanded areas, irrigated areas and extent of water utilized.

(ii) Proposed facilities indicating gross commanded areas, culturable commanded areas and areas proposed for irrigation.

(iii) Land already under cultivation with dry crops to be brought under cultivation.

(iv) Land to be newly broken up and brought under irrigation.

(v) Stabilization of existing irrigation.

(vi) Scope of double cropping in the commanded areas under the project.

(vii) (a) *Proposed annual Irrigation Area. Percentage of C.C.A.*

(i) *Kharij*

(ii) *Rabi*

(iii) *Perennial*

Total

(b) (i) Soil surveys and pattern of crops indicating existing and proposed areas under various crops.

(ii) Number of experimental and demonstration farms existing and those required to be set up to adequately cover the commanded area of the project as advised by the State Agricultural Department.

(c) Existing and proposed duties, delta and intensity of irrigation.

(d) Monthly requirements of crops based upon the proposed crop pattern.

(e) Losses due to evaporation, absorption and transmission from the canal system.

(f) Period of development of irrigation and its stages, if any.

- (g) (i) Direct additional benefits in foodgrains and other crops.
- (ii) Set of yard-sticks adopted for additional production per acre of irrigated land for the principle crop and the basis thereof.
- (h) Water supply provided to towns and villages, if any.
- (j) Any likelihood of water-logging taking place in the project areas.
- (k) (i) Provision made for drainage facilities and anti-water-logging measures.
- (ii) The cost per acre of C.C.A. for the facilities.
- (iii) Adequacy of this provision for the purpose envisaged.

(B) *Alignment of Main Canals and Branches: Considered in view of the following*

- (a) A contour map showing existing and additional irrigation canals, principal towns, rail-roads and highways, etc.
- (b) Alternative alignment of canals.
- (c) Final alignment of main canals and branches.
- (d) Test pits or boring data for canals excavation and foundation of structures.
- (e) Investigation for construction materials.
- (f) Land acquisition and compensation for properties.
- (g) Malaria control.

(C) *Consideration of Designs and Drawings in view of the following*

- (a) Remodelling of the existing system, if any.
- (b) Capacity factors, free-boards and other assumptions.

- (c) L-Sections, X-Sections of canals and branches.
- (d) Cross drainage works, bridges, regulators, etc.,
- (e) Methods of arriving at the discharges of cross-drainage works.
- (f) Regulating arrangements of off-taking channels.

(D) *Regarding Distribution System*

(a) Survey and alignment of distributaries and fixation of commanded areas of each.

(b) Calculations of head discharge of each distributary.

(c) Detailed designs and estimation of cost of distributary system, to provide a basis for estimating the cost of other distribution system, including minor and water-courses, as distinct from field channels to be constructed by the beneficiaries.

(E) *Development of Irrigation*

(a) Period required for realising full benefits of irrigation envisaged in the project.

(b) Pace of yearly development envisaged in the following form:—

Year following the one in which the irrigation potential is actually created	Percentage of the area irrigated to the potential created
1st.	
2nd.	
3rd. etc., etc.	

(c) Programme of allied developmental activities proposed in the project are to endure speedy development of irrigation, levelling of land, demonstration farms, roads, *mandis* and colonization, etc.

(d) Estimated cost of the developmental work mentioned in (c) above and its adequacy. Approximate period required for its implementation.

(e) Proposals for setting up community development blocks over the entire area to be served by the project after sanction of the project.

(f) Provision made in the project estimate for marking the alignment of water-courses at site by the project authority on the village maps.

ESTIMATES

(a) Estimated cost of the various stages of project and foreign exchange components thereof.

(b) The year to which the rates adopted in the estimate pertain.

(c) Allocated cost of irrigation, power, flood control, navigation and other purposes served by the project as considered equitable by the State Government.

ANALYSIS OF RATES

(a) Labour out-turn for various items.

(b) Materials required for unit quantities of various items of works.

(c) Current schedule of rates in the area and rates proposed comparing with rates on similar project.

FINANCIAL RETURNS AND BENEFITS

Consideration on the following aspects:

(a) Phased or year-wise programme of expenditure of various units of the project.

(b) Phased or year-wise programme of development of irrigation, power and navigation, etc.

(c) Compulsory irrigation cess proposed.

(d) Scale of water rates proposed for various crops, comparison with rates prevailing on existing project in the region/State.

(e) Betterment levy proposed.

(i) Rate lump sum or in instalments.

- (ii) Period of recovery.
- (iii) Date of commencement.
- (iv) Total estimated yield.

(f) Comparison of above rates with the rates proposed for other projects in the State.

(g) Concurrence of the State Revenue Department in regard to the rates of betterment levy, water rate, compulsory irrigation cess and flood cess, etc.

(h) Statements of gross revenue from the different functions of the project.

(j) Statement showing maintenance and establishment cost, interest charges and net revenue.

(k) Capital cost per acre of annual gross irrigated areas.

(l) Productiveness of the project in terms of percentage of financial return.

(i) at the end of 10 years.

(ii) on full development.

(iii) when the entire revenue from betterment levy as anticipated has been realized.

PUBLIC CO-OPERATION AND PARTICIPATION

(i) The degree of public cooperation and participation expected for the project.

(ii) Views and attitude of the beneficiaries about the advantages from the project irrespective of water rate, betterment levy, and irrigation cess, etc., as proposed.

(iii) Allowance made in cost estimate for people's participation.

The experience on irrigation, drainage and flood control works has shown that the engineers are put to an awkward position after the assess on any project is visualized on completion. It is often criticised in political circle. As such it is most essential that all the projects at initial stages

must be weighed in terms of the above aspects to avoid discredit to the engineering profession at latter stages.

ECONOMICS IN DESIGN AND EXECUTION

It is possible to effect considerable economy in the design costs by having a central organization and a proper control over the operation in the field. The economy can be affected as a result of the following:—

(i) Exclusive use of the pool rather than the project system of design.

(ii) Insistence upon the principles of standardisation in design on the various projects.

(iii) Formulation and close observation of sensitive production indices.

(iv) Insistence on the complete definition and approval of all fundamental elements of the economic design before undertaking rapid mass production of detailed drawings.

(v) Rigid adherence to the established lines of organization.

(vi) Design engineers should be allowed to visit other projects of similar nature in the country or abroad in order to collect the needful data and to hold discussion with the engineers under whose guidance the projects have been completed.

The principles can, however, be modified according to the situation and be applied to the design organization.

IMPROVEMENTS IN EQUIPMENTS FOR AFFECTING ECONOMY

The following are the improvements developed by the manufacturers of equipments during the last few years:—

(i) Change-over from slow manually operated levers to easily manipulated hydraulic air or electric control, on excavating and hoisting machinery.

(ii) Change-over from petrol engines to diesel engines which are cheaper in operation and maintenance costs.

(iii) Introduction of special alloys and metals such as aluminium, booms or drag lines, increasing the reach, speed and capacity of the machine.

(iv) Improvement in safety features.

In addition to all this, a great economy can be exercised by utilizing the services of experienced design and field engineers as well as skilled labour who have worked on other similar projects not in the State alone but having been completed successfully all over the country.

SUGGESTED CRITERION FOR FINANCING IRRIGATION, DRAINAGE AND FLOOD CONTROL PROJECTS

To promote irrigation, the government in the U.S.A. actually subsidizes it by charging no interest on construction cost. The revenue from irrigation works is in most cases supposed to repay in 40 years without interest. In general, the subsidizing of irrigation is warranted so long as the total benefits to the nation exceed the total construction cost and to the extent that the total benefits exceed those costs which the direct beneficiaries can afford to assume. But as a matter of fact, both the direct and indirect benefits must be taken into account while testing productivity of project. It would also seem fair to consider a particular irrigation project required to ensure a bare standard of living for a certain backward section of the country as a part of the overall irrigation system in the province and apply the test of productivity to this canal system as a whole instead of to the individual project. It has been accepted for a long time that the benefits accruing from irrigation and other projects cannot be measured only in terms of direct addition to revenue. These works also bring a large number of indirect benefits to the community and to local bodies, to provincial as well as Central Government. The existing standard of productivity, *viz.*, 4 per cent return on the capital cost, 10 years after the completion of the project should not thus be a criterion for determining whether to go

ahead with a particular scheme or not. All possible indirect benefits must be taken into account and if a particular project is likely to add to the national wealth of the province it should be pushed on as long as the irrigation system as a whole remains productive.

Conclusions.

(i) I trust that the Board will make a definite recommendation to the Government of India to set up machinery by which these additional benefits could be assessed and taken into account, in determining the productivity of irrigation and flood control projects which are presently under investigation all over the country.

(ii) As usual, this year too (1962), floods had taken a toll of sixteen human lives in Punjab State. 1966 villages were affected having spread over 6,90,000 acres (2,79,233 ha.) with a population of 7,88,000. The number of houses damaged were 13,510 valued at rupees 24,23,450. The damage caused to properties of local bodies was estimated at Rs. 5,23,000 and to roads and buildings at Rs. 31,90,000 and Rs. 1,00,000 respectively. Damage to irrigation works was put at Rs. 6,52,000 and to standing crops of about Rs. 5,82,000. In all, besides a toll of sixteen human lives and turning into unculturable thousands and thousands acres of fertile tracts of lands, the damage so caused was to the order of about Rs. 6½ crores which still is not abnormal in the State.

Keeping in view the heavy damages caused almost every year, it is most imperative that some concerted efforts should be made to overcome this havoc in the economical interest of the country as a whole. River valleys are not confined to state boundaries and various schemes have to be co-ordinated and interrelated for the achievements of maximum results. The projects themselves require large financial outlays for which control, planning and Central assistance can only prove helpful. Lastly, it is clear that the project of such significance to the economy of the country and involving financial outlays of such magnitude as may be necessary cannot be implemented successfully without support and co-operation of affected people. The ways in which this can

be secured vary from project to project. Following suggestions are, however, made for consideration:—

- (i) that the rivers and *nallas* should be canalised as far as possible and the areas thus saved can be acquired and used by the State for growing forests. Fertile lands made worth cultivation can be disposed of by auction to interested parties or handed over to the landless people on reasonable prices.
- (ii) Or the affected people should be organized through *Gram Panchayat* and made to offer free unskilled labour in their own areas compulsorily.
- (iii) Or levy of betterment fees may otherwise be imposed on the affected people.
- (iv) Or land under drains and floods control works should come out of the common pool, the cost of which in the estimate can be considered as contribution from the beneficiaries. The land required for this purpose can be demarcated at site by the irrigation department and the Director of Consolidation of Holdings should arrange to allot the same to the canal department out of the common pool; where consolidation of holding work is still going on. In case it is completed already in the villages, the required areas of land should be arranged by the *Gram Panchayats* themselves and put to the disposal of canal department.
- (v) Or, at least 25 per cent of the cost of drainage and flood control works should be borne by the beneficiaries and rest by the government. The recoveries can be made alongwith land revenue by the Revenue Department say in 25-year period.

To accomplish this, it is very essential that wide publicity is made in the villages affected by the Public Relation Department to make the people understand their interests in advancement of the above contributions. This is essential.

Besides, the objectives outlined above can only be accomplished to a greater degree of certainty if the status of engineers is raised monetarily as well as socially for which definite recommendation should be made by the Board to the Planning Commission for upgrading the engineers to the level of Indian Administrative Service Officers so that they could devote themselves for the national cause more enthusiastically when their services are properly secured and they are well fed. This will be the right step towards the removal of frustration all over the country in the engineering profession. Also, they should have strong and active support of the legislative, administrative and judicial officials besides public co-operation to solve the problems of soil and water conservation.

Economics and Financing of Irrigation, Drainage and Flood Control Works

by

G. P. Gupta*

Introduction

The development and prosperity of a country depends upon the technical soundness of the Irrigation Projects. Of late, a tendency has developed in reckoning the soundness of a project more on temporary economics. Such projects may remain sound for a short-term but subsequently they are likely to become a burden on the State and a menace to the public in general. The economics and technical utility of a project, therefore, needs be worked out on a well founded and long-term basis. In this connection, the following few suggestions are made.

Preparation of Projects

The efficiency of a project depends upon the correctness of the basic data. For example, if the catchment area and the rainfall data of a drain is incorrect or the alignment of a canal is faulty, even the best quality of construction will not be able to undo the basic mistake. I am, therefore, of the opinion that the best and experienced staff may be posted on the survey, collection of data and preparation of projects. At present, little checks are applied in the surveys made by junior subordinates and the whole scheme is based on such data. The checks that we apply are needed, in fact, more on the basic data and preparation of project than on the quality and accounting in subsequent construction.

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Alignment of Canals

The alignment of canals plays an important role in the subsequent development of a tract. If a canal is constructed across the slopes of a tract, it will act as a *bund* and dam the rainy water. The natural passage of water is throughout the slope. As we cannot construct the siphons and drainage crossings at every point, the flow will have to be artificially regulated on a few points. This will ultimately cause water-logging. It is suggested that canals may not be constructed across the slopes as far as possible. These should be taken along the slopes.

The canals should be generally aligned through the highest points of a tract so that it may divide the watershed clearly. In such a case, there will not be any drainage problem. When a canal has to pass through depressions and valleys, we bring restrictions to the flow of water. Accordingly, efforts may be made to follow the ridges subject to efficiency and economy even if the length becomes a bit longer.

Irrigation and Water-logging

In West and East Punjab and U.P., many tracts have become water-logged due to canal irrigation, resulting in reduction in the yield of crops and other sufferings to the people. Before we envisage the scheme of bringing river waters artificially on a land, we must provide safeguards against the above menace. For this the following procedure is suggested.

CANAL AND DRAINAGE

After completion of canal project, generally we postpone the completion of the drainage project of the tract. As the canals run, the sub-soil water-level goes on rising till the problem actually becomes acute. To check up the evil of water-logging, drainage project for the land should be taken up prior to canal project.

PERENNIAL AND NON-PERENNIAL CHANNELS

At present the decision whether a channel should be perennial or non-perennial depends upon the supplies available in a river. In my opinion, this decision should be

based on the depth of sub-soil water-level below the natural surface level. In case, the sub-soil water-level is below 30 ft. (9.14 m.) say, we may have perennial channels. When it is above this level, we should have non-perennial channels. This decision can also be based on the other climatic conditions of the tract such as intensity of rainfall, natural soil, etc. Another problem in this connection that has to be faced by the engineers is that when the canal irrigation is brought in a tract, the sub-soil water-level is quite low. Subsequently, the sub-soil water-level rises high. As per general practice, the *zamindar* establishes a right of canal water for irrigation and so under this commitment and the general public pressure, we are not able to change a perennial channel into a non-perennial channel to check up the rise of sub-soil water-level. The Canal Act ought to be amended to permit the engineers to effect such a change when the country needs it.

TUBE WELL-CUM-CANAL IRRIGATION

The canal adds the water to the sub-soil zone while the drains and wells take it out. With the incoming of the canal, the *zamindars* start depending entirely on the canal. The well irrigation becomes extinct because the well water is costlier and less fertile than the canal water. In the larger interest of the country, it is necessary that the well irrigation and the canal irrigation may be balanced in a tract to check up the water-logging. Alongwith the canals we should have State tubewell irrigation. In order to keep the tubewell in action, the rates of canal water and tubewell water should be made the same. We may increase the rate of canal water a bit more so as to compensate the loss incurred by tubewells. A rigid policy free from public pressure will have to be followed about the imposition of tubewell irrigation in a canal area to save the country from the subsequent sub-soil water troubles.

IRRIGATION FROM MAIN CANAL

As per general practice, we do not supply water to the *zamindars* from the main canal. The *zamindars* adjoining to the main canals are the greatest sufferers because their contribution of land to the canal construction is maximum and still they do not derive any benefit out of it. In

some cases, where the levels permit, we permit ditch channels to run parallel along the main canal to feed the adjoining area. If we give supplies to *zamindars* from main canal by rigid outlets instead of such ditch channels, lot of money now spent on land, construction and maintenance of such ditch channels can be saved.

LINING OF CANALS

Experience has shown that within 25 to 50 years of the construction of a canal, the areas become water-logged. At this stage, we start thinking of lining of channels. The longitudinal section, cross sections and capacities of lined and earthen canals are absolutely different. Designs of their masonry works are also different. Accordingly, it is not only extremely costly to line an existing earthen canal but, even the requisite efficiency cannot be achieved in such a subsequently remodelled canal. It is worthwhile to take up lining of main canals and the distributory system in the first instance.

Conclusions

Thus for working out the cost of a canal construction project, we should take into account the cost of drainage, tubewells and lining as these are the basic requirements. Economics of a project worked out on such lines will be in its true perspective and the utility of such works will be on a long-term basis.

Economics of Irrigation Projects : Criteria for Justification

by

R. Rangachari*

SYNOPSIS

The important role played by the Government in the field of water resource development is of a magnitude which calls for a proper economic evaluation of these projects. Various criteria followed for the evaluation and justification of irrigation projects in India have been discussed and compared with the experiences of the United States of America. The effectiveness of these criteria to evaluate the economic impact of these schemes adequately and the limitations of these criteria are discussed. General adoption of Improved Benefit Cost Analysis for evaluating such projects is suggested.

Introduction

All decision-makers strive to make the 'most'—as they conceive of the 'most'—of the input resources, whatever be their nature⁽¹⁾. There cannot, however, be one universal definition of what the 'most' should mean. Certain types of resources' planners, such as commercial firms, have a fairly clear cut idea of what means 'most' to them. Governmental units have somewhat greater difficulty in defining the same, more so in the fields of socio-economic national development programmes. But all of them are constantly attempting to do something in the various ways possible for them to achieve the best from the input resources.

Usefulness of Analytical Aids

In tackling problems of choice, it has always been found most advantageous to think ahead of the various possible courses of action and evaluate the probable consequences

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of the alternative policies, rather than, say, draw lots, or toss a coin, to help in decision making. Some of the fundamental analytical aids in this context have long been available and made use of, and further refinements are constantly being attempted, e.g., in theory of choice, economic theory, statistical analysis, etc. Recourse to such aids has proved very valuable in improved planning.

Development of Analytical Aids

In recent years Governmental units have turned increasingly to a *quantitative* evaluation of alternative policies open to them. The important role played by 'operations research' or 'operations analysis'⁽³⁾ in the comparison of military tactics, military development and procurement policies since the World War II, could be quoted as an instance of such usage. Another such use is the cost benefit analysis adopted for the evaluation of water resource development schemes.

Application in Government

The trend towards a greater use of quantitative analyses in the evaluation of various policy approaches by Governmental units is a rational response to a very real need. The investments of public funds in various nation building activities have spectacularly increased from year to year. For instance, in the sphere of Water Resources Development programmes, Government have, for various reasons which we shall not go into here, a near monopoly for all the activities under this sector. The absence of a built-in mechanism which would lead to greater efficiency, the comparative freedom enjoyed by Governments from the positive checks which are obtained in private enterprises which force them to seek profit motivating innovations and more efficient methods in order to avoid being edged out of competitive business by superior rivals, and the adoption of 'requirements approach', make it all the more necessary for the Governmental policy makers to exercise the greatest sense of caution and responsibility. What are the various criteria adopted by the planners for selecting water development projects for taking them up for execution in relative priority *inter se*? How could these criteria be improved/changed?

Financial Returns Test

About a hundred years ago, in 1867, the Government of India took a basic decision that irrigation works (and railways) should be got constructed by their own agency, instead of leaving such works to private entrepreneurs, who were till then being encouraged to invest in them, if need be with some guarantee of a minimum return on the investment. Irrigation was to be managed by the Government as one of their responsibilities to the people of the country. Simultaneously with this decision to develop irrigation in the public sector, the question of safeguarding the public investments engaged the attention of the Government, and attempts were made to evolve suitable criteria for the justification of such projects. In the words of the Select Committee on Indian Public Works, which reported to the House of Commons in 1879, "The financial returns of works of irrigation are (in the opinion of your Committee) the best test of their utility"(*).

Present Practice in India

In accordance with this recommendation, all the proposed irrigation works in India were tested by their probable ability to earn sufficient revenues which would, after deducting the working expenses, enable payment of a minimum return on the sum at charge at the end of 10 years from the completion of works, the sum at charge being defined as the capital cost of construction plus the arrears of simple interest up to that year(*). This basic test for the justification of irrigation projects has held its ground till this day, though the actual figure of interest to be returned was changed from time to time. However, Government had for various reasons undertaken certain works even though they did not satisfy this financial criteria.

Is the Test Adequate?

The criteria of a financial return for testing irrigation works came under considerable criticism from the early days. It was stated that the 10-year period adopted was too small to allow for the full development of irrigation benefits, the more so in new areas, the development in such cases taking as much as 30-40 years in certain instances. It was pointed out that financial returns did not

fully reflect the economic wealth accruing to the region and the community in particular and to the country as a whole as the result of such irrigation works. It was contended that one of the reasons advanced for entrusting water resource activities to Government was that it would be difficult for private firms or individuals to identify the various beneficiaries of the scheme precisely enough to charge them for their gains, whereas this difficulty was got over by Governmental development. It was generally recognised that besides the direct and indirect receipts which could be accounted for, more wealth was being added to the nation by these projects. Socio-economic surveys, which examined the economic effects of irrigation benefits from works which were considered to be unproductive in the conventional sense, brought to light that substantial returns were actually being derived to the community^(*)(¹). It was also felt that due to the ever increasing cost of labour and material and the gradual exhaustion of simpler and cheaper projects, progressively greater outlays were necessitated for equivalent benefits as time passed^(*).

How far have Indian Schemes satisfied the Test?

Partly for these reasons and partly due to special considerations such as the need for balanced regional development, for famine relief, etc., Government have continued to sanction from time to time a number of schemes which were not found productive according to the standard test, though the criteria of financial returns was retained for assessing the acceptability of projects. It will be interesting to note that out of the 122 new major and medium irrigation schemes approved by the Planning Commission during the Second Plan period (1956-61) as many as 92, or nearly 75 per cent, did not satisfy the prescribed conventional productivity test. This is tacit evidence that the financial return test, as currently applied is no longer considered as fully comprehensive to cover all the benefits to a developing economy and that it is, at best, suitable up to a point.

The U.S.A. Experience

The Indian experience is not an isolated one. The history of irrigation development in the U.S.A. shows similar

developments in that country as well. The Reclamation Act of 1902 provided that Government should determine whether a proposed scheme was 'practicable' and it was provided that annual charges to be levied for the use of water be determined to enable the return of the estimated cost to the Reclamation Fund within ten years⁽⁸⁾. This criteria of return of the capital was found to be too rigid, and amendments were made from time to time extending the period of repayment first to 20 years (1914), and later to 40 years (1926). As no interest was charged on the deferred payments, the annual direct return amounted to a small fraction of the investment. Even on such liberal terms irrigation cost could not be fully realised in all cases and this necessitated further modifications of the repayment requirements later on.

Benefit Cost Analysis

The present-day test of the productivity of water resource projects in the United States of America is the Benefit Cost Analysis. The idea that benefits should be measured and that they should exceed costs in a reasonable time in order to justify the undertaking of a project, became widespread in the U.S.A. and elsewhere, in the late thirties. The Flood Control Act of 1936 of the U.S.A. established the principle of "comparing benefits to whomsoever they may accrue with the estimated costs"⁽⁹⁾. Though the United States Congress had made it clear by its various legislations that economic evaluation should be made for all Federal Water Development Projects before their authorisation, it has not, however, established any uniform policy or standards for use in making such evaluations. Though considerable progress has been made by them in the development and use of mutually acceptable standards and techniques, the several agencies engaged in such works follow their own standards and procedures at present. However, all these agencies work out the benefit cost ratio to test the economic justification of a proposed development programme. They also use the same to assess the relative merits of different proposals. The benefit cost analysis recognises the various effects of a project not all of which are or could be represented in a repayment analysis. In other words, the benefits that are counted are not limited to the project revenues.

U.S.B.R. Practice

In a benefit cost analysis, benefits represent in monetary terms the value of the functions performed by a project. These include increases in the production of goods and services and improvement in the general welfare. Tangible benefits, direct and indirect, are expressed in monetary terms, while intangible benefits are described in qualitative terms and as specifically as possible. According to the Bureau of Reclamation (U.S.A.), the direct benefits include, for irrigation projects, the increased net farm income; for power, the estimated cost of equivalent power from alternative source; for Municipal and industrial water, the estimated cost of the most economical alternative; for flood control, the reduction of flood damage; for navigation, savings to shippers; for recreation, an amount equal to the cost of recreation facilities, etc., and other such direct beneficial effects⁽¹⁰⁾. Indirect benefits are those derived from the secondary use of project products. Examples are the benefits derived from the increased economic activity in the trading area, and a share of the profits in transporting, processing and distributing the increased farm products. The public benefits accounted for include the increase in settlement, improved employment opportunities, the increase in community facilities, etc. The intangible benefits are those benefits which are not included in the preceding categories, but are significant enough to be described in qualitative terms. The U.S. Army Corps of engineers recognise direct benefits, both tangible and intangible, for their projects which mainly relate to flood control and navigation and channel stabilisation schemes. The U.S. Department of Agriculture recognises direct benefits in its evaluation of watershed treatment projects. The Federal Power Commission also recognises direct benefits for its projects. The procedure proposed by the Sub-Committee on Benefits and Costs for measurement of irrigation benefits would exclude indirect benefits from the economic analysis⁽¹¹⁾.

The preliminary steps in the analysis are to spread the capital investment over time, convert them to annual costs, to add in the average annual operating costs, and estimate the value of average annual output. Although benefits and costs could be compared on the basis of present values, the usual practice is to compare the average annual equivalents.

Limitations of Benefit Cost Ratio

What are the limitations of this form of criterion? The benefit cost analysis, as adopted, has also been subject to criticism by various authorities⁽¹²⁾⁽¹³⁾. It was felt that ratios were treacherous as they revealed nothing about the absolute scale of gains or costs. Various improvements in the criteria, the time-scheme adopted, and in the evaluation of uncertainties were held feasible. It was felt that there is ample room for better treatment of the actual measurements of costs and benefits. It was shown that most commonly overcounting of benefits occurred in these analyses. The use of widely varying practices followed by the different U.S. Agencies which could lead to contradictory conclusions in marginal cases was cited as reason for considering the test inappropriate. Considerable differences of opinion existing between the various agencies in the adoption of certain basic factors that were involved such as the assumption regarding the economic life of the project works, the recognition or non-recognition of secondary benefits, the interest rate used for conversion of non-uniform benefits to equivalent annual averages, etc., are additional criticisms advanced against the Benefit Cost Ratio.

Improved Benefit Cost Analysis

However, the various criticisms against the benefit cost analysis seem to be levelled against the form in which the analysis is being made at present, and the methodology involved in assessing costs and benefits, not against the principle of selection of projects on their cost benefit aspects.

Numerous suggestions for the improved working out of the benefit cost analysis have been made⁽¹¹⁾, ⁽¹²⁾, ⁽¹³⁾, ⁽¹⁴⁾. From the present-day knowledge of the various criteria followed to test the productivity of water resource development programmes, it would appear that a modified form of the cost benefit analysis, with realistic assumptions of the various factors involved in such a study, particularly in regard to the identification and evaluation of the costs and benefits would be an important step towards proper evaluation of the economics of water resources development schemes.

Conclusions

The various States and the Central Agencies concerned with the Water Resources Development in India should be enjoined to adopt the benefit cost analysis procedures for testing the economic impact of a proposed investment and the results of such studies should find place in every project report in addition to the statements relating to the financial return. These agencies should, in course of time, be encouraged to propose and agree upon uniform practices in the methodology followed for the evaluation of projects.

It should, however, always be appreciated that the most that any criteria could do is to supply the guidelines and standards which are essential for making better decisions and that it would be futile to attempt to devise a fixed formula that would always give the correct answer in all circumstances.

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DISCUSSIONS

November 1961 Session

SHRI HANDA (C.L.) conducted the Symposium.

After the General Report the authors of various papers introduced their papers.

BALESHWAR NATH stated that insofar as investments were concerned, it was fairly rigidly worked out for the best possible returns, but usually in practice the returns were not encouraging. Citing an example he stated that disparity in water rates were there between Saharanpur District of Uttar Pradesh and Jagadhri in Ambala District of Punjab which are hardly 10 miles apart and the ratio was as much as 2. Questioning such a disparity he suggested that a rational basis of irrigation policy in the country was required which would definitely improve the existing conditions of returns in the case of irrigation projects. Further, he pleaded that irrigation projects should not be judged from the direct returns criteria on the State investments but should be measured on the national return basing on the national investment by State, cultivators, industrial capital, etc., and the return from each source consolidated.

The idea of combining tubewells with canal irrigation, he said, was not a correct approach as they vary widely in their investments and other conditions. The observations made in regard to tubewell irrigation in three States of Punjab, Gujarat and U.P. had shown a wide variation. In Gujarat the ryots came forward to pay as much as Rs. 60 whereas in the Punjab even payment of Rs. 20 was grudged by the people. Hence the present thinking on such national investments had to be changed and the irrigation projects should try to evolve a self-generating economy not always dependent on State subsidies.

He later referred to the paper of Shri Jatindra Singh wherein figures up to 1957-58 regarding sub-soil water

fluctuations and area of water-logging were given and stated that an up-to-date appraisal of the latest figures might present a different picture contrary to the conclusions. Similar was his observation on the area reduction under cotton which might have been due to extra irrigation of rice. He, therefore, suggested for an overall picture being presented to draw conclusions thereon. Further, he observed that the proposal of lining worth Rs. 44 crores to reduce water-logging was not commensurate with additional acreage developed.

DAFTRY (N. D.) stated that uptil now the schemes were less costly and therefore were remunerative and now as the projects were costing more requiring specialised efforts through storage facilities, etc., and unless the indirect benefits were accounted for projects were not going to be remunerative. Apart from leading water to beneficiaries' fields they required help in the form of better seeds, better farming, marketing, etc., which if not attended to simultaneously would not yield the desired results. It was, therefore, essential that the other functions which required to be done by the various departments should be done in time so that higher benefits, yields and returns could be ensured. By adopting the right measures he said the returns would improve and would justify the execution of irrigation projects. He stated that there were legislations for recovery of irrigation cess and water rates but no effective steps were taken to recover them when the beneficiaries were actually realising the benefits of irrigation projects. In regard to water-courses this should be constructed by the irrigation authorities so as to ensure utilisation of irrigation water to the full extent wherever the irrigators were prepared to pay for such work.

CHAKRAVARTY (R. B.) quoted from old records in respect of a statement made by the *Zamindar* of Uttarpara in the year 1890 on the possibility of running a canal from Raniganj to Chinsura, "*The Zamindar* seems to have expressed that he had constructed several canals without, at any time, bothering about the revenues and without any difficulty the revenue was coming to him". He felt that such an attitude in respect of irrigation projects should be recommended. Regarding the favourable opinion expressed in respect of irrigation schemes in the U.S.A., he

stated that the construction of dams, etc., was mostly charged to items of utility other than irrigation which was least burdened. Drawing attention to the statements made by some speakers, indicating that interest on capital was not charged to irrigation in the U.S.A., he stated that this fact confirmed that the problem in the U.S.A. was no less serious. Quoting an analogy of bullock carts which damage the roads most, but are not charged for repairs, he expressed that in the case of irrigation a similar concession should be granted. Further, the conditions of droughts being tided over by irrigation amounts saved out of normal expenditures on relief works should be considered a direct revenue.

From the point of fairness of water rates he stated that in West Bengal in one of the districts till 4 years back the *ryot* had been paying as much rent as Rs. 200 or so per acre which has been brought down to only Rs. 9 or so by the Government and in such cases he stated that the cultivators should not grudge paying Rs. 10 more per acre if this was collected as part of the land rent. He drew the attention to the double expenditure involved in the policy of taking up of small irrigation schemes at places where bigger schemes are feasible and thereafter spending again for the big schemes in such areas. The position, he said, required careful analysis before hand.

PAPPU (V.) stated that at present the economics was considered on the basis of direct returns and benefits. He said that the indirect benefits have to be considered basing on primary, secondary and tertiary benefits on economic principles. For example, the water-courses, he said, assisted directly growing sugar-cane which yield molasses and bagasse. From bagasse paper was made and from molasses alcohol, which in term yielded customs duty as well as other taxes, etc. He, therefore, suggested that a share from these could be apportioned by the Finance Commission which go round the country once in five years. Similarly, canals afforded navigation and would offset transport cost and a share of which had to be counted towards financing irrigation projects. The sum total of the benefits, he said, should be evolved and applied for the

future projects. He suggested this suggestion on the analogy for rural electrification. He suggested this for the Programme Evaluation Committee of the Planning Commission.

CHOPRA (FROM RAILWAYS) referred to the statement in the paper of Shri Jatindra Singh, "The allocation of expenditure to railways may, however, have to be done at some stage and quite a few crores of rupees will be their share", and remarked that the capital gains were being taxed by Government and there was no reason why the cultivator who was benefited by the construction of the irrigation projects should hesitate to pay betterment levy when the capital returns started flowing in from the scheme. To another remark that roads, railways and canals happen to be the cause of water-logging, he clarified that so far as railways were concerned the policy has been that before a fresh line was laid the concerned State was given the free choice of specifying the waterways required to be provided when laying the line and even after that a 10-year period was allowed for further requirements to be notified after observation. Such being the case he pointed out, the railways could not be accused of being responsible for providing inadequate waterways and thereby causing water-logging conditions. He felt canal irrigation was responsible for water-logging. His ancestors were having lands in West Punjab and during every five years they were experiencing how far this would extend as a result of canal irrigation. He suggested, therefore, that remedies like lining, tubewells, etc., were there and such costs should also go as a part of the scheme itself. Further, he pointed out that Irrigation, Drainage and Flood Control Works being welfare works should not be expected to pay high percentage of returns on the capital invested.

KHUSHLANI (K. B.) stressed that the criterion of irrigation projects should be to get over the present food deficiency rather than the returns on the capital investment. He pointed out that only in free market it was possible to evaluate the true gains and returns and costs. Exemplifying he stated that in the same area there would be two projects, one of a diversion type and the other a

storage type yielding the same type of benefit but definitely the costs would be different and the same criteria, therefore, would not hold good to finance such projects. Further, the fluctuations of the world market need to be considered. As such it was only of academic interest and at best we have to evolve a rough return on the national investment applicable from period to period, irrespective of individual projects.

ANAND (D. B.) stated that in India 75 per cent of the population is agricultural and even with increased industrialisation a very large percentage would have to stay on the land. Therefore, irrigation projects would have to continue to be undertaken and the matter of cost would not be the only guiding factor. He also stated that each region may have special conditions and aspects which would need to be considered and therefore the same yardstick could not apply to every place. The difference in local conditions may be climatical, topographical, geological, etc., which would call for individual treatment.

Shri ANAND stated that diversion schemes, for example, cost about Rs. 200 to Rs. 300 per acre, whereas the cost of storage schemes so far sanctioned in the country varies between Rs. 600 to Rs. 1,000 per acre; in some places it has been as high as even Rs. 2,000 per acre. He said that interest alone on diversion schemes would be of the order of Rs. 16 to Rs. 18 per acre and for storage schemes Rs. 36 to Rs. 60 per acre. Such being the case, it would be observed that no dry crop would pay an assessment high enough to cover even the interest charges. It was, therefore, left to the local State to balance the economy by levying differential rates on wet and dry crops. Even so, it may not always be possible to cover the expenditure on irrigation schemes.

He further pointed out that the assessment of indirect benefit was not an easy problem as it involved so many factors both direct and indirect. He was, therefore, of the opinion that it would be easier to go in for simple yardsticks with regard to productive or non-productive schemes. For example, he suggested that the present criterion of $\frac{1}{2}$ per cent may be suitably brought down to a smaller

percentage to allow for indirect benefits. It was his opinion that it would neither be possible nor advisable to consider indirect benefits as a concrete item for calculation, but that a simple yard-stick may be fixed taking into account all the relevant factors as may be considered suitable.

VENKATARAMAN (A. R.) informed that recently an assessment of sales tax realised on the produce of an irrigation project came roughly to about 2 to 4 per cent. In this connection he drew attention to one of the statements during the symposium recently held by economists wherein one of the Financial Advisers of a project (a retired Accountant General) stated that the indirect benefits were not measurable and should not be counted and added further that the projects should be considered on productivity ratio criteria and if less than 30 per cent, should be categorised as unremunerative. Drawing reference to such a statement by the Financial Adviser he stated that such ideas have to be countered and cleared from the minds of our financial authorities in charge of irrigation projects, and also it should be brought home to them that in no case the irrigation projects were unremunerative. Further, he suggested that by allowing liberty to the farmer to raise any dry crop like onions, ground-nuts, chillies, etc., suiting to the favourable market price structure it would work very well to bring in larger return to the project. He categorically disagreed with the supposed advantages in the suggestion of the Centre taking over the irrigation works, their construction and maintenance.

KUMRA (P. N.) pointed out that the present cost benefit ratio in deciding the economies of flood control works considered the direct damage to crops, to works, etc., and emphasised that the indirect non-assessable losses were much more, namely loss to life, misery created, disruption to traffic, causes of epidemics, loss of property, lands, etc., should be counted.

NAG (B. S.) informed that the Planning Commission with a view to finding out the elements involved in the indirect benefits of projects took to study six well established projects established over 10 years and the study of projects indicated different trends. In some, it exceeded

the direct benefits whereas in some others it was insignificant. He stated that in the case of an irrigated land the investments both in money and in labour have to be borne by the cultivator unlike that for a rain-fed crop. Assessment of indirect benefits he stated was very difficult, as so many factors crept in and he was wondering whether it would be worth evaluating the indirect benefits. To the feeling that the projects would be held back by the Planning Commission due to financial yard-sticks, he stated that it was not so. The yard-stick of returns was used only to determine the *inter se* priority to suit the limited resources so that the more productive one was taken up first and the lesser ones were held back temporarily till such time as more productive ones were exhausted, though in the final analysis all were required to be completed. To aid such a judgment the only easy criterion that could be relied upon was the financial return yard-stick.

To the suggestion that the Centre alone should meet all the cost of irrigation projects, he clarified that the plan resources for development comprised States' own resources namely land revenue and other taxes and the Centre's from central taxes. This would get distributed according to the needs on which the States allotments were decided. After this, the States assigned their priority either for irrigation, power or other aspects considering the developmental activities urgently required for the State. In case the Centre had to take the complete burden of all the irrigation projects in the country, he questioned what should be done to the Central Schemes such as railways, transport, major industries, etc. He informed that the Centre charged a low rate on the loans made to the States for irrigation projects compared to what it paid for raising the loans and as such subsidies were already being given to the States in the form of low interest. He emphasised the need, that India being basically agricultural country, there was need for money to be found from irrigation and agriculture alone and said that the projects have to stand on their own financial soundness. He felt, therefore, that there was scope for increasing the water rates. Regarding flood control and irrigation being linked he felt that irrigation should stand on its own and flood control in all cases might not have the same footing and at times it might have to be financed from the State revenues.

Soob (M. L.) expressed that the economics of a project was determined on the basis of the cost of the project and the revenue realised. It was well known that a project should be well investigated with detailed designs in hand before construction is taken up. He complained that owing to lack of experienced staff this aspect did not receive adequate attention and the cost kept on rising after its construction is taken up. He felt, therefore, that until and unless all the elements associated with investigation and construction of an irrigation project functioned effectively it would lead to the cost of the project rising.

In regard to the revenue aspect he stated that the water rates were very low, being based on the arguments that the *ryots* were not in a position to pay more, etc., which was not true in view of the return that the *ryot* was expected to receive. He further stated that water being only one of the factors for enhancement of out-turn, other facilities like better seeds, manure, *taccavi* loans etc., had to be coordinated simultaneously for the *ryot* to produce maximum results. Though legislation was there in some of the States to enforce and collect betterment levy, it was ineffective in practice. In regard to the argument of providing the water-courses also by the Government as a help, he cited the example of Chambal Project wherein a special division constructed the water-courses but was not quite effective so far and only resulted in enhancing the cost of the project. It was, therefore, evident that unless the cultivators were fully conscious of the proper use of water the cost mounts without corresponding favourable results. In this connection he referred to the suggestion made by him to his Government for a full time Dy. Director for Agriculture whose main work should be to co-ordinate activities of agriculture and new irrigation facilities provided by the Irrigation Department and stated that that had not materialised so far. Unless the above lack of co-ordination was remedied he was of the opinion that the out-turn would not improve sufficiently from irrigation projects to justify realisation of higher revenues. Regarding the other suggestion of free supply of water in the first few years, he stated that it would prove difficult at later stages, as free water once given would make it difficult to raise the water rates to requisite standards.

FRAMJI (K. K.) in reference to the subject of direct benefits drew attention to a study made by an FAO Team of the Ganga Basin for future utilisation of its water resources. He pointed to the strange conclusion from the report that in view of the likely requirements in the distant future of projects downstream, the available water resources in the Ganga upstream should not be utilised without storage schemes. He remarked that this suggestion was made to provide double or triple cropping with varieties of water-expensive rice crops in areas downstream which are already almost 100 per cent cultivated by rice, and even in areas which are inundated by floods and tides with 4 to 5 ft. (1.22 to 1.52 m.) of standing water. This does not permit a balanced and uniform criterion of direct benefits *vis-a-vis* costs for projects upstream and downstream in a basin.

The one salutary feature of the recommendations was that it has been suggested that an agronomist should invariably be attached to each project so that the crop pattern was fixed in relation to the water availability. He hoped that an agronomist would pay no less attention to the mal-effects of water-logging, etc., which would be caused by double and triple cropping in areas already heavily inundated, which call for drainage rather than irrigation.

Referring to the paper by Shri Kanwar Sain, he stated that the old formula of productiveness could no longer be applied to future projects without modification, as indicated in the paper. In view of the difficulties of defining indirect benefits in terms of money, he felt that it was desirable to standardise proformas for exhibiting the evaluation of direct and indirect benefits on uniform lines so that the Planning Commission could assess projects in relation to needs on an equitable basis. For instance, he suggested that the cost benefit ratio should be indicated for each project, both excluding and including the value of indirect benefits, the indirect benefits being evaluated according to standard proformas. He expressed that the proformas should invariably contain other measures of the benefits of a project, such as the water requirements per thousand acres C.C.A., the cost per thousand acres irrigated, the cost per unit of power generated, the cost per

ton mile of transport before and after the project, the cost per thousand acres flood protection afforded, and foreign exchange *versus* the rupee expenditure ratio, etc.

GOVINDA RAO (N. S.) stated that both direct and indirect benefits have to be considered for the purpose of evaluating economics of irrigation projects. Drawing reference to the visit of Dr. Visvesvaraya to Krishnarajasagar after 20 years of the completion of the project he said that Dr. Visvesvaraya made an estimate of the direct and indirect benefits accruing to the State from the project. So far as the project was concerned the direct return was estimated at Rs. 4 lakhs in 1930 gradually reducing to nil at the time of estimation in 1950 in a period of 20 years. Coming to the question of indirect benefits it was assessed at about Rs. 10 lakhs in 1930 but in 1950 the economy of the whole area had completely transformed with the development of sugar factory and gave other industrial and commercial crops in the project areas and the return from the sugar factory alone came to about Rs. 3 crores which included returns to the State and Central revenues and to the factory. The total indirect benefits worked to about 60 per cent per annum of the capital outlay. As such he said, that the 10-year period was too short for assessment of indirect benefits from irrigation projects. Therefore, in assessing the indirect benefits it was not merely enough to consider returns to the State only but it should be in terms of national wealth and national income for the whole country which would be a much more important criteria. Coming to the Krishnarajasagar works, he said that the value of crops grown each year now have exceeded the total cost of project itself. Concluding he suggested that in preparing proforma for assessing benefits from irrigation projects the following had to be considered:—

- (i) The period to be considered for assessment of benefits should be at least 20 years after the project had started yielding benefits.
- (ii) The indirect benefits from a project should be periodically assessed, say at intervals of every 10 years.

And full data maintained of the increase in: (a) National wealth, (b) National income, (c) total yearly income (direct and indirect to the State, Centre and to the project).

DR. RANGAPPA (K. S.) referring to the papers presented at the Symposium stated that two distinct features were noticeable—one was that 'Finance' insisted, in a traditional way, on direct dividends from the project to the State, while the engineer stressed equally the long-range and additional indirect benefits which would not be available if the projects were not executed. He stated that the views of the Treasury were more like those of a capitalist State, whereas a socialist welfare State required that social needs be satisfied. He stated that we were repeatedly told that paucity of resources stood as an obstacle to wholehearted implementation of our projects. Questioning this, he said that we had the land, the water and the man-power needed to develop the resources to productive levels. He suggested that the concept of paper money and the cost benefit ratio, which prevailed at present, were the real factors that stood in the way of maximum production in the shortest possible time. He urged that all our resources and efforts should be suitably coordinated, which would positively enable the building of ten dams in place of one that was now being built in conformity with outmoded financial criteria and procedures.

APTE (B. S.) referring to the paper of Shri Ahuja stated that self-sufficiency in food was only one of the criteria for the economic development of the country and not necessarily the only one. He opined that what was to be aimed at was the maximum production in the wealth of the country keeping in view the regional development. He felt, therefore, that development of water resources should be aimed at maximum production of wealth and in case of emergency internal adjustments in the production of one commodity or the other could be made and would not be a problem as area under cash crops like cotton could be diverted to food crops in times of emergency.

ANANDA RAU (U.) stated that indirect benefits would outweigh the usual financial criteria. As the run of the river projects were becoming scarce and only storage schemes were now left for exploitation, he felt that the indirect benefit assessment only would make it possible for the schemes to become remunerative. Drawing attention to the study made by the Gokhale School of Economics on one of the Deccan projects he informed that the

indirect benefits were assessed to be between 25 per cent to 45 per cent. Such a study he stated was also made by them on the Parambikulam Aliyar Project of Madras State which was costing Rs. 35 crores to feed 2.5 lakh acres irrigation and also producing 1.8 lakh kW of power. He informed that by supplying water to irrigation, nearly Rs. 5 crores worth of food would be produced at the same time getting a revenue of Rs. 1.5 crores directly by power supply which helped the indirect production of about Rs. 45 crores worth of goods in the country. As such, he stated that without this project there would be no production and no wealth of the order of Rs. 50 crores could be realised. With the above example he expressed that the criteria should be to account the indirect benefits and not the direct revenues only. To improve the revenue he suggested flood insurance for usually flood affected areas. Further, he emphasized that irrigation should be extended to as much area as possible and not restricted to one-third of the area by suggesting three crops to that area. Concluding he stated that irrigation and power as a combination should be the aim in the construction of reservoirs.

HANDA (C. L.) mentioned for information of the House the views of Shri Jatindra Singh as the latter could not be present during the meeting. The views were that at the present moment the farmer was not in a position to pay any thing more than what he hitherto had been paying on irrigation projects and the question of paying for flood control and drainage works did not arise. As such, the flood control and drainage works required complete subsidy from the Central Government. The farmer at best might be able to share the cost of the canal system excluding lining for anti-water-logging measures if canal lining is due; it required complete subsidy from the Central Government. The storage dams which included in their scope, electricity, flood control and irrigation aspects should not be a burden on the irrigation aspects and the flood control part should be completely subsidised by the Central Government.

The arithmetical balancing of expenditures and incomes was fallacious and should be given up in the case of irrigation projects and further the anxiety to

balance with levies like betterment, flood cess, drainage cess, etc., should be dropped. In this connection it might be stated that in the original old canal systems, little cost was incurred on such works and, therefore, the incidence of taxes was comparatively low and they were within the means of the farmers. But the presentday structures, lining, etc., were prohibitively costly and, therefore, the irrigation facilities should be thought of on the basic consideration of feeding the people and not earning any returns on them. The suggestion has been that industries have been coming up which derive a lot of benefits from the supply of irrigation water and those beneficiaries ought to be taxed more to make up the funds. With the present commitments combined with poverty on the part of the cultivator he should not be further exploited. Hence it was for the Central Government to completely subsidise irrigation schemes basing the benefits from indirect sources as is done in countries like the U.S.A. and Europe. Estimates of returns should only be considered as of an academic interest and should only guide us to fix up *inter se* priorities in sanctioning any project and not to be thought of in terms of the water rates from the irrigation projects.

AHUJA (P. R.) replying to the comparison made by Shri Apte earlier in his paper stated that England was an industrial country and India was mostly agricultural and a comparison was not in order. Diversion of water to irrigation in times of emergency was not a feasible suggestion as irrigation could not be developed at short notice. He suggested that water resources should be developed in the best manner possible in the river basins irrespective of the State boundaries.

JATINDRA SINGH drawing attention to the remarks made by Shri Baleshwar Nath on the different water rates existing in the contiguous lands on either side of the State boundaries, stated that it was not correct to compare only the water rates prevailing on the W.J.C. in Punjab and the U.P., as there were varying water rates for each canal system depending on local conditions. Hence for a proper assessment of the problem it would be only proper that the comparison should consider the entire rate structure between the two States.

Regarding the rise of water-levels as reported in his paper, he said that it was due to increased discharge that was being forced in the canals from time to time, for W.J.C. alone. This figure now stood at about 14,000 cusec (396.44 cumec) as against 6,000 cusec (169.90 cumec) for which it was originally designed. Therefore, lining had to be done in such affected reaches where thur conditions might develop or in places where the soil was poor, etc., and it was not commended as a general measure throughout the canal system. In regard to lining of water-courses he said that the cost would be prohibitive and not feasible. Further, it would not be possible to frame a uniform irrigation cess structure and a better way would be to tax on the actual crop produced, which would take into account the different water rates suiting local conditions.

Sood (M. L.) in regard to the direct and indirect benefits pointed out that it was difficult to exactly assess the indirect benefits. With the present borrowing position in respect of our projects it would be better that some rule of direct benefits was followed in sanctioning the projects. If the projects were to indicate the indirect benefits also it would only mean a good deal of guess-work. Regarding the subsidies to irrigation projects he stated that in the U.S.A. 20 per cent of the population was engaged on agriculture and the rest on industry and, therefore, the subsidies were justified, but to subsidise the 80 per cent engaged on agriculture in this country would not be realistic.

HANDA (C. L.) summing up the discussions stated that as pointed out by Shri Ahuja no one questioned that while giving us the rivers God never thought of the political boundaries in this country and therefore it was for us to maximise the utilisation of these resources by ignoring such artificially created boundaries.

But as pointed out by Shri Anand it would also equally be important that the regional bodies should aim at development of their own States in pace with the political atmosphere which meant that within the boundaries the agency of the State should do intensive work for the maximum utilisation of the resources. As pointed out by Shri Jatindra Singh who had collected a lot of data; an analysis of this showed that to check the ill effects and set right

the wrongs, a number of plans had to be thought of in Punjab which might come to about Rs. 250 crores in itself, as direct effect of irrigation development. Further, he had mentioned that if direct benefits were only considered, then it would be difficult to meet any expenditure on the future projects. Coming to Shri Framji's view point he stated that the thoughts expressed by him were to bring out a questionnaire reducing parameters of estimation of direct and indirect benefits into 40 or 80 questions like the World Bank which puts forward such questions for the loans given by them to any project. Prof. Govinda Rao had pointed out very correctly that the direct benefits of any project would dwindle as in the case of Krishnarajasagar from Rs. 4 lakhs to nil but the indirect benefits run into crores as a result of the project. Similar has been the observation by the President of the Board in regard to their project Parambikulam Aliyar. It was, therefore, evident that the C.B.I. & P. should strike the note that *the wealth of this country would not increase unless the water resources management was accorded the high priority.* In this context he pointed out that if the water management was taken away from the index of production of wealth, then no scheme would be feasible. While discussing irrigation projects and their criteria of sanctions it should be brought home how exactly the community development projects and educational projects were functioning in respect of returns; when all other activities of Government could get funds which build up the national economy, why should we not tell the respective governments that we also were entitled for such treatment in respect of irrigation projects.

As pointed out by Shri Sood it was clear that unless the agricultural department plans ahead, and unless the markets come up simultaneously with roads, railways and other communications by the time the irrigation projects start production, it would be of no use to have only the system of canals with water running in them. It was, therefore, necessary that all these aspects should be brought home and the people should be made co-responsible alongwith the other departments connected with it for the success of any irrigation project. It might be of interest to note that in Punjab, the Executive Engineers have been empowered to report on the non-compliance of

duties expected of such officers as the Deputy Commissioner, etc. This has been a very good step to simplify the opposition at higher levels and therefore the required cooperation was forthcoming to the efforts of an engineer. He stated further that lining as suggested by one of the speakers would be justified wherever saving of water was concerned but not as an anti-water-logging measure which would be an expensive remedy. Regarding the view point of growing three crops of rice, he stated that it was not within the experience of this country. In regard to the proforma suggested by Shri Framji he requested him to be a member of the Drafting Committee to give further thoughts and details and help them in bringing out a comprehensive proforma.

Thanking the President and the Members who took part in the discussion, he concluded the Symposium and suggested that at least one or two more sessions in continuation of this should be arranged to thrash out in detail the lacunae and suggest remedies to build up tempo of irrigation projects to achieve self-sufficiency in food.

May 1962 Session

HANDA (C. L.) in his introductory remarks recalled the various views brought forth before the Symposium held in November 1961, at New Delhi. He pointed out that there was quite a solid opinion at the last Symposium that the engineers should strongly recommend a new method to evaluate the criteria for sanctioning a project. He stated that the Central Board of Irrigation and Power, as early as in 1944, had stressed the importance of taking the indirect benefits also into account. He hoped that the proceedings of the last meeting and discussions during this Session would form the basis for finalising the subject and urged the participants to look forward imaginatively into the future. To avoid difficulty in finalising schemes, he suggested the fixing up of the quantum of resources available for a Plan so that the regional requirements could be fitted into the sectional plan.

RANGACHARY (R.) introducing his paper stated that the financial criterion was not strictly followed by the Planning Commission for sanctioning the schemes. Among the

schemes approved by the Planning Commission for the Second Plan, he pointed out, 75 per cent of the schemes did not satisfy the conventional $4\frac{1}{2}$ per cent financial return test. Referring to the general criticism against the benefit cost analysis, he stated that these seem to be levelled against the methodology adopted in assessing costs and benefits and the form in which the analysis is being made at present, and not against the general principle of benefit cost productivity test. Quoting the experience of the United States, he disclosed that the various agencies adopting the benefit cost analysis, have not yet arrived at a fully acceptable standard procedure. He, therefore, felt that engineers should accept the principle that something more comprehensive than the financial return test was necessary and that it should be in the form of a comparison of costs and benefits. The benefit cost ratio should also be worked out in future schemes in addition to financial returns, he suggested.

JAGAT KISHORE JAIN pointed out that our water rates structure was not found on any rational basis. The increase in water rates in recent times had not been consistent with the increase in the cost of irrigation projects. By following the financial criteria, ground water lift schemes got eliminated. As an alternative criterion for sanction of irrigation schemes, he suggested the consideration of the cost of water delivered at the outlet. He pointed out that while initial cost as well as the operational cost of a tubewell was comparatively low as compared to open wells, yet the open wells were very popular in many areas. The open wells were operated by bullock power which was bound to be more expensive for operation than mechanical power. However, as most of the farmers already possess bullock power for agricultural operations, they did not have to incur any additional cost in operation. On the other hand the open wells belonging to the cultivators themselves brought to them greater psychological satisfaction. Shri Jain, therefore, advocated that the socio-economic features should also be taken into account while evaluating the different irrigation projects.

SREERAMA SASTRY (A.) pointed out that over a decade ago, the only revenue the Government was getting from irrigation works was a direct charge from the projects.

With the introduction of the sales-tax, which was dependent upon the agricultural produce from the particular area, the position had changed quite a lot. In places where the Government was getting Rs. 11 due to direct levy, it was now getting about Rs. 33 because of the sales-tax, the income-tax, etc. The financial return tests were, therefore, to be applied on the basis of this increased return and not on the direct levy alone. By taking the over-all revenue accruing to the treasury into account—leaving awhile all the indirect benefits—most of the projects satisfied the financial criterion. Even the carryover reservoirs abandoned from the Second Plan onwards could be taken up because they were remunerative in the light of this argument.

BHATTACHARYA (A. P.) informed that some of the economic surveys conducted some time back by the Gokhale Institute, Poona, had revealed that the projects usually satisfied the economic productivity test. Regarding the period taken by a scheme for attaining maturity, which was assumed as 25 years by some experts, he felt that this period should not be fixed arbitrarily. It could be based upon the primary benefits attaining certain peaks, since the intangible benefits went on rising with time. He also suggested that certain determinants had to be indicated for the guidance of economists who were trying to assess the productivity or otherwise of a project. In the absence of such uniformity, the conclusions arrived at by any two economists were widely different. The Gang Canal Project for instance, which yielded a benefit cost ratio of 2.3 to 1 was classified as productive by one agency while the Sarda Canal which showed a benefit cost ratio of 2.64 to 1 was deemed unproductive by a different survey group. Referring to the economic survey reports of some irrigation projects brought out by the Planning Commission, he disclosed that these assumed certain fallacies regarding fundamentals of irrigation. He, therefore, urged that the economists who conducted such surveys should take some experienced engineer into confidence.

ABRAHAM (J. G.) pointed out that prior to 1947, schemes were classified as productive and unproductive. The unproductive schemes were not normally sanctioned. Some of the schemes in Madras considered the indirect benefits

also, but there were certain difficulties in applying the technique. A number of old projects were giving increased returns, whereas the water rates and taxes did not change much. He, therefore, felt that the water rates of all old projects should be revised after every five years so that the increased income from the old schemes could partly relieve the burden of taxation in new project areas. In view of the increasing labour cost for construction of new projects and the rising income from the agricultural produce in old areas, he made a strong plea for the revision of water rates which had remained nearly static over a number of years. He also suggested that while making the recommendations about the criteria, there should be a provision for regional considerations. There should be no attempt for uniform methodology for the entire country but only criteria applicable to different areas could be indicated.

BHARATAN (K.) felt that prominence should not be given to the assessment of indirect benefits. These indirect benefits existed somewhere unknown. There were so many unknown factors which could not be correctly measured in benefit cost analysis. A number of assumptions made in the analysis were also not susceptible to checking. The direct returns from irrigation was a State subject and the water cess and levies were imposed by State Governments. There was not much increase in water rates for a long time, nor was the betterment levy decision implemented everywhere. In the absence of implementation of these positive revenue earning measures already agreed upon, there was no need to give prominence to indirect benefits.

CHAKRAVARTY (R. B.) felt that it would be very difficult to lay a common yard-stick, in view of the varying factors prevailing in different parts of the country. He, therefore, suggested that the special requirement of the different zones, should form the criteria. He also felt that a high level body should go through the costly schemes proposed by the State Government and decide them on their merits, other than the cost comparison. Regional needs were to be taken into account for the development of the different areas. Yard-sticks required constant revisions in view of the ever changing circumstances and were not worth all the trouble. It is better not to have any yard-stick than to have one and then deviate from it.

About a common yard-stick for finding out the viability of a project, Shri Char felt that in a nation like ours with varied natural facilities, there could be no common yard-stick for the whole country. The criteria was not what the project paid. The most beneficial and desirable projects in the areas needed to be sanctioned. From the view point of our pressing food requirements, the taking up of irrigation projects was more or less the duty of the nation and needed to be taken up, unmindful of the return. The most beneficial schemes were to receive priority.

Regarding the non-payment of the Krishnarajasagar Project in Mysore on the irrigation side, Shri Char informed that the combined irrigation and power project was paying initially. But with the separation of irrigation and power costs and benefits, irrigation was apparently found to be a losing concern giving—2 per cent return. However, when a new sugar factory sprang up in the project command, the excise duty on sugar alone came to be Rs. 40 lakhs. This revenue did not come under direct returns.

MANLEY (from T.C.M.) felt that much confidence could not be reposed in the economist in the U.S. also for benefit-cost analysis. The benefit cost analysis were subject to pressure and consequent manipulations. Outlining the policy of financing of irrigation projects in the United States, he disclosed that the policy was a very generous one. The anticipated return from a project on full development was only $2\frac{1}{2}$ per cent. A number of major projects there could not have been built without the subsidy from power. There was some resentment in the eastern parts of the United States against subsidising the irrigation projects, which were usually located in the West. The projects, however, paid enormously in an indirect way. Sometimes, the projects were also sanctioned on the basis of the revenue got from the particular State to the Federal Exchequer. For instance, projects were sanctioned in States which earned large funds from oil revenues. The speaker felt that adequate study was not made in India about the cost of the project and its method of operation. He, therefore, advocated the conducting of soil surveys and study of drainage problems in advance, so that, the project might yield all the anticipated benefits.

RAHMAN (M. A.) suggested advance economic surveys for framing the projects. In backward areas, the question of financial returns was not to be thought of, as the amount of money spent by the Government was realised by way of indirect benefits. The financial return criterion was very much dependent upon the tax structure in the State. For example, the tax on sugarcane areas in Maharashtra, was Rs. 140 per acre whereas in the neighbouring Andhra Pradesh it was Rs. 40 only. The financial return test, therefore, adversely affected the chances for sanctioning of schemes in States which collected lower water rates. Referring to the water cess levy in the Krishna-Godavari Deltas, he pointed out that the cess was fixed at about Rs. 6 per acre when the cost of the paddy per bag was a like amount. Now the cost of the paddy per bag had gone up by four to five times, he called for a reasonable rise in the water cess rates also.

MAITRA (B.) suggested evolving of separate yard-sticks for different areas in a State, instead of a yard-stick for the entire State. Regarding flood control works, he pointed out, the Government spent considerable sums for affording relief. Therefore, the Government was duty-bound to finance flood control and drainage improvement works, without enforcing any sort of financial criteria.

HOON (R. C.) suggested that it would contribute towards the economy of a project if the benefits expected to accrue could be made to start earlier than the usual time. While planning a project, seldom did the engineers look into the details of water utilisation. The problems of the cultivator for acquiring more livestock, the problem of transport of produce, facilities for marketing, etc., were not considered in advance. In the case of Hirakud Project, for instance, these aspects were not taken up till 1955, when the project had fairly advanced in construction. He, therefore, felt that timely attention bestowed on these aspects would help in getting the benefits of the project earlier, thereby helping to improve the economy of a scheme.

FRAMJI (K. K.) called for an honest preparation of the project reports and an objective assessment of the direct and calculable indirect costs and benefits attributable to

the project, in addition to the usual productivity test financial forecasts to enable a fair comparison of the relative merits of various projects. The incalculable indirect costs and benefits should also be set out in unexaggerated terms. He shared the general opinion that it may not be possible to prescribe or agree upon a uniform or standard yard-stick to be applied all over the country or to all kinds of projects. He, however, suggested that the relative values and economics of the projects could be compared more readily and more rationally if there were a standard proforma for the economic analyses of the direct and indirect costs and benefits of a project from various considerations. An invariable proforma should be prescribed to be an essential feature of every project report. The proforma would have to be devised with the greatest care, and deliberation to be precise, scientific and comprehensive and to cover all the various criteria which affect costs or benefits or needs that can be thought of, though it is appreciated that not all these criteria would apply to all projects and additional justifications or data not covered by the proforma would have to be furnished. The special conditions and difficulties of a region justifying the need for the project would find an important place in the proforma. The proforma should also include such factors as the ratio of foreign to indigenous resources required, savings in foreign exchange or increased potentialities of exports as well as the price index, labour utilisation index, cost index, etc. A periodic revision of the proforma according to changing economic concepts should be made. This procedure will greatly help the decision making authorities such as the Ministry of Irrigation and Power, Planning Commission, etc., to accord priorities to conflicting projects on a rational basis.

The abandonment of the productivity test resulted in recent times in some undesirable practices. In some of the projects recently executed, no water rate was levied at all. This eventually increased the burden of the general tax payer. It was but fair that those who derived benefit by way of increased yield also contributed a part of the additional income, instead of throwing the entire burden on the general tax payer. The water rates also varied widely (about 10 times) from place to place. A reasonable levy on the beneficiary helped to reduce the burden on the general tax payer.

Referring to the American practices of financing the irrigation schemes, SHRI GULHATI informed that they had a large revolving fund built out of land sales, oil revenues, etc. It was enough if the project could pay back the capital cost in 40 years after full development and there was no question of interest on the capital. In many projects in the U.S.A., one part of the multi-purpose scheme was subsidised by revenues from another part of the project. For example, cost of lifting of power for canals in the Grand Coule Dam was charged to power. In the light of these practices in the U. S., projects were to be taken up mainly to improve the country.

He advocated carrying out comprehensive economic studies on projects. The analysis was to include direct and indirect benefits which could be evaluated. While considering the indirect benefits, it was essential to take the indirect costs also into account. The indirect costs were in the shape of levelling of land, construction of transport system, marketing centres, etc. In any economic analysis of a project it was, therefore, necessary to take both the entire cost and the entire benefits into account. He suggested that the Board should draw up a proforma by which every major project could be analysed. While assessing the cost of the project it was necessary to take the 'real cost' of the project, as against the 'money cost' normally considered. The customs, import and excise duties, paid by the project were to be separated from the money cost for finding out the 'real cost' of the project.

The cost analysis, he stated, would eventually lead to the allocation of the cost of a project between the States and the Central Governments. In Mexico, for example, the entire cost was borne by the Central Government, while there were different practices prevailing in different countries. He endorsed the need for careful economic appreciation of costs and benefits of irrigation projects and suggested to the Board to evolve some rules for carrying out the analysis and indicate to what degree the economic analysis should be done.

ANANDA RAU (U.) felt that the evolution of a proforma for finding out the benefits of a scheme might adversely affect the chances for sanction of the schemes in scarcity

areas. These schemes rarely showed any return and were generally aimed at improving the needs of the society. He was, therefore, opposed to the preference of the projects, promising higher returns. Replying to a general criticism in some quarters, that projects in Madras were costing more than in Northern India, he clarified that it was largely due to the adoption of paddy crop which had a very low duty. As a measure for improving the viability of schemes, he suggested the introduction of power development on irrigation works, such as, canal falls. This improved the revenue aspect of any scheme.

HANDA (C. L.) winding up the discussion analysed the various view points put forth before the Symposium. Some members wanted that there should be no financial criterion because of the backwardness of a particular area, while some other members desired to use the financial criterion only for fixing the priority of schemes. While some speakers preferred to consider only the direct benefits, some others suggested summing up of direct and indirect benefits. He, therefore, felt that all realised details, could be tabulated in a proforma. The proforma, he was sure, could not exhaust the reasons for sanction of a project. He wanted direct representation for the engineers at the highest level, where the priority of the project was decided upon. He also advised the engineers to put forth honestly all their requirements for the functioning of the schemes, such as soil surveys, afforestation measures, etc. As a curative measure for the general criticism on the constructional details of projects, which usually come forth, long after the completion from legislative bodies, he suggested the method of a continuous review and stock taking. Irrigation and Power development was the need of the country and the priority of the sector needed to be elevated.

ANANDA RAU (U.) desired that the Board's office should undertake the preparation of a comprehensive proforma for assessing the direct and indirect benefits.

LIST OF PUBLICATIONS ISSUED BY THE CENTRAL BOARD OF IRRIGATION AND POWER

(PUBLICATIONS MARKED WITH AN ASTERISK ARE OUT OF STOCK)

- *1. Digest of Technical Notes, 1931 (Reprint).
A summary of views of Chief Engineers on the following subjects:—
 - (i) Water-logging and Reclamation.
 - (ii) Effect of Deforestation and Afforestation on River Floods.
 - (iii) Design of works on Sand Foundations.
 - (iv) Fluming of Canal Works.
 - (v) Regulation at Canal Headworks.
 - (vi) Design of Canal Falls.

- *2. Digest of Technical Notes, 1932.
A summary of views of Chief Engineers on the following subjects:—
 - (i) Water-logging.
 - (ii) Design of works on Sand Foundations.
 - (iii) Design of Canal Falls.
 - (iv) Staunching of Canals.

- *3. Catalogue of books (up to December 1933) in the Library of the Central Board of Irrigation, New Delhi and its 1st and 2nd Annual Supplements, (1935 and 1936).

4. Hydraulic Diagrams : Energy of Flow, Pressure-plus-Momentum Diagrams for the simple graphic solution of problems involving a change of section in a stream of water (compiled by Mr. A. M. R. Montagu, M.I.C.E., etc.) (1934). [Revised and Enlarged Edition 1948 by Shri N. D. Gulhati, I.S.E., M.I.E. (Ind.)].

5. Glossary of Technical and Vernacular Terms in connection with Irrigation in India, together with Standard Notations (1934). Second Edition 1941 and Third Edition 1953.
6. Fluming: A series of examples illustrating the use of Hydraulic Diagrams, C. B. I. Pubn. No. 4—by Mr. A.M.R. Montagu, M.I.C.E. etc. (1934). 1st Revised Edition 1957.
7. The Standing Wave or Hydraulic Jump, (1934), (Second Edition Revised and Enlarged 1950). Supplement to Publication No. 7—by Prof. R. M. Advani.
- *8. Observation and Record of Pressure below works on Permeable Foundations—by Shri A. N. Khosla, (1935).
- *9. Stabilization of Soils by the use of Bitumen Emulsion—by Brigadier C. H. Haswell (1935).
- *10. Irrigation Canal Falls, (compiled by Mr. A. M. R. Montagu, M.I.C.E. etc.) (1935).
11. Annual Report (Technical) of the Central Board of Irrigation, India 1934-35.
- *12. Design of Weirs on Permeable Foundations—by Shri A. N. Khosla, Dr. Nelni Kante Bose and Dr. E. McKenzie Taylor, (1936), Reprint 1956 and 1962.
13. Annual Report (Administrative) of the work of the Central Board of Irrigation, India, 1935-36 (*For the use of Board Members only*).
14. Annual Report (Technical) of the Central Board of Irrigation, India, 1935-36.
15. Annual Report (Administrative) of the work of the Central Board of Irrigation, India, 1936-37 (*For the use of Board Members only*).
16. Annual Report (Technical) of the Central Board of Irrigation, India, 1936-37.
17. Notes on Water-logging and Land Reclamation in the form of a Questionnaire, 1938.