FINANCIAL AND ECONOMIC EVALUATION OF TANK IRRIGATION PROJECTS

A DISSERTATION

Submitted in partial fulfillment of the requirements for the award of the degree of

MASTER OF TECHNOLOGY

in

WATER RESOURCES DEVELOPMENT

By

K.D.NIHAL SIRIWARDANA

DEPARTMENT OF WATER RESOURCES DEVELOPMENT AND MANAGEMENT
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
ROORKEE -247 667 (INDIA)
JUNE, 2007

CANDIDATE'S DECLARATION

I hereby declare that the work which is being presented in this dissertation entitled **"Financial and Economic Evaluation of Tank Irrigation Projects"** in partial fulfillment of the requirement for the award of the degree of **"MASTER OF TECHNOLOGY IN WATER RESOURCES DEVELOPEMNT"** and submitted in the Department of Water Resources Development and Management, Indian Institute of Technology, Roorkee, as an authentic record of my own work carried out during the period from 16 July 2006 to 20 June 2007 under the supervision of Dr U.C. Chaube. Professor, WRD&M, IIT- Roorkee, India.

The mater embodied in this dissertation report has not been submitted by me for the award of any degree or diploma.

K.D. NIHAL SIRIWARDANA

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

Dr U.C. Chaube
Professor, WRD&M
IIT- Roorkee
Roorkee

Place : Roorkee
Date : June 20, 2007

ACKNOWLEDGMENT

I would like to take this opportunity to express my sincere and profound gratitude to **Professor Dr. U.C.Chaube,** Professor, Department of Water Resources Development and Management, Indian Institute of Technology Roorkee, for his guidance, encouragement and suggestions at every stage of this dissertation, to complete this work in time.

I express my sincere gratitude also to **Dr. S.K. Tripathi,** Professor and Head of Department, all the Faculty members and staff of WRD&MD IIT-Roorkee for the facilities extended.

I am also thankful to all my co-trainees of 50th WRD and 26th IWM Batch, WRDMD, for their cooperation in the completion of the works.

I wish to express my wholehearted gratitude to Chief Engineer MP Water Resources Department Sagar and to **Mr. R.A.Singh,** A.E. (Tubewells) & staff of Irrigation Department – Roorkee for the support extended by providing necessary data.

Ultimately, a special and sincerest thanks to my mother **G.Jayalath,** my wife **Ayodhya,** my son **Hirushan** and daughter **Binuri** for their forbearance, never-ending support and patience during the course of my study at WRD&M.

Roorkee, **K.D NIHAL SIRIWARDANA**

Dated : June 20, 2007

SYNOPSIS

Though irrigation sector continues to be the largest consumer of water, there are competing demands by other sectors, where economic values are being attributed very strongly. Huge sum of investment is required in storage and conveyance of water to meet the demand in irrigated agriculture. Thus, water is now being generally considered as an economic good, with cost attached to it. Therefore, proper financial and economic evaluation of irrigation project play vital role in justification of an irrigation project.

A large number of tank irrigation projects have been taken up in India and other developing countries. Several of these are still incomplete for want of financial resources. Some of the irrigation projects started in recent past have shown poor financial and economic performance due to failure to achieved targets envisaged at the project appraisal stage. Therefore, proper financial and economic evaluation of irrigation projects play vital role in justifying and managing irrigation projects with competing other sectoral demand where economic values are being attributed very strongly.

In this dissertation, four domestically funded tank irrigation projects in India and three foreign funded rehabilitation irrigation projects in Sri Lanka have been taken up as sample for financial and economic evaluation.

National Bank for Agriculture and Rural Development (NABARD) in India has provided finance for completion of the balance works of the four irrigation projects

Tank Irrigation Projects in Madhya Pradesh in India

S. N.	Name of Project	RIDF Tranche	RIDF loan (Rs. Lacs)		Irrigation potential (ha)			CCA	Annual irrigation		
			Sanction	Disbursement	Kharif	Rabi	Total		2003-04	2004-05	2005-06
1.	Mahuakheda	I	43.23	43.23	20	180	200	200	-	-	-
2.	Khairana	III	127.98	122.29	20	275	295	308	-	100	60
3.	Maheri	III	75.58	75.58	40	91	131	160	-	-	-
4.	Hinauta Kharmau	III	88.83	87.73	63	185	248	386	80	15	138

Scope of evaluation study covers a variety of aspects such as physical and financial progress, reasons for time and cost overrun, impact assessment on cropping system and farm income, financial performance of projects, ground water recharge and use, issues for policy intervention, success/risk factors and improvement measures.

Possible future investment scenarios (Canal lining and wells) to improve the performance of irrigation projects are analyzed through study of one irrigation project.

Financial Progress and Reasons for Time, Cost overrun

There has been significant time gap between date of sanction and date of completion of balance works and significant cost revision against as envisaged at the project appraisal stage. Comparisons have been made for (i) Original cost and expenditure before financial support by NABARD sanctions (ii) Revised cost and balance cost and (iii) Total expenditure on balance works

Main reasons for time and cost over run are as stated below:

1. Increase in cost of material and labor over a period of time and delay in framing revised cost estimate
2. Delay in administrative approval of the revised estimates
3. Inadequate annual budget allotments and thin spreading over several years
4. Delay by contractors for reasons such as local interference, delay in payments
5. Higher percentage of tender than that envisaged at the time of sanction

Impact on Cropping System and Farm Income

Four situations of analysis are defined for impact evaluation. These are i) before project situation corresponding to situation prevailing at the time of NABARD sanction ii) designed situation corresponding to proposed situation as per project reports, iii) existing situation based on recent data and iv) ultimate situation corresponding to full operation stage. For the purpose of impact evaluation, control situation corresponds to the before project situation.

Existing cropping pattern is significantly different compared to before project and designed cropping pattern. Soyabean in kharif and Gram in rabi have become major crops now. Kharif paddy is nonexistent. Annual cropping intensity has increased significantly in all the projects.

Due to overall increase in prices of various inputs, cost of cultivation has increased but at the same time farm income has also increased. Soyabean provides highest return in kharif season. Irrigated gram provides higher return in rabi season. Incremental farm income (with reference to control situation) is significantly more than for the designed situation. It is expected to further improve when projects are in full operation stage.

Time and cost overrun as well as changes in cropping system have affected the financial parameters. Khairana and Maheri have become financially infeasible with benefit cost ratio less than 1.0 and IRR less than 15%. Additional costs for completing the remaining works have not been considered. Further, all irrigated areas (by different sources are assumed to correspond to canal irrigation). In a more realistic evaluation, benefit cost ratio and IRR could be lower making all the projects financially infeasible.

Ground Water Status, Future Investment Opportunities & Economic Performance

Ground water recharge in the command areas has increased due to surface water storage in tanks. The farmers are making use of increased recharge for irrigation and drinking water supply. On long term basis water table may rise significantly in the command areas having clay soil (Mahuakheda and Hinauta Kharmau) to cause water logging in the absence of field drainage.

In this study, attention is also paid to examine possible improvements in project performance & economic parameters in the existing tank irrigation projects. The following possibilities are studied in detail and economic parameters have been estimated Khairana project for each option.

1. Impact of concrete lining
2. Impact of conjunctive use of ground water using Agricultural wells
3. Impact of conjunctive use of ground water using Tube well
4. Combined Impact of ground water using Tube well and concrete lining.

Financial performance of Khairana project in connection with concrete lining and conjunctive use of surface and ground water are given in table below.

Summary of Economic Performance:

	PWC	PWB	NPV	B/C	IRR
Existing	124.66	79.65	-45.01	0.64	10.34
Concrete lining	19.28	15.981	-3.299	0.83	12.18
Shallow Well	33.735	44.078	8.36	1.23	19.05
Tube well	33.725	44.078	10.355	1.31	21.6
Combination of concrete lining and Tube well	47.509	49.689	2.179	1.05	15.8

Consideration of Economic Prices (Irrigation Projects Sri- Lanka)

In evaluation of Tank irrigation projects in India, which were financed with domestic funds (NABARD), economic prices of goods and services were not considered. Main objective was to evaluate impact of financing the ongoing projects.

Requirement of financial and economic analysis are more rigorous in case of international financing. An evaluation exercise of irrigation rehabilitation project in Sri Lanka has been taken up to study the impact of international financing. This study differs from the evaluation of four tank projects in terms of followings.

1. It is a rehabilitation project of medium size (> 1000ha)
2. It is internationally funded
3. Economic price prices have been worked out (Shadow prices, Labour pries, Opportunity cost of the capital)
4. Cost of family labor was considered

Summary of Economical Parameters as per Recent Data

Scheme	As per appraisal			As per recent Data		
	Liyangastota	Muruthawela	Badagiriya	Liyangastota	Muruthawela	Badagiriya
NPV (10%) Rs Mn	398	616	121	601.6	509.38	75.01
B/C Ratio	2.36	2.68	2.48	2.19	2.03	2.26
EIRR	19.03	22.3	24.25	20.1	19.8	22.04

Note:-year 2005 is taken as the base year

Financial and economic evaluation for with project and before project conditions shows that all the three projects in Sri Lanka are financially viable and economically feasible. In case of Liyangastota scheme, all the three economic parameters have increased considerably when compare with other two projects without achieving the original targets stipulated at project formulation stage. But there is a marginal improvement in both yield and cropping intensity. Cropping intensity and yield have improved as shown in table 5.2 and 5.3. There has been significant increase in price (more than the target) which has resulted in better economic performance.

CONTENT LIST

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (Cont.)

NOTATIONS AND ABBREVIATIONS

BCR	: Benefit Cost Ratio
CCA	: Culturable Command Area
CIF	: Cost, Insurance, freight
DMP	: Domestic Market Price
ERR	: Economic Rate of Return
FOB	: Free on Board
GOMP	: Government of Madhya Pradesh
GOSL	: Government of Sri Lanka
HIRP	: Hambantota Irrigation Rehabilitation Project
HP	: Horse Power
HYV	: High Yield Variety
IITR	: Indian Institute of Technology Roorkee
IRR	: Internal Rate of Return
Irri	: Irrigated
JICA	: Japan International Cooperation Agency
Kharif	: Wet (monsoon) Crop Season
LBC	: Left Bank Canal
MCM	: Million Cubic Meters
NABARD	: National Bank for Agriculture and Rural Development
Nala	: Stream
NIH	: National Institute of Hydrology
NPC	: Net Present Cost
NPI	: Net Present Investment
NPW	: Net Present Worth
O&M	: Operation & Maintenance
OFD	: On Farm Development
PTDH	: Processing, Transporting, Distribution, Handling in Economic Price
PWB	: Present Worth of Benefit
PWC	: Present Worth of Cost
Q	: Discharge (m3/sec)
Rabi	: Winter Crop Season
RBC	: Right Bank Canal
Ref	: Reference
RIDF	: Rural Infrastructure Development Fund
SLR	: Sri Lankan Rupees
TDH	: Transport, Distribution and Handling in Economic Prices
TIP	: Tank Irrigation Project
Un Irri	: Unirrigated
VRB	: Village Road Bridge
WMP	: World Market Price
WRD	: Water Resource Department
WRDM	: Department of Water Resources Development and Management

CHAPTER 1
INTRODUCTION

1.1 BACKGROUND

Sectoral demand over water viz domestic, industrial, energy, navigation etc. are rising and will continue to do so due to increasing population as well as changes resulting from rising income, urbanization, and fast industrialization. This scenario of rising competing demand for various sectors has been challenging in demand for irrigated agriculture. Though irrigation will continue to be the largest consumer of water, there are competing demands by other sectors, where economic values are being attributed very strongly.

Huge sum of investment is required in storage and conveyance of water to meet the demand in irrigated agriculture. Thus, water is now being generally considered as an economic good, with cost attached to it. There is a huge gap between availability of funds for development of water resources in irrigated agriculture and other sectoral demands due to their attractive economic efficiencies. Therefore, proper financial and economic evaluation of irrigation projects play vital role in justification of irrigation projects.

On the other hand, one of the major criticisms of irrigation sector is about the large gap between potential created and its utilization. The potential area which can be irrigated in a system depends on several factors including, besides the availability of distribution networks, the volume and seasonal pattern of water supply, the losses in conveyance, distribution and application, the extent to which the conjunctive use is developed and the cropping pattern on the ground. Ultimately, this condition may lead to poor economic efficiency in irrigation projects.

During the past fifty years or so, an extensive and critical scrutiny has been made by experts in engineering economy, finance, management and social welfare on the problems connected with appraisal of water resources. Much of that thinking has not frequently been accepted by the developing countries. Irrigation projects in developing countries have been criticized as lacking in in-depth study of contentious problems such as post evaluation of projects, environmental cost and benefit, economic efficiency, return on investment, recovery of cost and so on.

There is considerable uncertainty in long range projection of benefit and cost over project life. For example, prices of inputs and outputs, cropping pattern, water availability and technical changes can't be forecast with acceptable accuracy. Further, the social, public and other intangible costs and benefits are not easily susceptible of monetary evaluation and yet these often become the determining factor in project justification in developing countries.

The projects are taken up on the basis of economic analysis of benefit, cost stream over the project life. These benefit cost stream are based on several assumptions but no effort is made to evaluate the economic performance of these projects during operation stage. Economic post evaluation could be used for better management of the projects besides providing more realistic assumptions for planning of new projects.

Difference in financial and economic analysis

The economic analysis of project is similar in form to financial analysis: both appraise the profit of an investment. The concept of financial benefits is not the same as economic benefits. The financial analysis of a project estimate the benefit accruing to the project operating entity or to the project participant, whereas economic analysis measures the effect of the project on the national economy. For a project to be economically viable, it must be financially sustainable, as well as economically efficient. If a project is not financially sustainable, economic benefits will not be realized. Financial analysis and economic analysis are therefore two sides of the same coin and complementary.

For a project in the private sector, the normal objective is taken to be maximization of profit generated. This is often referred to as commercial profitability. Commercial profitability and financial analysis are not necessarily equivalent. Financial criterion is used in judging a project's viability on its own merit, without introducing any wider consideration. Financial analysis is also being used in government funded projects in judging project viability.

Position is rather different for projects in the public sector financed by international institute. Economic viability of the project has become prime criterion in judging the project viability. In case of social welfare project, such as health, education etc. the profit maximization is frequently an explicit objective. Their objectives define

rather differently, such as their contribution towards attaining specific sectional goal or meeting prescribed needs. These are non commercial type of projects.

1.2 OBJECTIVE OF STUDY:

This study has been undertaken to critically examine the financial and economic efficiencies of small tank irrigation projects and economic evaluation of structural improvements. More specifically the study covers the followings

(1) To study the time overrun and cost overrun of irrigation projects and reasons

(2) Post evaluation of financial performance of tank irrigation projects

(3) Evaluation of structural improvement such as canal lining and different irrigation sources such as shallow wells, tube well, combination of canal lining and tube well.

(4) Post evaluation of economic performance of irrigation rehabilitation project.

(5) To identify strengths and weaknesses and learning points for better management of small irrigation projects.

1.3 SCOPE OF THE STUDY

Chapter 2 critical reviews the financial an economic analysis of irrigation projects based on criteria adopted by international funding agencies. Criteria adopted and their historical development for sanctioning irrigation projects in India and other countries are explained.

Chapter 3 In order to analyze various aspects in implementation of irrigation projects (financed by domestic funds), a sample of four tank irrigation projects in India has been chosen keeping in view availability of data. The four tank irrigation projects are Mahuakheda, Khairana, Maheri, and Hinauta Kharmau projects in Sagar district of Madhya Pradesh in India. Various issues involved in time overrun and cost overrun associated with the tank irrigation project have been discussed.

Chapter 4 Post financial parameters pertaining to the four tank irrigation projects are analyzed and compared with respective parameters in project appraisal stage.

Chapter 5 discusses the possible improvements such as canal lining and different irrigation sources such as shallow wells, tube well, combination of canal lining and tube well that can be introduced in a tank project through case study of Khairana project and their financial performances.

Chapter 6 Case study of an irrigation project in Sri Lanka has been carried out to discuss procedure for economic evaluation as required by international funding agency. Various physical, hydrological and geological features of the Hambantota irrigation rehabilitation project in Sri Lanka are explained. Post economic parameters of irrigation rehabilitation project are evaluated and compared with the corresponding values at the project appraisal stage.

Chapter 7 The strengths and weaknesses are discussed and learning points on financial and economic evaluation of small irrigation projects are highlighted based on the case studies in India and Sri Lanka.

CHAPTER- 2
FINANCIAL AND ECONOMIC EVALUATION AS A MANAGEMENT TOOL

2.1 CRITERIA FOR SANCTIONING IRRIGATION PROJECTS

India:

The criteria followed in India for considering whether a project is viable or not have changed with time, location and other changing concern. (Chaube-1997)

- Under the British rule – the economic return of revenue for government was chief criteria used for sanctioning project. The irrigation project used to generate between 4 and 6 % returns on investment even after deducting the working expenses.
- After independence, provision of irrigation was deemed to be a responsibility of the government for social welfare, the minimum acceptable rate of return on capital investment was lowered from the pre-independence level of 6% to 3.75 % in 1949.
- The norm was again raised to 4.5% in 1954 and further to 5% in 1960
- In 1964, Godgil committee asserted that minimum acceptable rate of return on capital criterion for sanctioning irrigation projects was highly inappropriate from a social point of view. After deducting charges for land level, interest in capital, depreciation and administration expenses. It recommends a BC ratio of 1: 5 for considering the project viable.
- In 1972, the Irrigation Commission decided that the B/C ratio of 1 should be considered as acceptable for drought prone areas and B/C ratio of 1.5 or more for other areas..
- In 1983, the B/C ratio criteria for sanctioning irrigation project were replaced by the internal rate of return criteria. To qualify , projects were required to yield a minimum IRR of 9% which irrigation project located in drought prone area, hilly track and in areas where 75% of the dependable flow of basin had already be trapped a lower IRR of 7% was allowed.

Sri Lanka:

- Under the British Rule: Shifting in agricultural policy from monoculture farming to an export oriented agriculture took place. The economic return for government was the chief criteria used for sanctioning project.
- Post Independent Period – In 1950's, Irrigation works were considered as social service and economic benefits. Priority was given to irrigation and settlement projects. Benefit cost ratio greater than one was considered as criteria for sanctioning irrigation projects.
- In 1980's – primary focus under agricultural strategy had been on new irrigation developments such as the Mahaweli Development Programe aimed at achieving self sufficiency in domestic food production. IRR greater than 6% and B/C ratio greater than one were the basic criteria for sanctioning irrigation projects.
- In 1990's – Economic as well as environmental and social factors were considered in sanctioning irrigation projects. EIRR, B/C ratio and prorate cost (upper limit for unit cultivable area) have become the governing factor for sanctioning irrigation projects in addition to transfer of responsibilities of O&M to the beneficiary farmers to reduce the government burden on O&M and ensure practical and sustainable projects. Social acceptance and environment sustainability now play major role.
- Present Criteria for sanctioning irrigation projects in Sri Lanka is

  EIRR - greater than 10%

  B/C ratio - greater than 1.5%

  Prorate cost – SLR 110,000 per ha (varies)

  Environmental clearance

United State of America:

- The practice followed by the U.S Bureau of Reclamation is to consider benefit defined as the increase in the net farm income that result from the application of irrigation water. Project investment cost includes construction cost plus interest at 2.5 percent on half the cost for the period of construction, less the present worth

of salvage value remaining at the end of the period of analysis. The benefits and costs are evaluated on the same time, basis for period of analysis of 100 years. The indirect benefits, though recognized and reported in the project report, are not taken in reckoning in the analysis (Chaube-1997)

Australia and Algeria:

- The government pays from its general revenue the cost of either dam or all conveyance canals and related structures or both, but the beneficiaries have to pay the maintenance and operational charges (Chaube-1997).

Japan:

- The government subsidizes capital cost of irrigation and drainage projects while the beneficiaries have to pay the balance of the capital cost and also the regular maintenance charges (chaube-1997).

2.2 PURPOSE OF FINANCIAL AND ECONOMIC ANALYSIS

The purpose of the Financial and economic analysis of projects is to bring about a better allocation of resources, leading to enhanced incomes for investment or consumption. Economic analysis is used to choose the means using the least resources for a given output. All resource inputs and outputs have an opportunity cost through which the extent and value of project items are estimated. Projects should be chosen where the resources will be used most effectively.

The procedure for undertaking economic analysis follows a sequence of interrelated steps:

⇒ defining project objectives and economic rationale;
⇒ forecasting effective demand for project outputs;
⇒ choosing the least-cost design for meeting demand or the most cost-effective way of attaining the project objectives;
⇒ determining whether economic benefits exceed economic costs;
⇒ assessing whether the project's net benefits will be sustainable throughout the life of the project;
⇒ testing for risks associated with the project;

⇒ identifying the distributional effects of the project, particularly on the poor; and

⇒ Enumerating the nonquantifiable effects of the project that may influence project design and the investment decision.

For indirectly productive projects, economic analysis would comprise all of the above steps, except determining whether economic benefits exceed costs. The following sections explain concepts and procedures which are followed internationally in financial and economic analysis. This is based on review of literature. (EDRC-1997)

2.3 FINANCIAL AND ECONOMIC CONCEPTS

The financial analysis of a project estimates the profit accruing to the project-operating entity or to the project participants, whereas economic analysis measures the effect of the project on the national economy. For a project to be economically viable, it must be financially sustainable, as well as economically efficient. If a project is not financially sustainable, economic benefits will not be realized. Financial analysis and economic analysis are therefore two sides of the same coin and complementary.

Both types of analysis are conducted in monetary terms, the major difference lying in the definition of costs and benefits. In financial analysis all expenditures incurred under the project and revenues resulting from it are taken into account. This form of analysis is necessary to

- Assess the degree to which a project will generate revenues sufficient to meet its financial obligations,
- Assess the incentives for producers, and
- Ensure demand or output forecasts on which the economic analysis is based are consistent with financial charges or available budget resources.

Economic analysis attempts to assess the overall impact of a project on improving the economic welfare of the citizens of the country concerned. It assesses a project in the context of the national economy, rather than for the project participants or the project entity that implements the project. Economic analysis differs from financial analysis in terms of both (i) the breadth of the identification and evaluation of inputs and outputs, and

(ii) the measure of benefits and costs. Economic analysis includes all members of society, and measures the project's positive and negative impacts in terms of willingness to pay for units of increased consumption, and to accept compensation for foregone units of consumption.

2.3.1 Concept of Before Project, Without Project and With Project

To identify project costs and benefits, the situation "without the project" should be compared with the situation "with the project". The "without-project" situation is not the same as the "before-project" situation. The "without-project" situation can sometimes be represented by the present levels of productivity of the relevant resources. However, present levels of productivity would frequently change without the project, and this should be taken into account in defining the "without-project" situation.

2.3.2 Valuation of Economic Costs and Benefits

Costs and benefits of a project are valued according to common criteria. This allows them to be aggregated and compared. Decisions by producers and users of project output will be based on financial prices. However, to evaluate the consequences of their decisions for the national economy, costs and benefits need to be valued at economic prices that represent their value from the national economic perspective (see table 2.1).

Costs and benefits should be valued in constant prices that are, in terms of the price level prevailing in the year in which the project is appraised. Any expected change in the general price level can be ignored. In an economic analysis, market prices are adjusted to account for the effects of government intervention and market structure. The result is shadow prices.

All project items should be valued using the same reference point. There are different levels of prices: producer prices, wholesale prices, and retail prices. The economic prices of all outputs and inputs should be valued at the project level. Generally, this means at the point of production for the project or subproject. World prices and other forms of valuation should be adjusted to the level of the project for purposes of comparing the economic value of project costs and benefits (EDRC-1997).

Table 2.1 Valuation of Main Project Outputs and Inputs

	Category	Project Impact	Basis of Economic Price	Basis of Valuation
Output	Tradable	Incremental	Demand price	WMP (=FOB)
		Nonincremental	Supply price	WMP (=CIF)
	Nontradable	Incremental	Demand price	DMP + CT
		Nonincremental	Supply price	DMP - PT - OS
Input	Tradable	Incremental	Supply price	WMP (=CIF)
		Nonincremental	Demand price	WMP (=FOB)
	Nontradable	Incremental	Supply price	DMP - PT - OS
		Nonincremental	Demand price	DMP + CT

CIF - Cost insurance freight
CT - Net consumption tax
DMP - Domestic market price
FOB - Free on board
OS - Operating surplus
PT - Net production tax
WMP - World market price

The world price for the country is the border price; the price in foreign exchange paid for imports inclusive of insurance and freight at the port. Outputs that substitute for imports should be adjusted by the difference in transport, distribution, and handling costs between the existing point of sale and the project site. Project inputs that reduce exports should be adjusted by the difference in costs between the point of production and the project location. In each case, the traded good or service is estimated through its border price equivalent value (BPEV), adjusting for the economic cost of local costs (see Table 2.2).

2.3.3 Bringing Economic Prices to a Common Base

The aggregation of costs and benefits requires a unit of account to be established in terms of the currency, the price level and time equalence in which the analysis is to be conducted. Economic analysis can be undertaken in the currency of the borrowing country

or a foreign currency, and at the domestic or the world price level. Bank economic analysis generally will be undertaken in the currency of the borrowing country.

Table 2.2 Border Price Equivalent Value Adjustments

Outputs		
Exported	FOB price	less PTDH from project
Imported	CIF price	plus TDH to market
		less TDH market to project
Inputs		
Imported	CIF price	plus TDH to project
Export Substitutes	FOB price	less PTDH production to port
		plus PTDH production to project

CIF - Cost insurance freight

FOB - Free on board

PTDH - Processing, transport, distribution, handling in economic prices

TDH - Transport, distribution, handling in economic prices

2.3.4 Conversion Factors

Conversion factors can be calculated and used when testing the economic viability of a project. A conversion factor is the ratio between the economic price value and the financial value for a project output or input. This ratio can be applied to the constant price financial values in project analysis to derive the corresponding economic values. Conversion factors can be calculated for

- specific project items, for example, the main outputs and inputs;
- groups of typical items, such as, petrochemicals or grains; and
- the economy as a whole

2.3.5 Testing the Economic Viability of the Best Alternative

The basic test for economic viability is whether or not there are other projects in the national economy that, when estimated in the same way, would yield a greater increase in net output. In practice, not all investment opportunities are collected together

and compared. The way this comparison is done is to specify a rate of discount representing the next best alternative project in the economy, and to ensure that the project being analyzed creates net benefits in present value at a rate that exceeds those of the next best alternative. This can be done using any of the three criteria discussed above. The chosen rate of discount for decision making is between 10 and 12 percent. At a discount rate within this range, the two main criteria can be used as follows (EDRC-1997):

- **Net Present Value**: the discounted value of economic net benefits should be positive.
  Criterion: Accept all independent projects and subprojects for which the ENPV is greater than 0.

- **Economic Internal Rate of Return**: The economic internal rate of return on resources should exceed that on the next best alternative project. Criterion: Accept all independent projects and subprojects for which the EIRR is greater than the chosen discount rate.

2.3.6 The Chosen Discount Rate

It has been standard practice for the international Banks to use the EIRR criterion. The project is considered economically viable if its EIRR exceeds the economic opportunity cost of capital in the country concerned. Because it is difficult, in practice, to estimate precisely what this value should be for each country, 10 to 12 percent is used for all countries as the minimum rate of return for projects for which an EIRR can be calculated, and the rate at which to choose least-cost options.

Most directly productive projects have some element of benefits or costs that cannot be quantified or valued. The minimum rate of return within the range of 10-12 percent could be interpreted to take account of these factors. The banks follow the guideline given below

- accept all independent projects and subprojects with an EIRR of at least 12 percent;

- accept independent projects and subprojects with an EIRR between 10 and 12 percent for which additional unvalued benefits can be demonstrated, and where they are expected to exceed unvalued costs;
- reject independent projects and subprojects with an EIRR between 10 and 12 percent for which no additional unvalued benefits can be demonstrated, or where unvalued costs are expected to be significant; and
- reject independent projects and subprojects with an EIRR below 10 percent.

2.3.7 Uncertainty: Sensitivity and Risk Analysis

The EIRR or ENPV is calculated using the most likely values of the variables incorporated in the cost and benefit streams. Future values are difficult to predict and there will always be some uncertainty about the project results. The effects of different values should be investigated. For directly productive projects, this means assessing the effect of possible changes on the ENPV or EIRR and, hence, on the project decision. For indirectly productive projects, this means assessing the effects of possible changes on a basic project parameter, such as the unit cost of service provision.

Sensitivity analysis is a simple technique to assess the effects of adverse changes on a project. It involves changing the value of one or more selected variables and calculating the resulting change in the NPV or IRR. Changes in variables can be assessed one at a time to identify the key variables. Possible combinations can also be assessed. Sensitivity analysis should be applied to project items that are numerically large or for which there is considerable uncertainty.

2.3.8 Overoptimistic Assumption during Design and Appraisal

The international funding agencies evaluate the viability of its supported projects in terms of economic, financial, technical, and environmental viability. The Key parameter of these evaluations has consistently been the estimation of the project economic rate of return. Project Managers have gained the "expertise" needed for exceeding the rate of return threshold value by "manipulating" the key estimated parameters which are used for its calculation within reasonable limits.

It is a scourge of irrigation projects in Asia that the original cost-benefit estimates are seldom honest, water never reaches much of the area notified to be irrigated, crop productivity increase is less than expected, and environmental and social damage is far than expected.

The India irrigation sector review in 1998 stated that there was tendency to overstate water availability through the analysis procedures used because of social pressure to maximize area coverage and because irrigation efficiency was systematically overestimated. The same India review stated that dependability of water was based on averages rather than on statistical analysis of demand, which would better show the peak demand in dry years. (FAO-2002)

2.4 EVALUATION AS A MANAGEMENT TOOL

Evaluation is an important management tool, but in order for it to play its role, there needs to be careful consideration of evaluation recommendation as a basis for management decision. While there is formal systematic process in place for integral evaluations that are presented to the responsible authorities, the same rigorous consideration of evaluation recommendations has not systematically taken place. As a result, evaluation has become a formal procedure to fulfill the requirements of funding agency or few interested group.

Definition of Key Terms and Concepts (Krzyszz.J-2002):

Evaluation:

What?	Evaluation is an assessment that refers to design, implementation and results of completed or on-going project / program / policy.
How?	Evaluation should be systematic and objective. Key criteria to be used are: relevance, fulfillment of objectives, developmental efficiency, effectiveness, impact and sustainability.
Why?	Evaluation should provide credible and useful information to enable the incorporation of lessons learned into the decision-making process (recipients and donors).

Monitoring:

What?	Monitoring is an integral part of a day-to-day management.
How?	Monitoring embodies the regular tracking of inputs, activities, outputs, reach, outcomes, and impacts of development activities at the project program, sector and national levels
Why?	Monitoring provides information by which management can identify and solve implementation problems and assess progress towards project's objectives

Effective projects are those that can demonstrate the achievement of results. Results are derived from good management. Good management is based on good decision making. Good decision making depend on good information. Good decision making requires good data and careful analysis of the data. These are critical elements of evaluation.

Evaluation refers to a periodic process of gathering data and then analyzing or ordering it in such a way that the resulting information can be used to determine whether the project is effectively carrying out planned activities and the extent to which it is achieving its stated objectives and anticipated results.

Evaluation is often viewed by project managers, engineers as a threat rather than useful tool. In conducting any type of evaluation, areas of potential resistance should be identified ahead of time and try to address them before commencement of evaluation process.

2.4.1 Objective of Project Evaluation

The primary objective of evaluation is to improve the effectiveness and efficiency of the project by using evaluation results for better planning and implementation. Results of the evaluations which are conducted in different stages of the project life, should be capable to address the following objectives (see fig 2.1)

(1) Using Evaluation Feedback as Means for Project Operation and Management

By using evaluation results in decision making process, implementing/ donor agencies should be able to identify the design failures and implementing failures at different stages of evaluation process. It also uses them when making decision regarding project execution, selecting target project, reviewing plans and determining the continuation or termination of a project.

(2) Enhancing the "Learning Effects" of the Personnel and Organization Concerned for More Effective Project Implementation.

Evaluation feedback enhances how effectively the various peoples involved can learn and develop their skills. The term "learning effect" refers to how successfully the process of learning from evaluations enables stakeholders to better implement their future similar projects. For instances, the lessons learned from the past irrigation projects can be effectively applied in implementation of future irrigation projects under similar conditions.

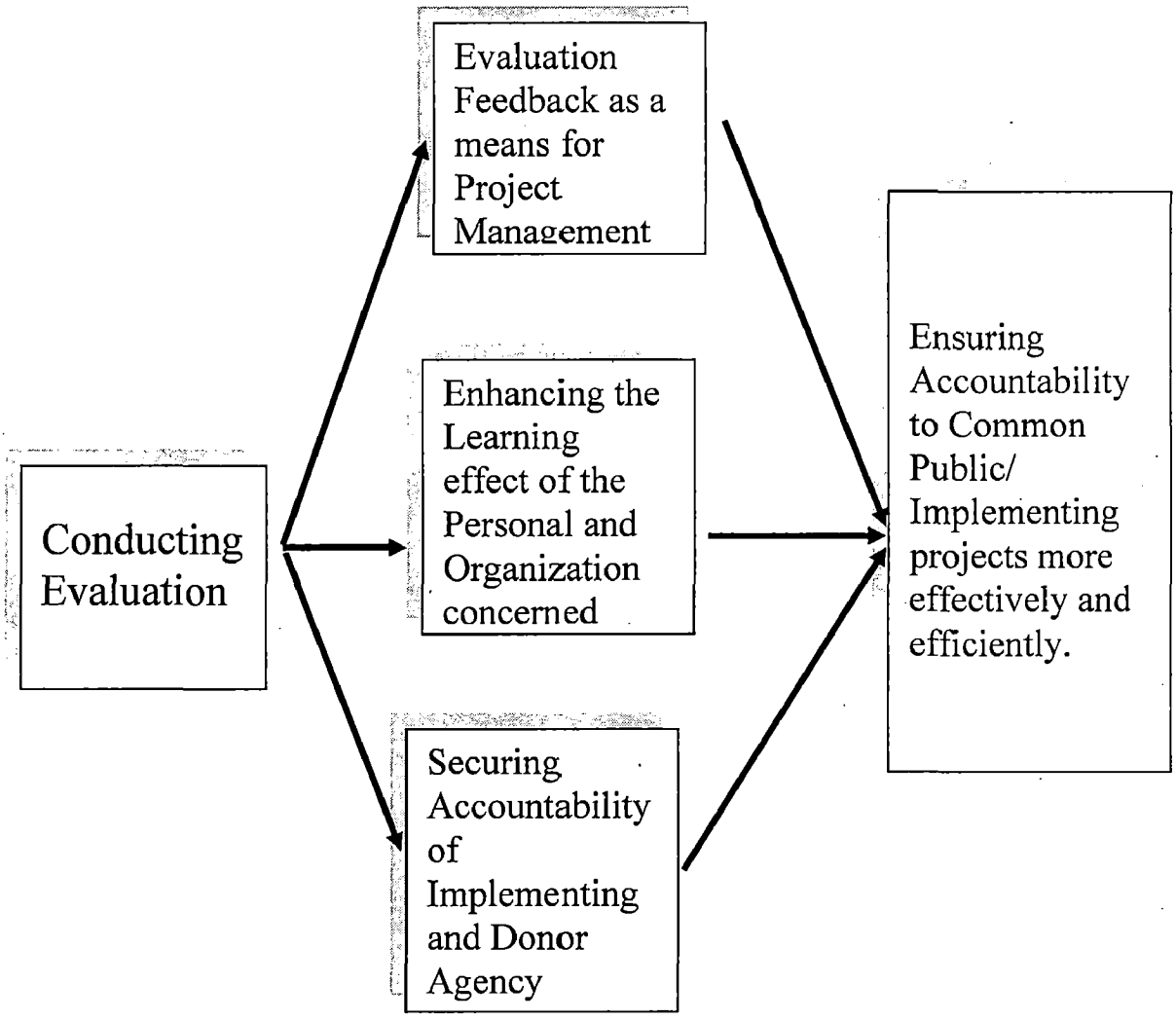


Fig 2.1 Utilization of Evaluation Results

(3) Disclosing Information Widely to Secure Accountability

Disclosing evaluation results to the public and explaining these for wining public support and understanding is one of the objectives in project evaluation. It is more appropriate to ensure the accountability to public in wider sense (JICA-2004).

2.4.2 Evaluation Types by Stages during Project Cycle

In principle three different stages of a project can be distinguished. Fig 2.2 depicts evaluation types by stages during project cycle.

- ☞ Evaluation during the Construction or Implementation Period
- ☞ Evaluation during the period of adaptation or transition
- ☞ Full Operation or normal operation

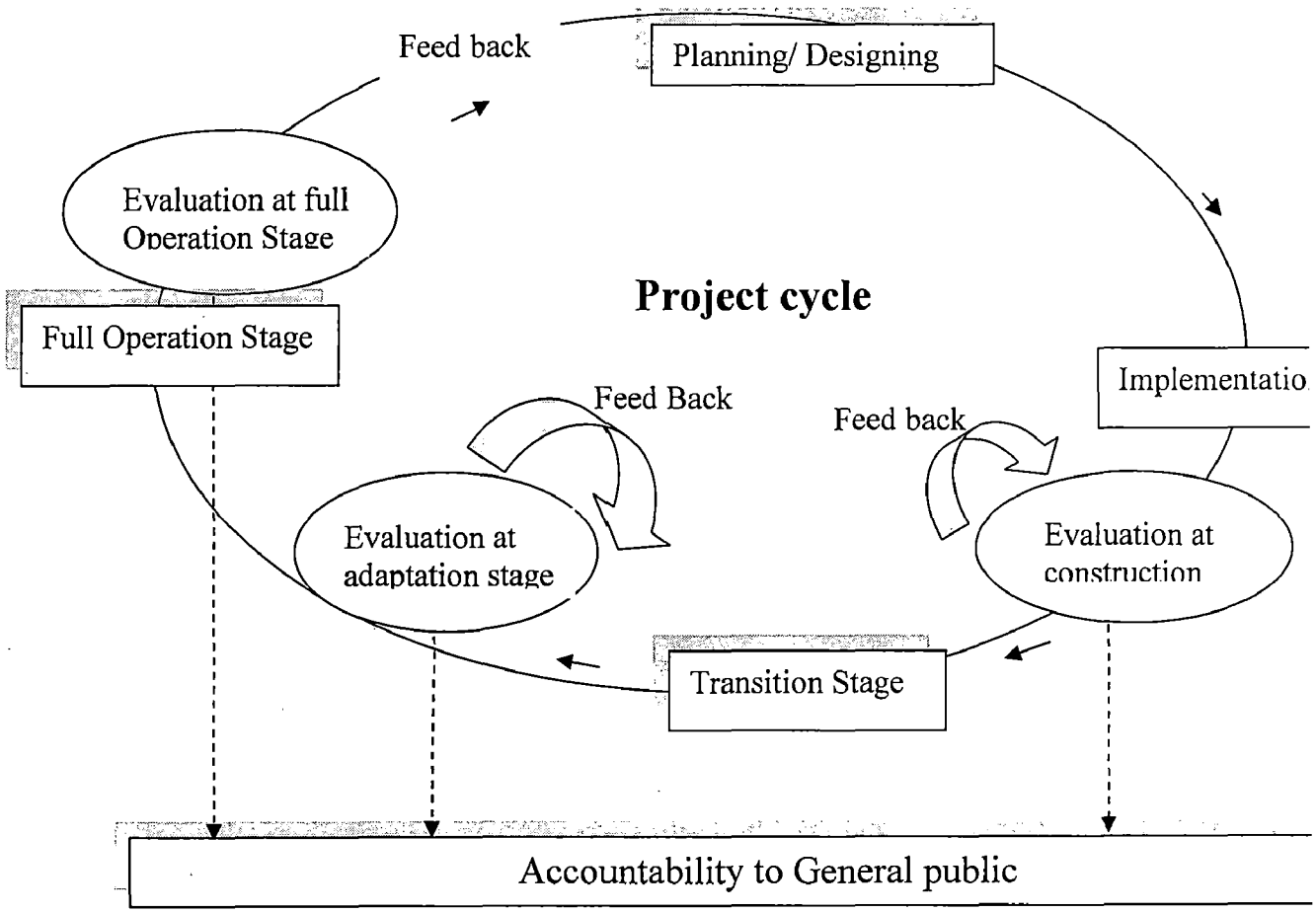


Fig 2.2 Evaluation types by Stages during Project Cycle

In practice these periods overlap, while one sector may have been completed and in full production for several years, another may have been under transition period and beneficiaries there have still to learn the effects of the project while in third sector construction may still be going on. The above mentioned evaluations have been attempted

2.4.3 Procedure for Using Evaluation as a Management Tool

- Plan the evaluation process so that it meets the needs of all interested parties (managers, staff, clients or beneficiaries) as well as those outside the project such as donors.
- Make sure that staffs from all levels of the project or organization are involved in some part of the evaluation so that staffs feel that they have been included in the process, that their concerns have been heard, and to encourage them to apply the results of the evaluation to make necessary management improvements.
- Work with your staff and other important stakeholders (including clients, senior staff, and your donor, if applicable) to identify the objectives of the evaluation.
- Decide on the scope of the evaluation including whether it will be conducted by an internal staff person or an external consultant and how much time and money can be allocated for it.
- Select the evaluation criteria, indicators, and standards for the evaluation.
- Identify sources of data and decide what methodologies you will use to collect the data. Make sure that the methodologies you choose are appropriate to the objectives of the evaluation and the people who will be involved in collecting and providing the data (particularly when you plan to collect information from other staff and/or your clients.)
- Collect the data using both quantitative and qualitative methods, as appropriate.
- Organize and analyze the data so that it is transformed into meaningful information that can be used by others in the organization to make program improvements.

- Formulate recommendations and present the findings of your evaluation in a way that is understandable and useful to all participants in the evaluation and other interested parties outside the organization.
- Take the consent of concerned authorities for findings of evaluation and fix the responsibilities and time frame to implementation of findings of evaluation.
- Allow plenty of time for reviewing and discussing the evaluation findings so that all interested parties will be committed to implementing the proposed solutions.
- Focus on finding realistic and appropriate solutions to problems identified through the evaluation.
- Encourage staff to implement the recommendations and make lasting program improvements.

CHAPTER – 3

EVALUVATION OF IMPLEMENTATION OF SAMPLE IRRIGATION PROJECTS (SAGAR DISTRICT-INDIA)

During the implementation period a regular comparison should be made between the figures set at the time of project appraisal and those actually achieved in practice. This comparison begins with the volume of work, and then extends to the actual construction cost and adherence to the timetable on annual basis. Increase in the cost, and delays in completion for the four tank irrigation projects in Saga District (India) have been analyzed in this chapter.

3.1 THE STUDY AREA

The study area consists of a sample of four tank (minor) irrigation projects (TIPs) in Sagar district of Madhya Pradesh, that have been provided with financial assistance by NABARD under RIDF tranche I and tranche III as per details given in Table 3.1 below.

Table 3.1: The Sample Rural Infrastructure (Irrigation) Projects

S. No.	Name of project	RIDF Tranche	RIDF loan (Rs Lacs)		CCA (ha)
			Sanction	Disbursement	
1	MahuaKheda	I	43.23	43.23	200
2	Khairana	III	127.98	122.29	308
3	Maheri	III	75.58	75.58	160
4	Hinauta Kharmau	III	88.83	87.73	386

Figure 3.1 is the index map showing location of the four irrigation projects (TIPs) in Sagar District. Longitude, latitude and village, block, tehsil reference of the TIPs are as given in Table 3.2.

3.1.2 Salient Features

Based on information given in project proposals (NABARD -2006) salient features of all the four TIPs have been compiled in Table. 3.2. All the four TIPs are designed for storage of monsoon runoff of local streams and canal irrigation in the command areas. The head works consist of earthen embankments with canal intakes and waste weir to carry water in excess of live storage capacity. Waste weir channels

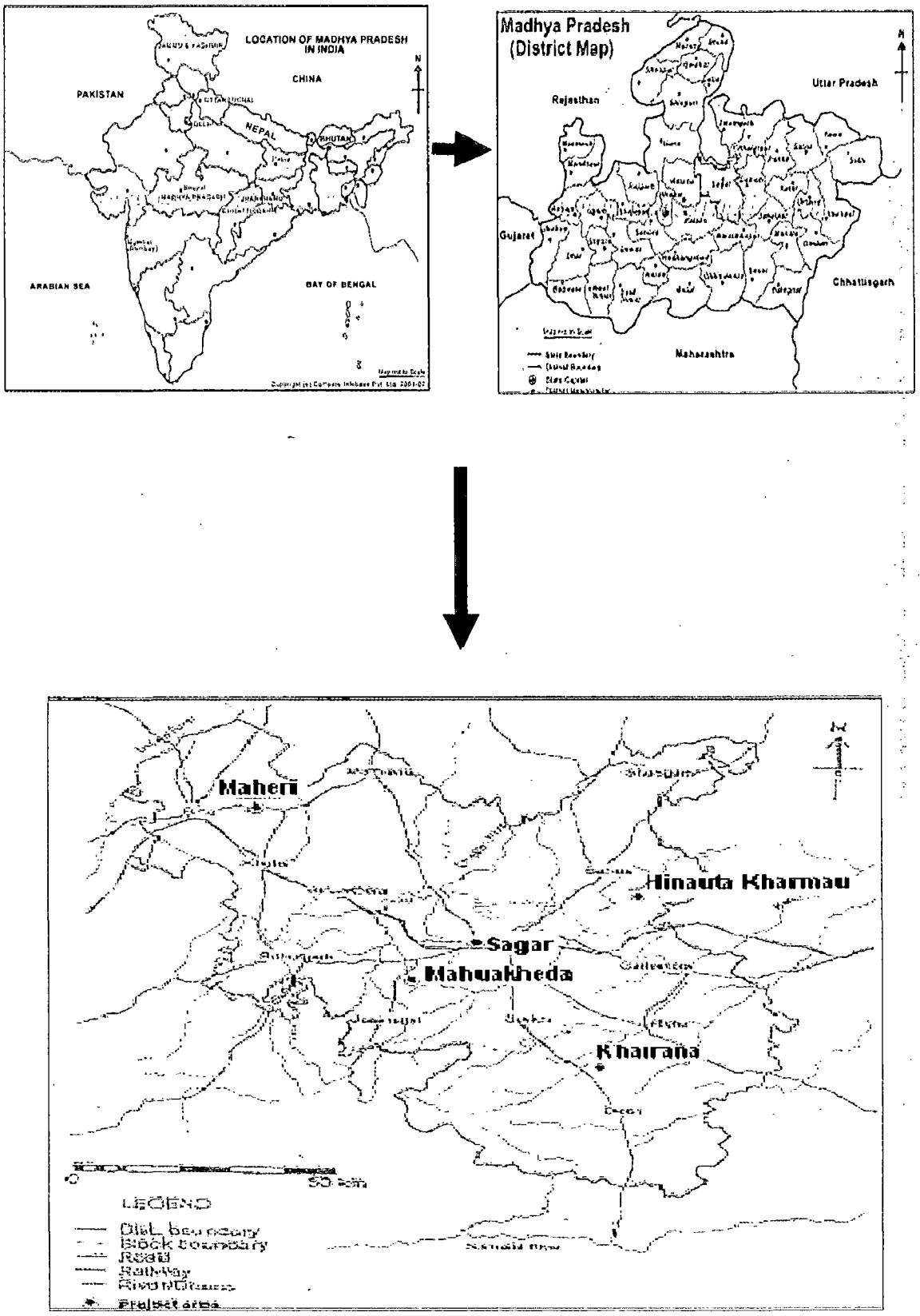


Figure 3.1: Index Map of the Four Irrigation projects in Sagar District

are excavated to carry surplus water to the stream in down stream. Irrigation is proposed in Kharif and Rabi seasons with main emphasis on rabi irrigation. Figure 3.2a to 3.2d show line diagrams of project layout.

Table 3.2: Salient Features

Item	Unit	Mahuakheda	Khairana	Maheri	Hinauta Kharmau
		RIDF I	RIDF III	RIDF III	RIDF III
Latitude	North	23° 46'03"	23° 33'03"	24° 12'30"	23° 53'00"
Longitude	East	78° 38'53"	78° 59'00"	78° 17'30"	79° 02'30"
Village		Mahua Kheda	Khairana	Basari	Hinauta
Distance from Sagar	km	22	56	70	47
Stream		Local	Local	Local	Local
Catchment Area	km^2	3.15	4.142	2.032	5.3
Annual rainfall	mm	1369	1177	1186	1163
Live storage	MCM	1.2	1.466	0.948	1.35
Silt reserve	MCM	0.08	0.096	0.07	0.13
Submergence at FRL	ha	N.A.	50.70	52	36.8
Length of dam	m	660	1025	1320	670
Max. height	m	9.94	9.87	9.15	13
Canal head discharge	m^3/s	0.12 LBC+ 0.12 RBC	0.1415	0.113	0.184
Length of canal	km	LBC 2.25 (CCA 126 ha)	3.51	3.21	1.8
Length of distr. and minor	km	RBC 1.32 (CCA 74 ha)	1.65	1.29	1.45
CCA	ha	200	308	160	386
Soil Type		Clay loam	Clay loam Sandy loam	clay	clay
Kharif Irrigation	ha	20	20	40	63
Rabi Irrigation	ha	180	275	91	185
Annual Irrigation	ha	200	295	131	248
Annual Irrigation Intensity	%	100	95.78	81.9	64.2

3.2 IMPLEMENTATION ASPECTS

Study of the project documents shows that Hinauta Kharmau, Khairana and Mahua Kheda projects were started during 1979 to 1982 and Maheri project was started in the year 1991. A variety of factors are responsible for abnormally large gestation period of these projects. In this section, physical and financial progress of works over the years, existing status and time and cost overrun are analyzed.

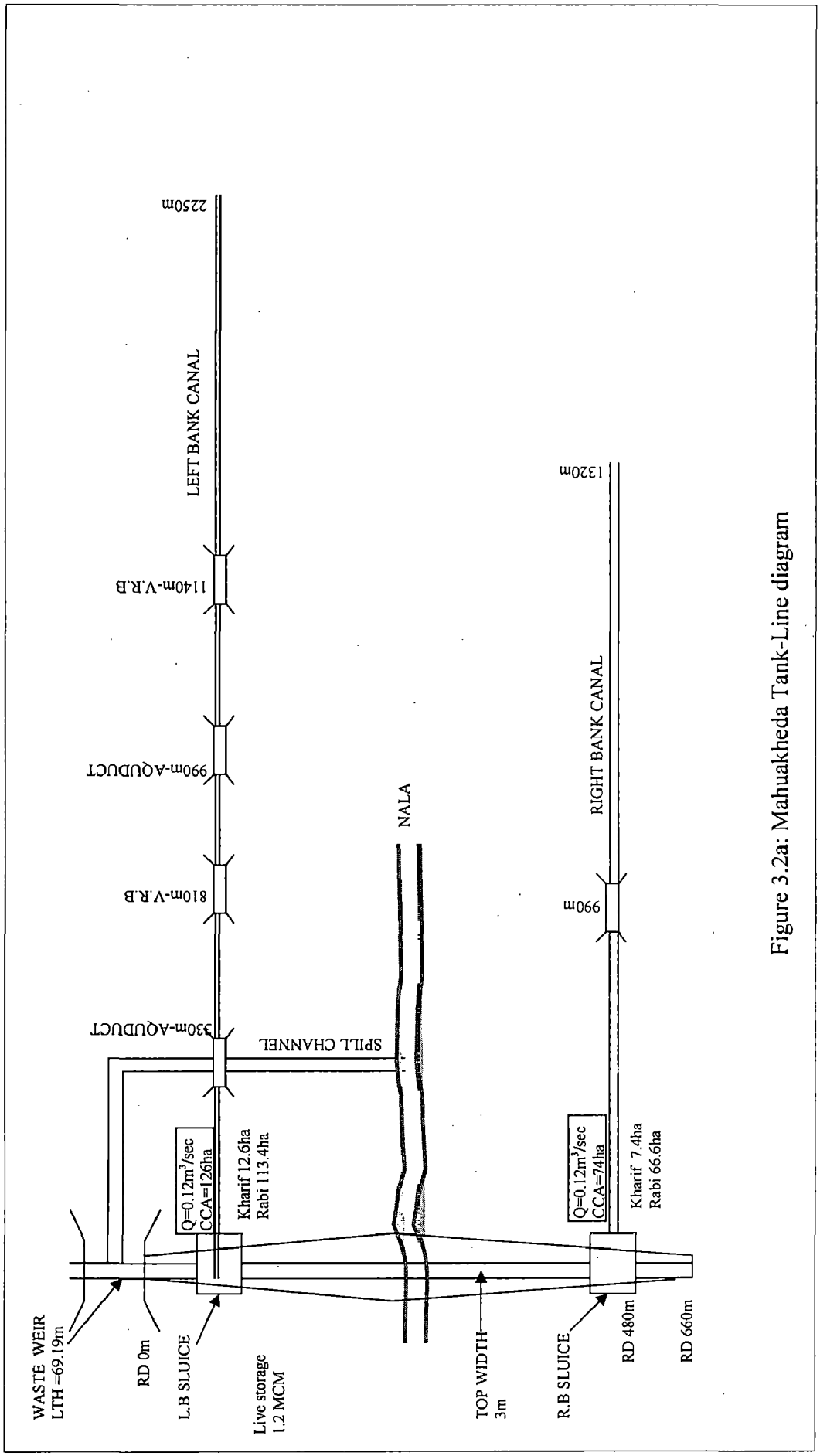


Figure 3.2a: Mahuakheda Tank-Line diagram

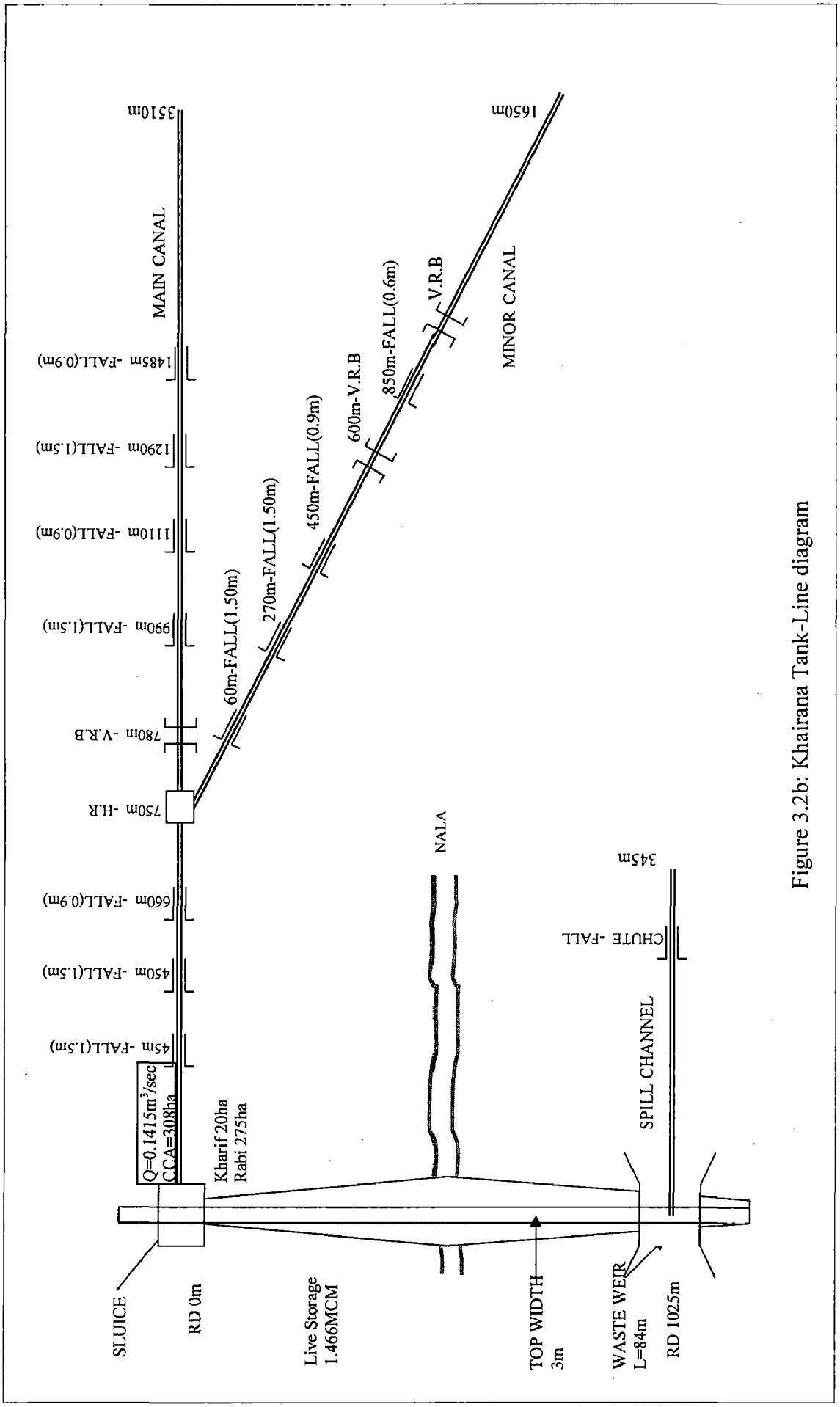


Figure 3.2b: Khairana Tank-Line diagram

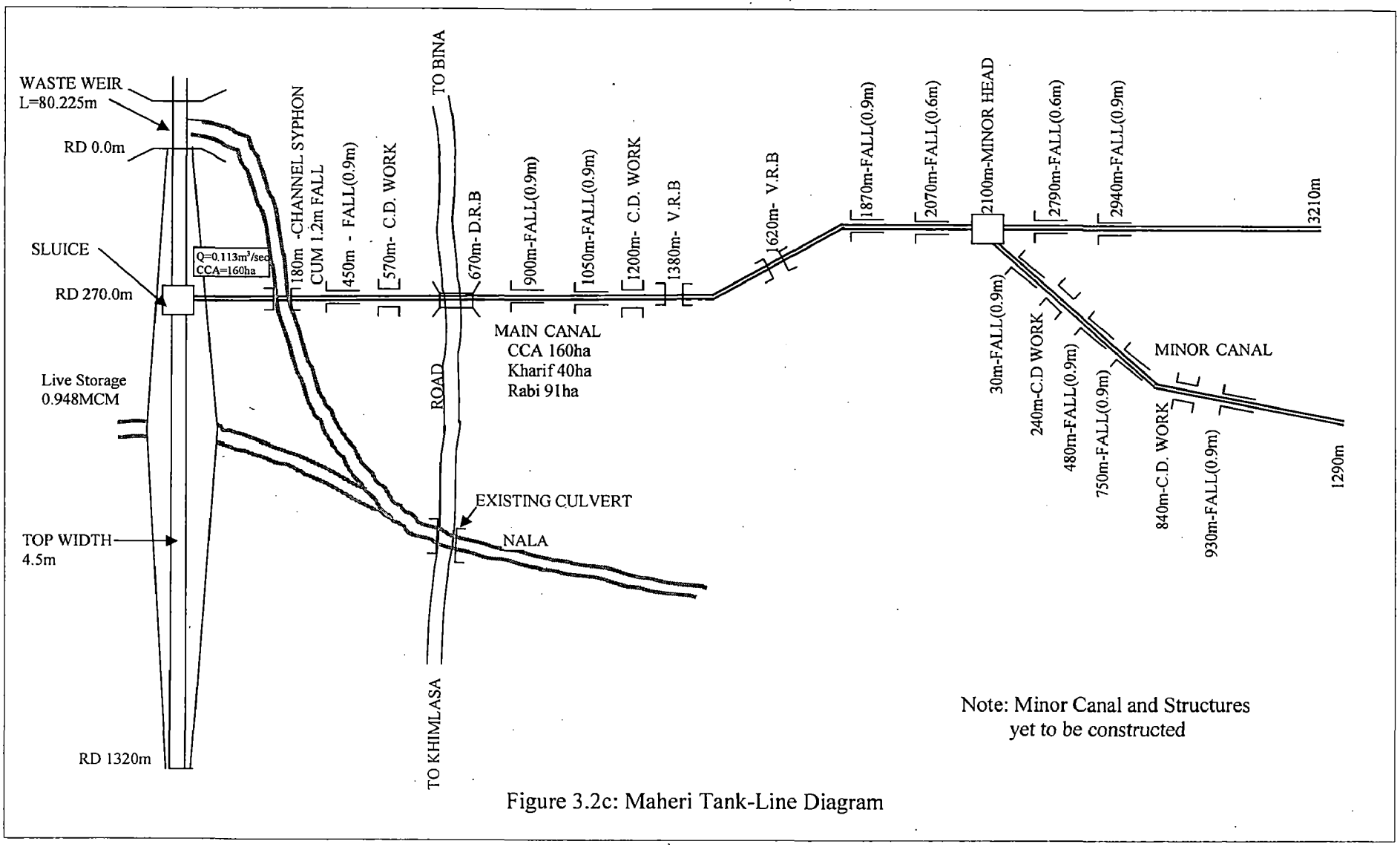


Figure 3.2c: Maheri Tank-Line Diagram

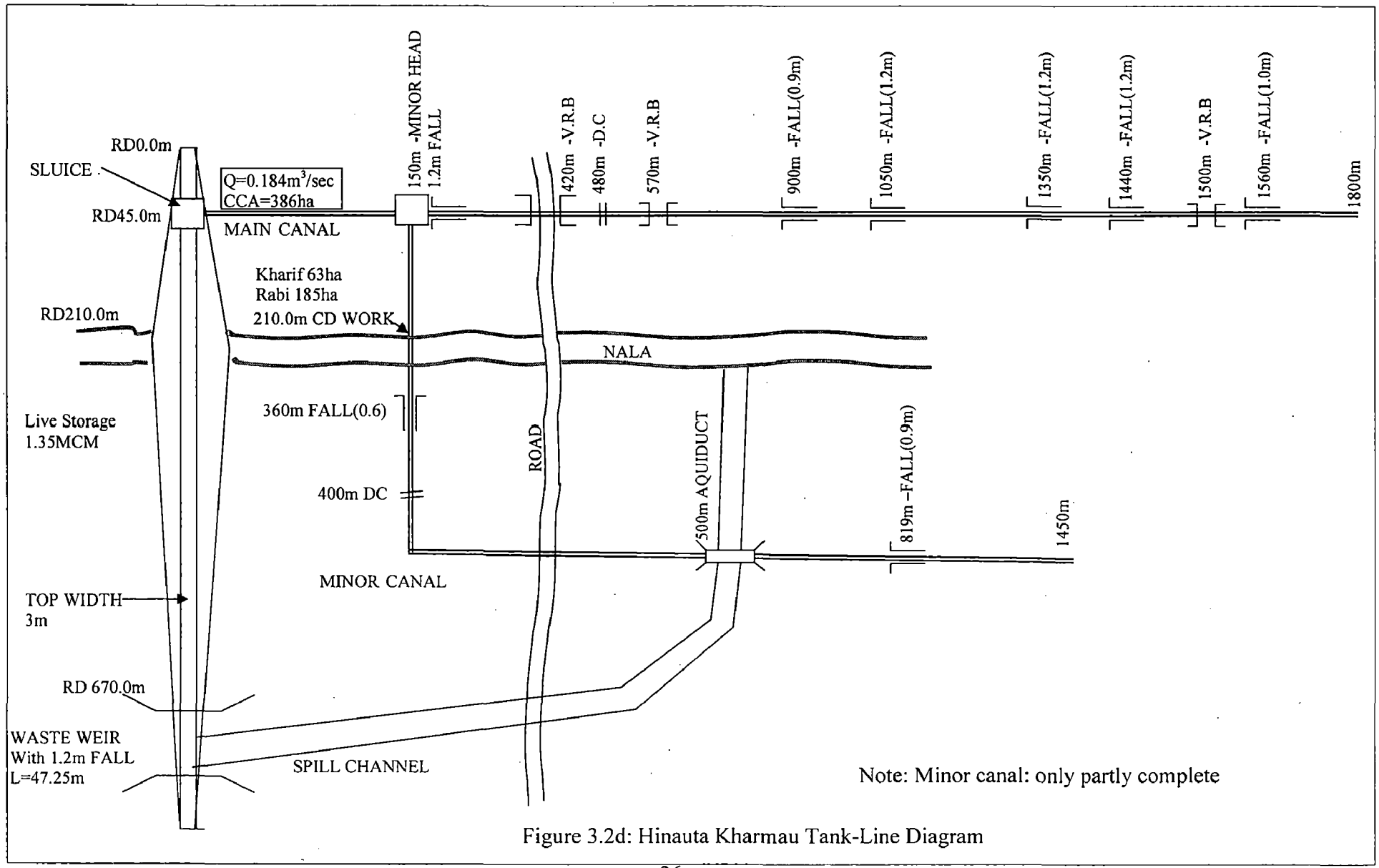


Figure 3.2d: Hinauta Kharmau Tank-Line Diagram

3.2.1 Analysis of Time Overrun

Table 3.3 shows the proposed and actual time schedule for implementation of the four sample projects. Data shows significant time gap between date of NABARD sanction and date of administrative approval by Government of M.P.

Implementation period for balance head works (mainly nala closure except Maheri for which no construction work was done before NABARD sanction) ranges from 43 months (Maheri) to 67 months (Mahuakheda). Implementation period for balance canal works ranges from 17 months (Khairana) to 59 months (Mahuakheda). Fig 3.3a, 3.3b and 3.4 show the time overrun in construction of head works & canals and overall time overrun respectively.

Table 3.3: Time Overrun in Implementation of the Projects

Item	Mahuakheda		Khairana		Maheri		Hinauta Kharmau	
	P	A	P	A	P	A	P	A
BASED ON RECENT INFORMATION PROVIDED BY WRD								
Headworks From	Oct 95	Oct 95	Sep 00	Sep 00	Sep 00	Sep 00	Jan 99	Jan 99
To	Jun 99	Mar 01	Jun 01	Jun 04	Jun 01	Mar 04	Jan 00	Mar 03
Construction period (months)	45	67	10	45	10	43	11	51
Canal works From	Apr 98	Apr 98	Feb 02	Feb 02	May 02	May 02	Feb 01	Feb 01
To	Mar 00	Mar 03	Dec 02	Jun 03	Nov 02	Feb 05	Feb 02	Mar 03
Construction period (months)	23	59	11	17	6	34	12	25
INFORMATION AS PER NABARD SANCTION AND COMPLETETION REPORT								
Year of start of project	Jan 1982		Dec 1981		1991		Dec 1979	
Sanction by NABARD	July 1995		Nov 1997		Nov 1997		Nov 1997	
GOMP.Adm.Approval Target Actual	Sept 1995 April 2001		BD Dec 2000		BD May 1999		BD May 1999	
Date of completion NABARD Target As per certificate As per recent Information	March 1997 March 2001 March 2003		March 2000 June 2002 June 2004		March 2000 June 2002 Feb 2005		March 2000 March 2002 March 2003	

BD: Before disbursement; P: Proposed implementation time; A: Actual implementation time

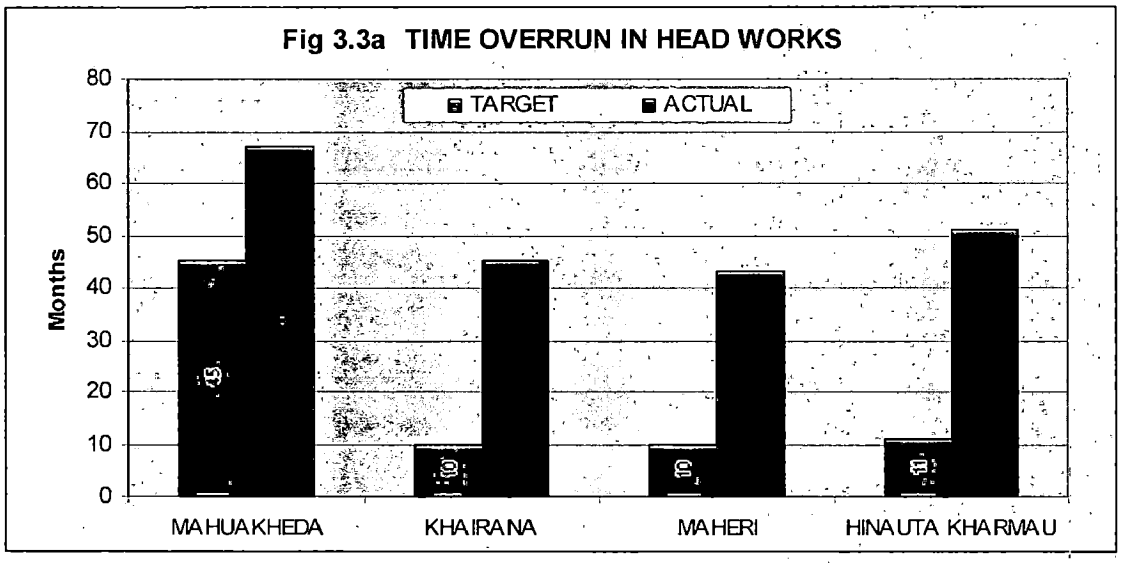


Fig 3.3a TIME OVERRUN IN HEAD WORKS
TARGET
ACTUAL
Months
80
70
60
50
40
30
20
10
0
MAHUAKHEDA
KHAIRANA
MAHERI
HINAUTA KHARMAU

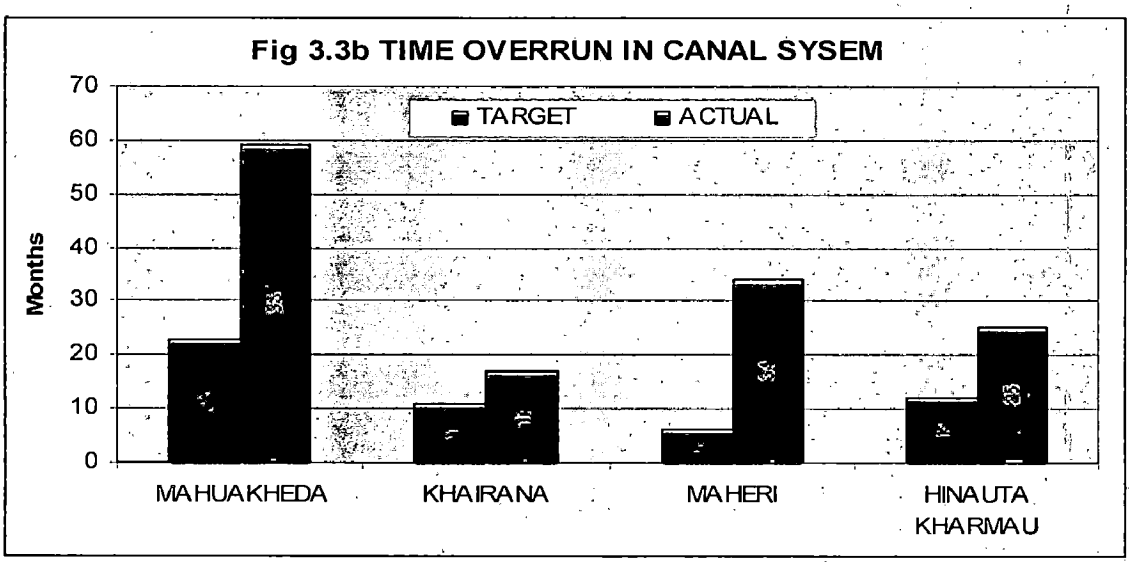


Fig 3.3b TIME OVERRUN IN CANAL SYSEM
TARGET
ACTUAL
Months
70
60
50
40
30
20
10
0
MAHUAKHEDA
KHAIRANA
MAHERI
HINAUTA
KHARMAU

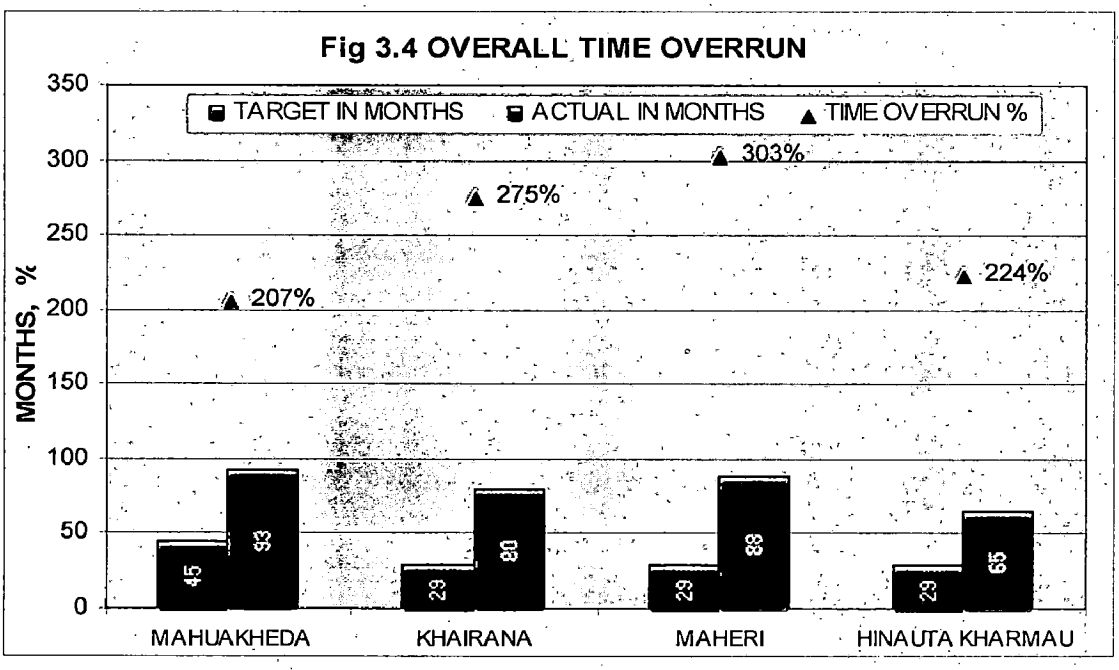


Fig 3.4 OVERALL TIME OVERRUN
TARGET IN MONTHS
ACTUAL IN MONTHS
TIME OVERRUN %
MONTHS, %
350
300
250
200
150
100
50
0
207%
275%
303%
224%
45
93
29
80
29
88
29
65
MAHUAKHEDA
KHAIRANA
MAHERI
HINAUTA KHARMAU

Based on performance information provided by WRD and information given in project documents, following reasons could be ascertained.

Common Reasons: Rise in cost of labor and material, delay in framing revised cost estimate, delay in administrative approval and thin spreading of available funds over the years are found to be the common reasons for time overrun in all the four projects.

3.2.2 Main Reasons for Time Overrun

Study of project documents shows that followings are main reasons for time overrun.

3.2.2.1 Mahuakheda Project: Contractors submit the tender documents did not meet the requirements of sponsoring agency necessitating repetition of tender calling process for five times.

NABARD provided sanction in 1995 but tenders were invited in Jan 1996 and contracting agency was decided only in April 1997. Due to ensuring monsoon season Nala closure work could be started after September 97.

Canal work has been delayed mainly due to incomplete land acquisition. Day to day hindrances was also made by land owners in the construction work.

3.2.2.2 Khairana Project: Main reason for delay is the excessive time taken in according technical sanction and necessity to frame revised cost estimate. Further delay occurred due to time taken in obtaining administrative approval for revised estimate.

Construction work progressed slowly, due to thin spreading of funds.

3.2.2.3 Hinauta Kharmau: Prior to NABARD sanction, project work got delayed due to implementation of Forest Conservation Act.

NABARD provided sanction in Nov 1997 but delay occurred in the tendering process and work could start in Jan 2000. Work was again stopped for some time as per instruction of Chief Engineer as per policy matter of M.P Govt.

3.2.2.4 Maheri Project: Main reasons are delay in according technical sanction and administrative approval by the higher authorities. NABARD provided sanction in Nov 1997 but tendering process took sufficient time and agency could start the work in September 2000 only due to delay by contractor.

3.3 FINANCIAL PROGRESS

Amounts of cost finance and expenditure for the four projects have been compared in Table 3.4. Comparison in bar chart form is shown in Figure 3.5 for (i) original cost and expenditure before NABARD sanction (ii) GOMP share in balance cost

and in up to date expenditure and (iii) NABARD share in balance cost and in up to date expenditure.

Table 3.4: Projects' Cost Finance and Actual Expenditure (Rs lacs)

Item	Mahua Kheda	Khairana	Maheri	Hinauta Kharmau
	RIDF-I	RIDF-III	RIDF-III	RIDF-III
AS PER NABARD SANCTION ORDERS (Ref: 3)				
Original Cost (Year)	24.98 (1981)	24.85 (1981)	54.4 (1991)	24.89 (1979)
Revised Cost (Year)	49.81 (1995)	171.55 (1997)	98.19 (1997)	179.7 (1997)
Expenditure (Year)	27.33 (1995)	30.64 (1997)	11.61 (1997)	75.5 (1997)
Balance Cost	22.48	140.91	86.58	104.2
NABARD Annual Loan NABARD Total	14.95 (95-96) 2.48 (96-97) 17.43	11.317 (97-98) 77.245 (98-99) 39.418 (99-2000) 127.98	14.74 (97-98) 23.71 (98-99) 38.13 (99-2000) 76.58	15.35 (97-98) 62.55 (98-99) 8.49 (99-2000) 86.39
Govt. Contribution	5.05	12.93	10.0	17.81
Total	22.48	140.91	86.58	104.2
AS PER COMPLETION REPORT				
Estimated cost of balance works				
Headwork	19.68	122.19	NA	79.85
Canal Works	2.8	18.72	NA	24.35
Total	22.48	140.91	86.58	104.2
Actual expenditure on balance work				
Head Works	39.58	97.829	NA	72.33
Canal Works	24.39	38.501	NA	33.0
Fixed Charges	3.37	2.276	2.54	Nil
Total	67.34	138.606	123.18	105.33
Adm: Approval Original Revised Re-revised	 24.98 73.4 108.48	 24.85 173.84 -	 54.4 126.45 -	 24.89 193.57 -
AS PER INFORMATION PROVIDED TO STUDY TEAM (Ref: 7)				
NABARD Share	22.48	127.91	76.58	86.39
Govt. Contribution	45.23	13.0	46.6	18.94
Total	67.71	140.91	123.18	105.33

Table 3.5 shows details of annual budget and annual disbursement over the construction period for completion of the remaining works. Cash flow of NABARD loan and expenditures are graphically depicted in figure 3.6.

Details on annual budget provisions are not available in case of Maheri and Hinauta Kharmau TIPs. Annual project budget and disbursement figures do not match. There has been thin spreading of the available funds over the years resulting in time and cost overrun. Time taken to complete the remaining works ranges from five years to

seven years against envisaged period of two to three years and still works are remaining incomplete in case of Maheri and Hinauta Kharmau projects. (Ref. completion report). Cost history and reasons for cost overrun for each of the project are analyzed in the following paragraphs.

Table 3.5: Annual NABARD Loan, Project Budget and Disbursement (Rs lacs)

Year	Mahua Kheda			Khairana			Maheri			Hinauta Kharmau		
	P	B	D	P	B	D	P	B	D	P	B	D
95-96	14.95	12.0	7.42	-	-	-	-	-	-	-	-	-
96-97	2.48	4.0	14.83	-	-	-	-	-	-	-	-	-
97-98	-	15.0	16.28	11.317	1.0	0.80	14.74	-	-	15.35	-	-
98-99	-	12.6	13.52	77.245	45.0	29.88	23.71	NA	1.70	62.55	NA	9.38
99-0	-	14.0	11.01	39.418	10.0	41.13	38.13	NA	22.36	8.49	NA	29.57
	-	-	4.29	-	17.0	17.35	-	NA	4.47	-	NA	26.91
	-	-	-	-	20.0	21.45	-	NA	37.80	-	NA	21.96
	-	-	-	-	30.0	27.02	-	NA	45.23	-	NA	17.50
	-	-	-	-	5.0	5.00	-	NA	11.62	-	-	-
Total	17.43	57.6	67.35	127.98	128.8	142.61	76.58	-	123.18	86.39		105.32

P: Annual NABARD Loan Provision; B: Annual Project Budget;
D: Annual Disbursement to project; B & D include GOMP share; NA: Not available

3.3.1 Analysis of Cost Overrun

3.3.1.1Cost Overrun of Mahuakheda Project:

Balance cost of Rs 22.48 lacs was proposed to be financed with Rs 17.43 lacs as NABARD share and Rs 5.05 lacs as Government contribution.

Expenditure incurred to complete the remaining works is 300% of the estimated cost of balance works. Government share in this expenditure is 896% of the stipulated share of Rs 5.05 lacs. Estimated cost of balance head works was Rs. 19.68 Lacs whereas expenditure on this item is Rs. 39.58 lacs. Estimated cost of balance canal works was Rs. 2.8 lacs whereas expenditure on this item is Rs. 24.39 lacs.

3.3.1.2 Cost Overrun of Khairana Project

Balance cost of Rs 140.91 lacs was proposed to be financed with Rs 127.98 lacs as NABARD share and Rs 12.93 lacs as Government contribution.

As per completion report, estimated cost of balance headwork was Rs 122.19 lacs whereas actual expenditure on this item was Rs 97.83 lacs. On the other hand, estimated cost of balance canal work was Rs 18.72 lacs whereas actual expenditure on this item was Rs 38.5 lacs; total expenditure being Rs 138.61 lacks (including Rs 2.276 lacs as fixed charges).

3.3.1.3 Cost Overrun of Maheri Project

It's original cost in the year 1991 was Rs 54.4 lacs. It was revised to Rs 98.19 lacs in the year 1997. During the period 1991 to 1997 only Rs 11.61 lacs was spent on this project unlike on other projects where amount spent before NABARD sanction has been more than original cost. Balance cost of Rs 86.58 lacs was proposed to be financed with Rs 76.58 lacs as NABARD share and Rs 10.0 lacs as Government contribution.

Expenditure incurred on the remaining works is Rs 123.18 lacs. Minor canal and related structures are yet to be constructed. Actual GOMP contribution in up to date expenditure is 466% of stipulated expenditure of Rs 10 lacs.

3.3.1.4 Cost Overrun of Hinauta Kharmau Project

Balance cost of Rs 104.2 lacs was proposed to be financed with Rs 86.39 lacs as NABARD share and Rs 17.81 lacs as Government contribution.

As per information provided, expenditure is Rs 105.3 lacs out of which Rs 86.39 lacs is NABARD share and Rs 18.94 lacs is Government share. Estimated cost of balance head work was Rs 79.85 lacs whereas actual expenditure is Rs 72.33 lacs. Estimated cost of balance canal works was Rs 24.35 lacs whereas actual expenditure is Rs 33.00 lacs.

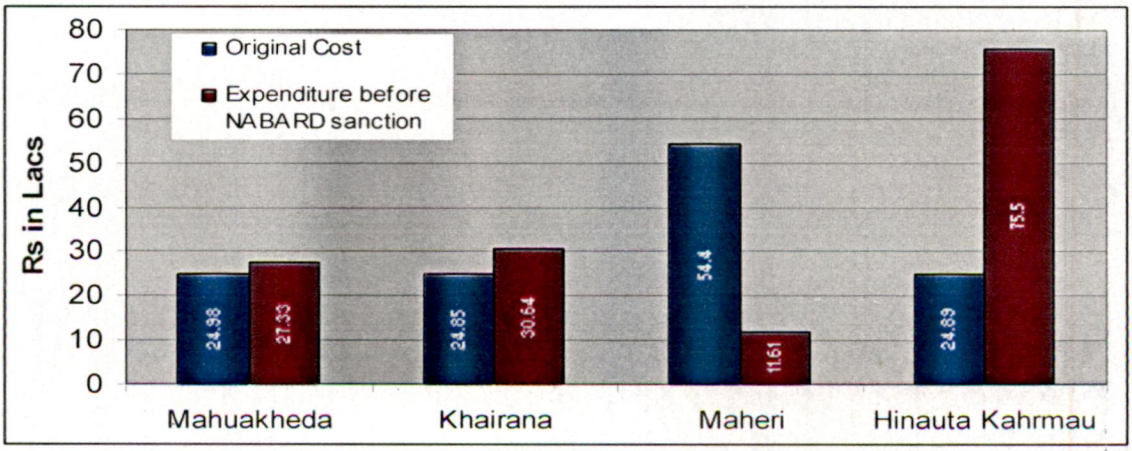
3.4 RECOMMENDATION TO OVERCOME COST AND TIME OVERRUN

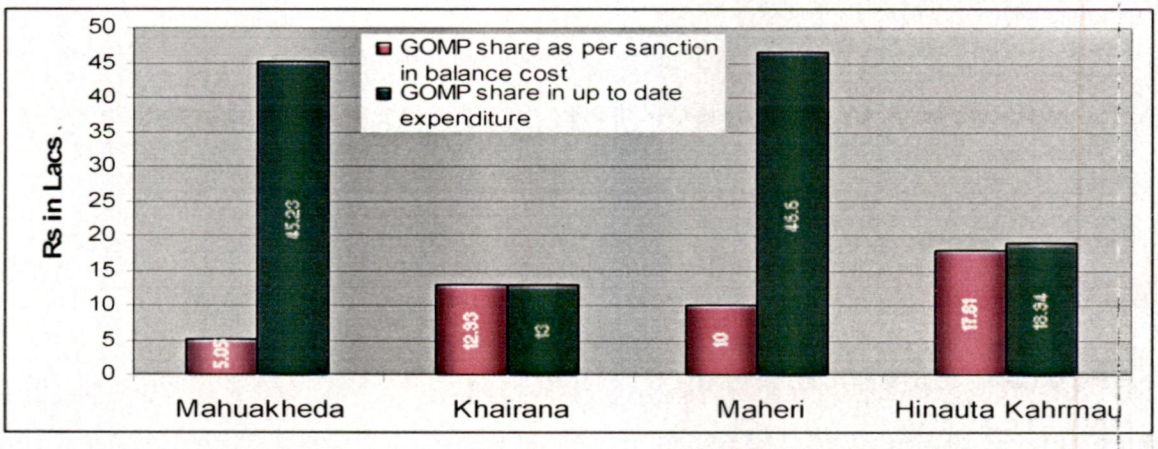
Time and cost overrun in implementation of the irrigation projects is a common phenomenon observed all over the world. It is the magnitude of time and cost overruns which is significantly large in case of these four TIPs. Financial valuation at regular intervals during the construction period is now commonly used as a management tool. Cash flow monitoring and impact on benefit cost ratio help in identifying the problem areas and appropriate management solutions.

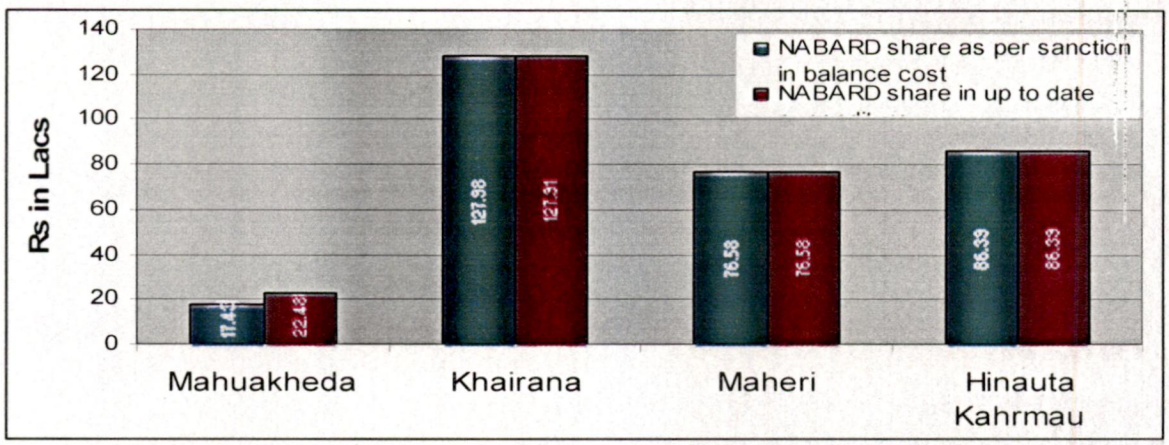
Prior to funding by NABARD, the projects have already been in construction stage for a long period as indicated by year of original start of the project in the table 3.4. It is seen that annual budget allocations for projects' construction have been inadequate and not consistent with annual disbursements of loan by NABARD. It is necessary that funds are transferred to project executive level swiftly for timely implementation.

Administrative approvals for revision in project cost should be provided well in time. NABARD criteria for accordance of administrative approval before release of assistance should be strictly enforced.

Tender percentage being a function of various complex factors, NABARD did not adopt any hard and fast limit for cost escalation and percentage of higher tenders provided







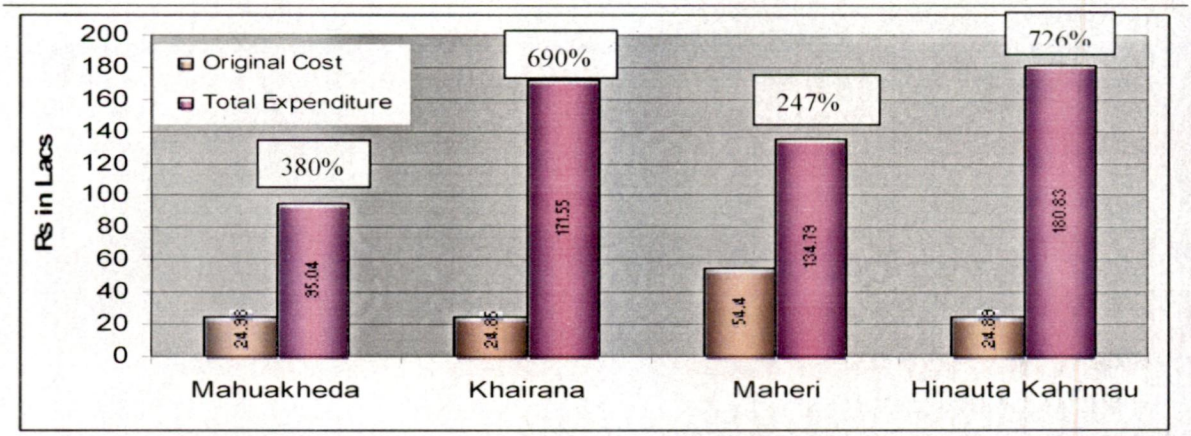


Figure 3.5: Cost Finance and Expenditure Comparison

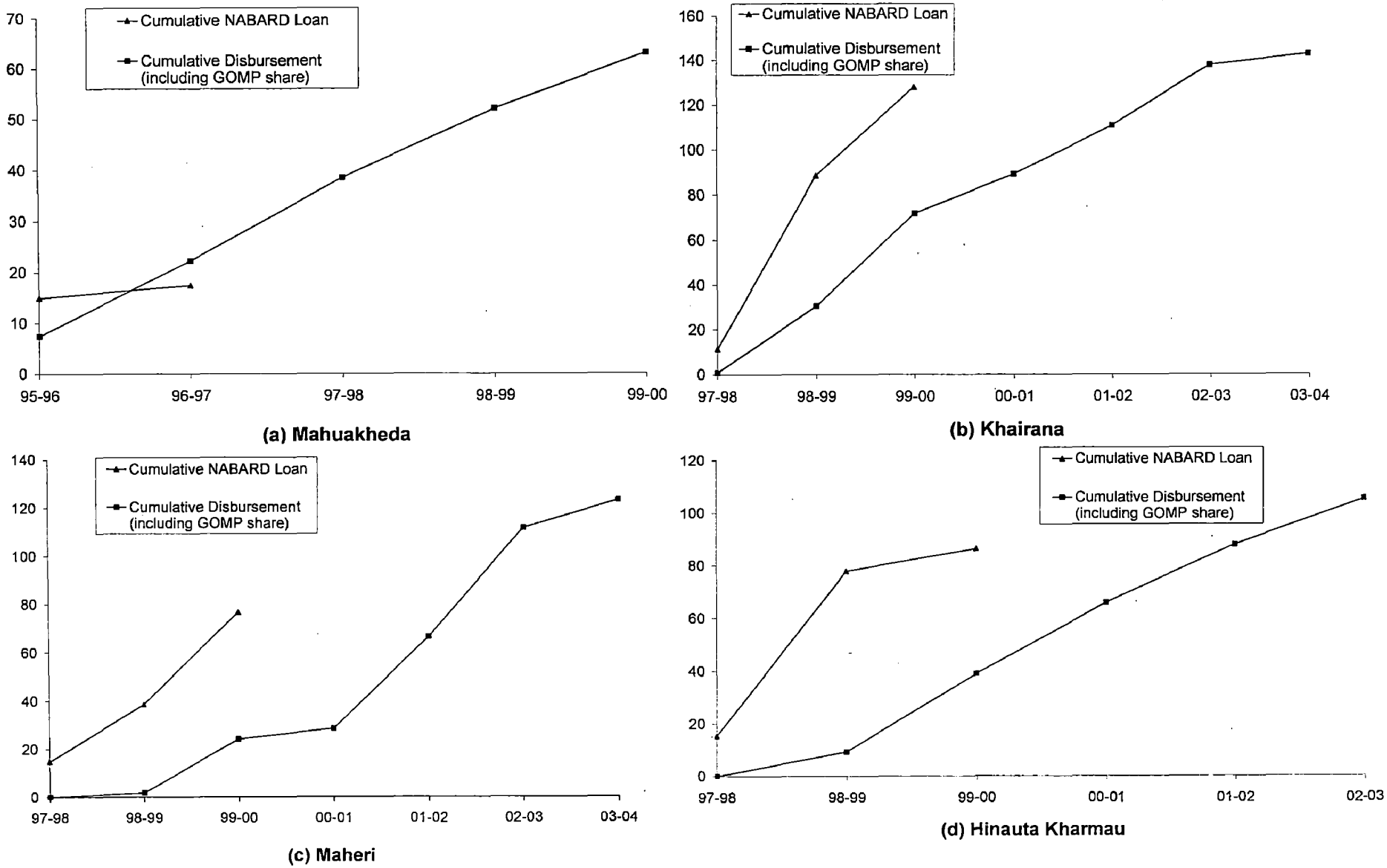


Figure 3.6: NABARD Loan and Expenditure over the Years for Balance Work

in the projects had been accepted as reasonable. And yet, the reasons for unusually large increase in actual cost and time overrun are high percentage tender which means that cost were either not assessed realistically or there are some other unexplained reasons beyond the scope of this study.

CHAPTER 4

FARM INCOME AND BENEFIT COST ANALYSIS OF TANK IRRIGATION PROJECTS

4.1 GENERAL

As in the construction period, evaluation during the period of adaptation and development takes form of a regular comparison between the progress actually made since the first year of the completion of the project and the target set at the project formulation stage.

In case of irrigation projects, such a comparison makes it possible to keep a constant watch on how the return develops. The latter are measured by substituting actual values achieved for crops, water consumption, yield etc. for the assumption made in the initial calculation.

Evaluation at full production or normal operation stage is conducted after certain period has passed since the completion of a target project and it is conducted with emphasis on the impact and sustainability of the project. This evaluation aims at delivering lessons and recommendations for improvement of planning and implementation of similar projects more effective and efficient way in future. (JICA-2004)

4.2 IMPACT ON CROPPING SYSTEM AND FARM INCOME

Cropping system consists of unirrigated and irrigated crop areas in kharif and rabi seasons. Cropping system is characterized by cropping pattern, cropping intensity, irrigation intensity on seasonal and annual basis. Farm income covers analysis of cost of cultivation, gross farm income, net farm income and incremental farm income with reference to control situation which is taken as prevailing before implementation of the projects (balance works). This section covers analysis of cropping system and farm income under various situations which are explained below.

4.2.1 Before Project, Designed, Existing and Ultimate Situations

Before Project Situation: This corresponds to situation prevailing at the time of NABARD sanction for implementation of balance works.

Designed: This corresponds to the proposed cropping system and related parameters as given in the project proposals submitted by WRD for NABARD finance.

Existing Situation: This corresponds to the present situation in the command area of the project. The existing situation may differ over the projects due to difference in implementation status of the projects. As stated earlier, part of the command area is under canal irrigation in case of Khairana and Hinauta Kharmau projects whereas canal irrigation has not yet started in case of Maheri and Mahuakheda projects. Therefore existing situation in command areas of Maheri and Mahuakheda projects is "without project" situation and situation existing in command areas of Khairana and Hinautakharmau pertains to transition stage to ultimate situation.

Ultimate Situation: This refers to expected situation when the projects will be in full operation stage. It is assumed that existing rabi crops which are irrigated from other sources as well as unirrigated rabi crops will ultimately be irrigated by canal water. Further, direct use of tank water for irrigation will not occur under ultimate situation. However, it is debatable whether farmers already accustomed to direct use of tank water will surrender such benefit.

Cropping system and farm income are different under the above mentioned four situations. Changes in cropping system and farm income may occur over a period of time even without project due to improvements in agriculture technology (use of high yielding variety seeds, farm machinery, pesticides, fertilizer, bank credit and switch over to cash crops). Such impacts can not be attributed to the irrigation project. For realistic assessment of impact attributable to the projects, it would be more logical to consider change from "without project in future" to "with project in future" situations.

Exercise on evaluation of project impacts gets further complicated due to recognition of the fact that even where canals are not in operation or are partly in operation, tank water is being utilized for irrigation (without using canals). Whether cropping system based on such use of tank water should be considered as pertaining to "with project" or "without project" situation is debatable. In the present study it has been assumed to be pertaining to "with project" situation.

In the following sections cropping system and farm income are analyzed under different situations using sample data and other information.

4.2.2 Design Irrigation and Actual Canal Irrigation

Conventional procedure to determine design irrigation area is based on 75% dependable water supply (with or without storage) and irrigation demand (usually monthly or fortnightly) within a normal year. Long term simulation study incorporating variation in (i) cropping pattern, (ii) irrigation requirement, (iii) water availability and (iv) irrigation efficiency over the years is desirable but usually not carried out. Table 4.1 shows design irrigation area and canal irrigated area in different years as per information supplied by WRD

Table 4.1 Design and Actual Irrigation by Canal

Name of the Project	CCA (ha)	Designed Irrigation (ha)			Actual Irrigation (ha)		
		Kharif	Rabi	Annual	2003-04	2004-05	2005-06
Mahuakheda	200	20	180	200	Nil	Nil	Nil
Khairana	308	20	275	295	Nil	166(54%)	60(20%)
Maheri	160	40	91	131	Nil	Nil	Nil
Hinauta Kharmau	386	63	185	248	80 (32%)	15 (6%)	138(56%)

Utilization of irrigation potential is nil in case of Mahuakheda and Maheri projects. There is under utilization of irrigation potential with significant fluctuation over the years in case of Khairana and Hinauta Kharmau projects.

Annual irrigation shown in table above is for canal irrigation only. It does not include direct irrigation from tank, streams, and wells. Tank bed cultivation is common in all the projects. The cultivated tank beds as well as adjoining cultivated land on the periphery of the tanks are irrigated directly from tank using pumps to lift water.

In addition, farmers are making use of water flowing in nala in the downstream which is augmented due to seepage from dam, leakage from intake and also unauthorized diversion of tank water into nala by cutting the canal in head reach. In a way this has resulted in utilization of tank water which otherwise was not possible due to incomplete/ damaged canal network. In addition tank storage and canal irrigation has increased artificial recharge of ground water which is being utilized for irrigation.

4.2.3 Cropping Pattern and Cropping Intensity

Cropping pattern is expressed in terms of percent of cultural command area (CCA) under each crop. Thus, there is design cropping pattern (as reported in project proposal), existing cropping pattern (as observed during recent socio- economic survey) and cropping pattern expected in full operation stage (ultimate) which is based on realistic assessment of crop and crop areas.

Cropping intensity is defined as total cropped area (irrigated and unirrigated) expressed as percentage of CCA on annual basis. Annual cropping intensity may not necessarily be equal to sum total of seasonal cropping intensities if there are two seasonal or perennial crops.

Seasonal irrigation intensity is total of irrigated crop area expressed as percentage of CCA in a season. Annual irrigation intensity is sum of seasonal irrigation intensities.
Concept of cropping intensity is appropriate to farm budgeting and assessing water charges etc which are calculated on the basis of annual cropped area. Concept of irrigation intensity is useful for assessing water requirement and how much land to be irrigated.

4.2.4 Existing Cropping Pattern

Data have been collected from the farmers on the cultivated crops, crop areas (irrigated and unirrigated) and source of irrigation. Total land area and total crop areas owned by the farmers were worked out to assess the actual cropping pattern in the command areas as shown in table 4.2.

Soyabean is the most important kharif crop. Pulse (Udad) is also an important kharif crop in Maheri Project. Wheat, gram and pulse are important crops (irrigated /unirrigated) in rabi season. Socio economic survey of the farmers has revealed that farmers have followed similar cropping pattern for several years using improved agriculture technology and other sources of irrigation.

Seasonal and annual cropping intensities are high in all the projects. Annual cropping intensity ranges from 150% in Khairana project to 200% in Mahuakheda project.

Irrigated crop areas and irrigation intensities are based on area irrigated from all sources of irrigation. Only rabi crops are generally irrigated. Soil type being black cotton, irrigation is generally not practiced in kharif season.

Table 4.2: Sample Survey of Crop Areas (Acres) and Cropping Pattern

Item	Mahuakheda		Khairana		Hinauta Kharmau		Maheri		
	Area	%	Area	%	Area	%	Area	%	
Number of farmers surveyed	20		21		19		10		70
Total area owned by the farmers (acre)	421		342		412		67		1242
CCA of projects (acre)	500 (200 ha)		770 (308 ha)		965 (386 ha)		400 (160ha)		2635 (1054ha)
Crop Areas (acres)									
Kharif									
Soya	417	99.05	176	51.46	391	94.9	39	58.21	1023
Paddy	-		1	0.29	-		-		1
Pulses	-		1	0.29	-		-		1
Vegetable	4	0.95	-		-		4	5.97	8
Udad	-		-		-		11	16.42	11
Rabi									
Wheat Irrigated	90	21.38	92	26.9	127	30.83	33	49.25	342
Gram Irrigated	163	38.72	144	42.1	148	35.92	11	16.42	466
Pulses Irrigated	-		21	6.14	35	8.5	-		56
Vegetable Irrigated	3	0.71	-		-		-		3
Wheat Unirrigated	67	15.91	14.5	4.24	39	9.47	16	23.88	136.5
Gram Unirrigated	98	23.27	25	7.31	51	12.38	5	7.46	179
Pulses Unirrigated	-		38.5	11.27	-		-		38.5
Vegetable Unirrigated	-		-		-		2	2.99	2
Irrigated Intensity									
Kharif	0		0		0		0		
Rabi	60.8		75.14		75.25		65.67		
Annual	60.8		75.14		75.25		65.67		
Cropping Intensity									
Kharif	100		52.04		94.9		80.6		
Rabi	100		97.96		97.1		100		
Annual	200		150		192		180.6		

Note – Irrigated crop areas include areas irrigated using various sources of irrigation (canal, tank, stream, wells). Area owned by sample of farmers is distributed in canal command as well as in tank bed, tank periphery and outside command area. Source: NABARD- 2006.

4.3 IMPACT ON CROPPING SYSTEM

4.3.1 Change in Cropping Patten:

Table 4.3 shows cropping pattern under different situations (designed and existing) for the four projects.

Existing cropping pattern is significantly different compared to the designed cropping pattern in all the projects. Unirrigated /irrigated paddy area which was existing

Table 4.3: Comparison of Design and Existing Crop Areas at Project Level

Crop	Mahua Kheda		Khairana		Hinauta Kharmau		Maheri	
	Designed (ha)	Existing (ha)	Designed (ha)	Existing (ha)	Designed (ha)	Existing (ha)	Designed (ha)	Existing (ha)
Kharif								
Paddy (Unirri)	-	-	200	1	144	-	84	-
Paddy (irri)	-	-	20	-	23	-	-	-
Soyabean	20	198	-	159	40	366	40	93
Vegetable/Pluses	-	2	-	-	-	-	-	10
Udad	-	-	-	-	-	-	-	26
Rabi								
Gram (Unirri)	-	47	-	23	-	48	-	12
gram (irri)	-	77	-	130	-	139	-	26
Wheat (Unirri)	-	32	-	13	-	37	22	38
wheat (irri)	180	43	275	83	185	119	91	79
Pluses(Unirri)	-	-	-	35	-	-	-	-
Pluses(irri)	-	-	-	19	-	33	-	-
Vegetable	-	1	-	-	-	-	-	5
Total	200	400	495	462	392	742	237	289
Cropping Intensity %	100	200	160.7	150.0	101.6	192.2	148.1	180.6

Designed : as per project proposal
Existing : based on existing cropping pattern (table 4.3) and CCA

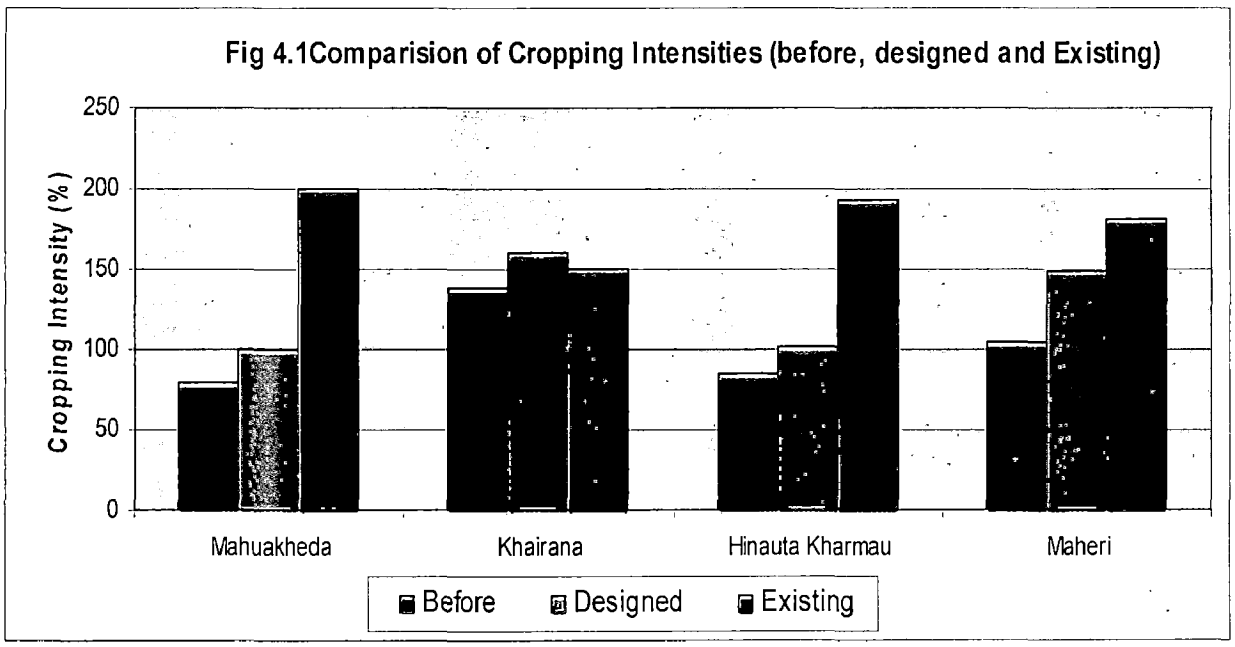
before project and which was proposed for canal irrigation (designed) are not existent now as it is not a cash crop. Instead, Soyabean has become an important kharif crop in all the projects irrespective of availability of canal irrigation.

Wheat was the only crop proposed for rabi irrigation in all the four projects. Existing pattern shows that gram has emerged as more important rabi crop in all the projects. Irrigated wheat area is now significantly less than what was proposed in the Mahuakheda and Khairana projects.

Ultimately when the projects are in full operation stage, it is expected that unirrigated wheat and gram crops will be converted into irrigated crops. Area under pulses and vegetables is also expected to increase.

4.3.2 Change in Cropping Intensity

Table 4.4 shows annual cropping intensity under different situations for the four projects. Cropping intensity has increased significantly in all the projects. Fig 4.1 shows the comparison of cropping intensities in different situations.



In case of Mahuakheda project it was 80% before project and it was designed to be 100% with the project. However, it is now 200% due to improvements in agriculture technology as well as due to use of various sources of irrigation.

In case of Khairana project, cropping intensity was already high (137.7%) even before the project. It was designed to be 160.7% but it is 150.3% at present mainly due to non existence of paddy crop area.

In the case of Hinauta Kharmau project, change in cropping intensity is similar to that in Mahuakheda project. It is now 192.2% compared to 84.7% before project and 101.5% as designed.

In Maheri Project Existing cropping intensity is 180.6% compared to 103.8% before project and 148% as designed.

4.4 UNIT COST OF CULTIVATION AND NET RETURN FOR CROPS

4.4.1 Cost of Cultivation and Net Crop Return under Existing Situation

Farmers have been interviewed to provide information on various items of farm expenditures and income. These data were collected for unirrigated and irrigated crops during Kharif and Rabi seasons. For irrigated crops, cost of water is different for canal water and for water lifted from wells or streams using pumps.

There are wide variations in reported cost of cultivation as well as farm income. Data provided by some of the farmers was either unrealistic or incomplete. Cost of self employed family labor and cost of owned machinery (tractor, thrasher, etc) was not reported correctly by some farmers. Therefore, information has also been collected from other sources to have realistic assessment of cost and benefits. Prices were ascertained by survey of local markets.

Table 4.5 shows unit cost of cultivation and net crop return for various crops during Kharif and Rabi seasons in the four projects. These are based on average value of yield, prevailing market prices and average cost of cultivation using primary data in each of the four projects. As seen in table 3.10, irrigation facility, crop yields and cost of cultivation differ over the projects.

Average parameters for the four projects show that Soyabean provides highest return (Rs 9137/ha) in kharif season.Net return with irrigation (gram, pulses and wheat) are significantly higher than those for without irrigation in rabi season. Irrigated gram crop provides the highest net return (Rs 20410/ha).

Table 4.4 COMPARISON OF CROPPING PATTERN AND CROPPING INTENSITY

Crop	Mahua Kheda (CCA-200ha)				Khairana (CCA-308ha)				Hinauta Kharmau (CCA-386ha)				Maheri (CCA-160ha)			
	Before* (%)	Designed (%)	Existing (%)	Ultimate (%)	Before (%)	Designed (%)	Existing (%)	Ultimate (%)	Before (%)	Designed (%)	Existing (%)	Ultimate (%)	Before (%)	Designed (%)	Existing (%)	Ultimate (%)
Kharif																
Paddy (Unirri)	10	-	-	-	71.43	64.94	0.325	0.00	47.41	37.31	0.00	0.00	52.5	53	0	0
Paddy (irri)	-	-	-	-	-	6.49	-	0.32	-	5.96	-	-	-	-	-	-
Soyabean	10	10	99	99	-	-	51.62	51.62	6.22	10.36	94.82	94.82	-	25	58.13	58.13
Vegetable/Pluses	-	-	1	1	-	-	-	-	-	-	-	-	17.5	-	6.25	6.25
Udad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16.25	16.25
Rabi																
Gram (Unirri)	10	-	23.5	-	-	-	7.47	-	-	-	12.44	-	-	-	7.5	-
gram (irri)	-	-	38.5	62	-	-	42.21	49.68	-	-	36.01	48.45	-	-	16.25	23.75
Wheat (Unirri)	50	-	16	-	52.60	-	4.22	-	31.09	-	9.59	-	33.75	14	23.75	-
wheat (irri)	-	90	21.5	37.5	-	89.29	26.95	31.17	-	47.93	30.83	40.41	-	57	49.38	73.13
Pluses(Unirri)	-	-	-	-	13.64	-	11.36	-	-	-	-	-	-	-	-	-
Pluses(irri)	-	-	-	-	-	-	6.17	17.53	-	-	8.55	8.55	-	-	-	-
Vegetable	-	-	0.5	0.5	-	-	-	-	-	-	-	0.00	-	-	3.125	3.125
Cropping Intensity %	80	100	200	200	137.66	160.71	150.32	150.32	84.72	101.55	192.23	192.2	103.8	148	180.6	180.6

Table 4.5 CROP YIELD, COST OF CULTIVATION AND NET CROP RETURN OVER THE PROJECTS

	Khairana				Mahuakedha				Hinuta kharmau				Maheri				Average			
crop	yield	Rate	cost of cultivation per ha	Net Return	yield	Rate	cost of cultivation per ha	Net Return	yield	Rate	cost of cultivation per ha	Net Return	yield	Rate	cost of cultivation per ha	Net Return	yield	Rate	cost of cultivation per ha	Ne Retu
Kharif																				
Paddy(Unirri)*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	700	7400	66(
Paddy(irri)*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	700	9900	76(
Jowar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Soyabean	13	1200	6650	8950	12	1200	5900	8500	11	1200	5300	7900	16	1200	8000	11200	13	1200	6463	91:
Rabi																				
Wheat(Unirrig)	14.5	800	5250	6350	12.5	800	4400	5600	13	800	5200	5200	15	800	6500	5500	14	800	5337	58(
Wheat(irrig)	25.5	800	5850	14550	25	800	8500	11500	25	800	5700	14300	25	800	8500	11500	25	800	7140	128
Gram(Unirri)	10.5	2000	6500	14500	9.5	2000	5400	13600	7	2000	5300	8700	9	2000	6000	12000	9	2000	5800	122
Gram(irri)	14.5	2000	6800	22200	15	2000	10000	20000	13.5	2000	5550	21450	13	2000	8000	18000	14	2000	7590	204
Pulses(Unirri)	7.5	1500	5200	6050	-	-	-	-	-	-	-	-	-	-	-	-	7.5	1500	5200	60:
Pulses(irri)	14	1500	5300	15700	-	-	-	-	15	900	5575	7925	-	-	-	-	14	1500	5300	157

* yield, rate etc based on data from other sources

4.4.2 Comparison with Designed Data

Crop yield, rate and cost of cultivation assumed during projects' appraisal are compared with recent data in table 4.6. Crop yield for various irrigated /unirrigated crops are more or less same except for wheat. Yield of irrigated wheat under existing situation (25quintals/ha) is only 71.4 % of the yield taken for project appraisal. Due to overall increase in market prices, cost of cultivation has increased but at the same time gross return has also increased.

Table 4.6: Comparison of Appraisal Data with Recent Data

Crop	Appraisal for NABARD Assistance			Recent Socio Economic Survey			
	Yield Qtls/ha	Rate Rs/Qtls	Cost of cultivation Rs/ha	Yield Qtls/ha	Rate Rs/Qtls	Cost of cultivation Rs/ha	Net crop Return Rs/ha
KHARIF							
Paddy (unirri)	20	500	3500	20	700	7400	6600
Paddy (irri)	25	500	4520	25	700	9900	7600
Jowar	18	450	1800	-	-	-	-
Soyabean	15	900	5200	13	1200	6463	9137
RABI							
Wheat (unirri)	15	550	2700	14	800	5337	5863
Wheat (irri)	35	550	5500	25	800	7140	12860
Gram (unirri)	-	-	-	9	2000	5800	12200
Gram (irri)	-	-	-	14	2000	7590	20410
Pulses (unirri)	6	1200	2730	7.5	1500	5200	6050
Pulses (irri)	-	-	-	14	1500	5300	15700

4.4.3 Incremental Farm Income

Farm income is assessed in terms of annual benefit per ha of land with a particular cropping pattern. It is equal to sum total of net crop return multiplied by crop area per ha of CCA. Crop areas per ha of CCA are nothing but the cropping pattern expressed in fractional form. Net crop returns are given in Table 4.5. Cropping patterns are given in Table 4.4. Farm incomes under the different situations (before, Designed, existing, ultimate) are shown in Table 4.7.

It is to be noted that net crop returns are for existing situation. Thus incremental farm income with reference to before project situation shows the impact of change in cropping pattern on farm income.

Table 4.7 also shows the incremental farm incomes with reference to control situation (before project situation). Incremental farm income in existing situation is significantly more than for envisaged (designed situation). Incremental farm income will further improve when projects are in full operation stage (ultimate). Incremental farm

income at present is highest in case of Mahuakheda project (Rs17167 /ha). It will further improve to Rs 19670/ ha in ultimate situation.

Table 4.7 Incremental Farm Income (Rs/ha)

Project	Annual farm income (Rs per ha of CCA)	Incremental Farm income with reference to before project condition (Rs per ha of CCA)
Khairan (308ha)		
Before Project	8783	-
Designed	17771	8988
Existing	20940	12157
Ultimate	22961	14178
Hinauta Kharmau (386 ha)		
Before Project	5809	-
Designed	10588	4779
Existing	21882	16073
Ultimate	24340	18531
Mahuakheda (200ha)		
Before Project	5670	-
Designed	11200	5530
Existing	22837	17167
Ultimate	25340	19670
Maheri (160ha)		
Before Project	6380	-
Designed	13452	7072
Existing	21344	14964
Ultimate	23219	16839

4.5 IMPACT ON FINANCIAL PERFORMANCE

A complete evaluation of the cluster of four irrigation projects is naturally possible only when these are completed and fully operating. On this basis, however it would be necessary to wait for perhaps another 4 to 8 years, keeping in view the status of the four projects and the transition required to achieve full operation stage.

The true objective of continuous evaluation is to provide a basis for decision making so as to improve the management of the projects in course of implementation itself and if need be, to modify it as far as possible to take account of the new information which emerges as time goes by. Furthermore, continuous post-evaluation will help to improve appraisal exercises for the projects awaiting NABARD sanction by means of critical comparison.

4. 5.1 Periods of Development

In principle, three different stages of a project can be distinguished.

a) Construction or implementation,

b) Adaptation or transition to the practice of irrigated agriculture

c) Full production (Normal operation)

The construction period is said to be over when the irrigation and drainage system is at the stage at which each parcel of land can be effectively irrigated and therefore has direct access to third and fourth stage channels. On this basis none of the four projects is complete as discussed. The period of adaptation starts with the effective irrigation of the first sector.

4.5.2 Need for Evaluation

During the construction period a regular comparison should have been made between the targets set for implementation and those being achieved in practice. This comparison should have begun with the volume of work, and then extended to the actual construction costs on annual basis. As part of this study, time and cost overrun have been analysed in previous section.

As in the construction period, evaluation during the period of adaptation and development takes the form of a regular comparison between the progress actually made since the first year of irrigation and the targets set for annual irrigation.

Such a comparison makes it possible to keep a constant watch on how the return develops. The latter can, of course, only be measured by substituting actual values achieved for crops, crop areas, yields etc, for the assumptions made in the initial appraisal. Negative effect of prolonging the construction or adaptation period can be offset by an increase in extension of kharif irrigation areas devoted to particularly profitable crops such as soyabean.

4.5.3 NABARD Criteria for Financial Sanction

The basic objective of NABARD RIDF is to support those ongoing projects (with considerable time overrun) which are likely to be completed within stipulated short period so that the created irrigation potential may start yielding the desired level of benefits to the ultimate beneficiaries viz. the farmers for increasing their agricultural production and productivity. The criteria for approval of projects for NABARD loan are as given below

(i) should have administrative approval of the Government

(ii) should be a budgeted item

(iii) should be free from all legal complications

(iv) should have forest and environmental clearance

(v) should have clearance from state government

(vi) NABARD will reimburse the cost of balance work only to the extent indicated below:

a) Where less than 10%expediture has been incurred, NABARD share will be only 90% of the balance cost and the rest should be borne by GOMP

b) Where more than 10% of expenditure has been incurred, NABARD share will be full cost of balance work

(vii) Balance cost of work only under the subheads A,B,C &L of unit I (Head works) & II (canal works) would be reimbursed

(viii) Revised Administrative Approval should be accorded wherever necessary before release of assistance

(ix) Upper limit of acceptable cost is Rs 90000/- per ha of annual irrigation or service area whichever (area) is more.

Earlier the upper limit was Rs 75000/ha of CCA, which was having some inherent flaw. The earlier criteria did not provide any weightage to irrigation intensity. Thus schemes having CCA of 100 ha and providing irrigation to say 85ha or 100ha or 130ha etc were kept on same footing. On the other hand, in some cases CCA was reported to be abnormally higher (50 to 100%more) than service area to show higher acceptable cost on basis of CCA.

Under RIDF-III the last date of completion fixed by NABARD was March 2000 and this aspect was kept as paramount in appraisal of the Khairana, Maheri and Hinauta Kharmau projects. Criteria as mentioned above were followed by NABARD in appraisal of the project reports for financial sanction.

The updated cost was estimated on the basis of actual expenditure plus balance cost (based on 1991 CSR) plus a suitable percentage for anticipated high tenders (30 to 50% for earth work and 60 to 90 % for masonry work in general).

4.6 FINANCIAL ANALYSIS DURING PROJECTS' APPRAISAL

NABARD carried out financial appraisal of Khairana, Maheri and Hinauta Kharmau. As an illustration table 4.8 shows financial appraisal of Hinauta Kharmau project. Following assumptions were made for project appraisal.

The economic life of 25 years was assumed in the analysis. Accordingly cash flow was prepared for 25 years. The investment cost representing the already incurred expenditure was shown in the zero year of the cash flow for all the projects. Annual maintenance cost was assumed to be 2% of total investment cost and to begin in first year of NABARD investment. Annual construction expenditures included NABARD loan and GOMP share for each year.

At the time of project appraisal, it was assumed that benefits would start accruing from second year of NABARD investment. Only 25 percent of the ultimate benefits were assumed to occur during second year, followed by benefit stream of 50 percent and 100 percent during the third and fourth year respectively. Full and stabilised benefits were assumed from the fourth year onwards. No salvage value was assumed. Annual indirect benefits were taken as 11% of the direct benefits.

In the finance analysis production benefits and cultivation cost were measured at the farm level (for the entire command area of the project) and accounted at the farm gate prices.

15% discount rate was taken to calculate net present cost (NPC), net present income (NPI), net present value (NPV) and benefit cost ratio (BCR).

Pre and post investment agricultural production, production benefits and cash flows of investment cost, recurrent cost, direct and indirect benefits were computed as shown in Table 4.8.

Project cost data used in the financial appraisal and as per NABARD sanction are shown in Table 4.9. GOMP share was assumed to be available on annual basis. In the case of Hinauta Kharmau project, expenditure incurred before NABARD sanction (Rs 75.5 lacs) had been assumed as sunk cost and it was not considered in financial appraisal.

Table 4.9: Project Cost Data

	Khairana		Maheri		Hinauta Kharmau	
	NABARD sanction order	Appraisal Report	NABARD sanction order	Appraisal Report	NABARD sanction order	Appraisal Report
Already incurred expenditure	30.64	30.879	1.61	1.783	75.5	0.0*
NABARD Loan						
97-98	11.317	12.0085	14.74	16.692	15.35	17.97
98-99	77.245	85.775	23.71	26.511	62.55	75.474
99-2000	39.418	42.8875	38.13	43.204	8.49	10.782
GOMP share	12.93	-	10.0	-	17.81	-
Total	171.55	171.55	98.19	98.19	179.7	104.226

*Already incurred expenditure of Rs 75.5 lacs had been taken as sunk cost. It was not considered in the financial appraisal

Table 4.8: Financial Analysis of Hinauta Kharmau Irrigation Project

	PRE-INVESTMENT (in Rs)						POST-INVESTMENT (in Rs)					
Crop	Command Area(ha)	Total Prod Qtls	Gross Income	Cost of Cultivation	Net Income		Crop	Command Area(ha)	Total Prod Qtls	Gross Income	Cost of Cultivation	Net Income
Paddy(un-irri)	183	3660	1830000	640500	1189500		Paddy(un-irri)	144	2880	1440000	504000	936000
Paddy(irri)	0	0	0	0	0		Paddy(irri)	23	575	287500	103960	183540
Jowar	0	0	0	0	0		Jowar	0	0	0	0	0
Soyabean	24	288	259200	96000	163200		Soyabean	40	600	540000	208000	332000
Wheat((un-irri)	120	1800	990000	324000	666000		Wheat((un-irri)	0	0	0	0	0
Wheat((irri)	0	0	0	0	0		Wheat((irri)	185	6475	3561250	1017500	2543750
Gram	0	0	0	0	0		Gram	0	0	0	0	0
Pluses	0	0	0	0	0		Pluses	0	0	0	0	0
Total	327		3079200	1060500	2018700		Total	392		5828750	1833460	3995290
Int on crop loan	0.12			95445			Int on crop loan	0.12			165011.4	
Total cost of cultivation		1155945		Net Income	1923255		Total cost of cultivation			1998471	Net Income	3830279
Net Incremental Income		1907024			GDP	2749660		NDP	1976690			
Additioinal Emplyment Generation			9290									

CASH FLOW

Years	0	1	2	3	4	5	6	7	8	9 ----T0---24		25
Initial Investment	0	1797000	7547400	1078200								
Rec Maint cost	0	359400	359400	359400	359400	359400	359400	359400	359400	359400	359400	359400
Total Cost	0	1617300	5930100	1078200	269550	269550	269550	269550	269550	269550	269550	269550
Benefit	0	0	476756	953512	1907024	1907024	1907024	1907024	1907024	1907024	1907024	1907024
Indirect Benefit	0	0	52443	104886	209773	209773	209773	209773	209773	209773	209773	209773
Total Income	0	0	582119	1164238	2328476	2328476	2328476	2328476	2328476	2328476	2328476	2328476
Net cash flow	0	-1617300	-5347981	86038	2058926	2058926	2058926	2058926	2058926	2058926	2058926	2058926
Discount Rate	15%		NPC	6718485	NPI 9513784		NPV 2795299		BCR 1.42		ERR 22.83%	

The financial parameters assessed during project appraisal (Table 4.15) have been compared with those obtained using recent data as discussed in following sections.

4.7 PROJECT BENEFITS IN DIFFERENT SITUATIONS

Table 4.7 provides per hectare income in the project command areas under different situations (before project, designed or proposed, existing and ultimate i.e. full operation stage). These parameters have been used to assess project benefits in different situations.

Project level benefit = Farm Income (Rs/ha)* CCA

Table 4.10 shows project benefits in different situations

Table 4.10: Project Benefits (Rs lacs)

Situation	Mahuakheda		Khairana		Hinauta Kharmau		Maheri	
	Benefit	Incremental benefit	Benefit	Incremental benefit	Benefit	Incremental benefit	Benefit	Incremental benefit
Before Project	11.34	-	27.05	-	22.42	-	13.41	-
Designed	22.4	11.06	54.73	27.68	40.87	18.45	21.52	8.11
Existing	45.67	34.33	64.49	37.44	84.46	62.04	34.15	20.74
Ultimate	50.68	39.34	70.73	43.67	93.95	71.52	37.15	23.74

The direct project benefits were planned to increase by about 100% in Mahuakheda and Khairana projects, 82% in case of Hinauta Kharmau and 60.5% in case of Maheri. However, because of increase in cropping intensity and shift to cash crops existing benefits are significantly high. Increase in direct benefit is 302.7% in Mahuakheda, 138.4% in Khairana, 276.7% in Hinauta Kharmau and 154.7% in Maheri project. Direct benefits will further improve in ultimate stage. It is important to note that canal irrigation has not yet started in Mahuakheda and Maheri projects and only part of area is irrigated in Khairana and Hinauta Kharmau projects.

4.8 ASSESSMENT OF FINANCIAL PARAMETERS

None of the four projects have achieved target irrigation potential. In order to illustrate impact of cost overrun and changed crop pattern on financial performance of projects, financial evaluation of the projects using recent data has been carried out.

4.8.1 Assumptions

Following assumptions have been made in the evaluation of net present worth, benefit cost ratio and internal rate of return. The assumptions are similar to those made during financial appraisal at the time of NABARD sanction as given below.

The economic life = 25 years

Annual recurring (maintenance) cost =2% of total capital cost. It begins in first year after end of construction

Annual indirect benefits = 11% of annual direct benefit

Direct benefit is incremental benefit in existing situation compared to before project situation (Table 4.10). It begins in first year of canal operation being 25% in first year, 50% in second year and 100% in 3rd year and onward.

Discount Rate =15%

Salvage value = Nil

4.8.2 Computation of Present Worth Cost, Benefit and Rate of Return

Existing situation corresponds to existing cropping pattern, yield and market prices based on field survey. Computation of present worth of cost (PWC), present worth of benefit (PWB) and internal rate of return (IRR) has been carriedout for the four projects. The computation procedure is illustrated below with reference to Table 4.14 for Hinauta Kharmau project.

Base year: NABARD sanction was provided in Nov 1997 (Table 3.4). Therefore 1997-98 is considered as base year.

Initial Cost: It is equal to total expenditure incurred prior to NABARD sanction. i.e. Rs 75.5 Rs lacs (Table 3.4)

Annual Expenditures: These are actual expenditures incurred in different years (Table 3.5)

Total Investment: Sum total of initial cost and annual expenditures. It is Rs 105.32 lacs

Annual maintenance cost: It is taken as 2% of total investment. i.e. (2/100)*105.32= Rs 2.11 lacs per year occurring uniformly over the years after end of construction.

Total annual cost: It is sum of capital expenditure and maintenance cost in different years.

Direct benefit: Direct benefit of the project is based on incremental farm income and CCA. For Hinauta Kharmau project, incremental farm income with reference to before project situation is Rs 16073/ha of CCA (Table 4.7) and CCA is 386ha

Therefore annul direct benefit= 16073*386

= Rs 6204178 or Rs 62.04 lacs

Direct benefits during irrigation transition and subsequence years:

In the first and second years of operation, direct benefits are assumed to be 25% and 50% of Rs 62.04 lacs i.e. Rs 15.51 lacs in first year and Rs 31.02 lacs in second year. In subsequent years of operation it is Rs 62.04 lacs per year.

Indirect benefits are assumed to be 11% of annual direct benefits for compatibility with the assumption made during appraisal stage. Thus indirect benefit in first, second and subsequent years are Rs 1.71lacs, Rs 3.41lacs and Rs 6.82 lacs respectively.

Total annual benefits are equal to sum of direct and indirect benefits in a year.

Present worth discount factor for n^{th} year $=1/(1+i)^n=1/(1.15)^n$

discount rate 'i' is 0.15 (15%) as assumed during appraisal stage.

Present worth of cost (PWC) and benefit (PWB) are obtained by multiplying cost and benefit in different years with corresponding discount factors.

Example: for 6^{th} year

PWC =2.11 * 0.4323 =Rs 0.9122 lacs

PWB = 17.22 *0.4323 =Rs 7.4441 lacs

Then, sum total of PWC = Rs 151.532 lacs

sum total of PWB = Rs 179.023 lacs

and net present worth (NPW) = 179.023 -151.532

= Rs 27.491 lacs

and Benefit Cost Ratio = PWB/PWC = 179.023/151.532 = 1.1814

For computation of internal rate of return (IRR) that discount rate was worked out (by trial and error) for which present worth of cost is equal to present worth of benefit.

i.e $$\sum_{n=0}^{25}(Bn- Cn)*1/(1+i)^{n=0}$$

The IRR works out to be 0.1685 or 16,85%

Similar procedure was adopted for each project as shown in table 4.11 to table 4.14.

4.8.3 Financial Parameters for Different Situations

Procedure as explained in previous section was followed to evaluate financial parameters under the following conditions.

1. Existing situation compared with before project situation. Existing cropping pattern was considered.
2. Ultimate situation compared with before project situation. Existing cropping pattern was modified by assuming that unirrigated crop areas during rabi season will become irrigated when canal water supply is available in the entire service area.

The financial parameters PWC, PWB, NPW, B/C ratio and IRR for above mentioned situations are given in table 4.15

4.9 IMPACT ON FINANCIAL PERFORMANCE

Time and cost overrun has occurred in all the projects as analyzed in previous section. In the assessment of present worth of cost, additional expenditures required for completion of the existing remaining works have not been accounted. Cropping pattern and cropping intensity in command areas are significantly different than those assumed at the time of the project appraisal. Changes in cropping system, crop production and farm income have been analyzed. Theses changes have occurred in all the projects even though canal irrigation is yet to start in case of Maheri and Mahuakheda projects and only part of CCA has received canal water in Khairana and Hinauta Kharmau projects.

Time and cost overrun as well as changes in cropping system have affected the financial parameters. Table 4.15 shows comparison of the financial parameters estimated at the time of project appraisal for NABARD sanction and those evaluated now accounting for time and cost overrun and changes in cropping system. Impacts on financial parameters of each project are discussed below.

4.9.1 Performance in Existing Situation

Mahuakheda Project: Financial parameters corresponding to appraisal stage are not available in the report. B/C ratio of the project is 1.12 and IRR is 16.32%. Mahuakheda project was financed in RIDF- I tranche. Canal irrigation is not yet provided.

Khairana Project: As per appraisal, its B/C ratio was estimated to be 1.29 with IRR of 19.93 percent. However its B/C ratio in existing situation is 0.64 at 15% discount rate. Its IRR is 10.34 compared to 19.93% envisaged during appraisal stage.

Hinauta Kharmau Project: Rs 75.5 lacs expenditure was incurred before NABARD sanction. It was taken as sunk cost and not considered in assessment of B/C ratio and IRR during the appraisal stage. Therefore, appraised B/C ratio (1.42) and IRR (22.83%) were the highest among the projects. In present evaluation exercise, expenditure incurred before NABARD sanction (Rs 75.5lacs) has been accounted for to maintain uniformity in analysis of the projects. Its B/C ratio in existing situation is 1.18 and IRR is 16.85%.

Maheri Project: During the appraisal, its B/C ratio was assessed as 1.02 and IRR as 15.56%. Its B/C ratio has decreased to 0.58 now and IRR has decreased to 8.5%. Canal irrigation is not yet provided and canal works are incomplete.

Table 4.11: Financial Analysis of Mahuakheda Project (With project)

									Discount Rate 15%			16.320%		
		COST			BENEFIT			NET CASH						
S.NO	YEAR	CAPITAL	MAINT	TOTAL	DIRECT	INDIRECT	TOTAL	FLOW	PWF	PWC	PWB	PWF	PWC	PWB
0	UP TO 95	27.33		27.33			0	-27.33	1.0000	27.3300	0.0000	1.0000	27.3300	0.0000
1	95-96	7.42		7.42			0	-7.42	0.8696	6.4522	0.0000	0.8597	6.3790	0.0000
2	96-97	14.83		14.83			0	-14.83	0.7561	11.2136	0.0000	0.7391	10.9606	0.0000
3	97-98	16.28		16.28			0	-16.28	0.6575	10.7044	0.0000	0.6354	10.3441	0.0000
4	98-99	13.52		13.52			0	-13.52	0.5718	7.7301	0.0000	0.5462	7.3851	0.0000
5	99-00	11.01		11.01			0	-11.01	0.4972	5.4739	0.0000	0.4696	5.1703	0.0000
6	00-01	4.29		4.29			0	-4.29	0.4323	1.8547	0.0000	0.4037	1.7319	0.0000
7	01-02	0	1.89	1.89	8.58	0.94	9.52	7.63	0.3759	0.7105	3.5789	0.3471	0.6560	3.3041
8	02-03	0	1.89	1.89	17.16	1.89	19.05	17.16	0.3269	0.6178	6.2275	0.2984	0.5639	5.6841
9	03-04	0	1.89	1.89	34.33	3.78	38.11	36.22	0.2843	0.5373	10.8332	0.2565	0.4848	9.7757
10	04-05	0	1.89	1.89	34.33	3.78	38.11	36.22	0.2472	0.4672	9.4202	0.2205	0.4168	8.4042
11	05-06	0	1.89	1.89	34.33	3.78	38.11	36.22	0.2149	0.4062	8.1915	0.1896	0.3583	7.2250
12	06-07	0	1.89	1.89	34.33	3.78	38.11	36.22	0.1869	0.3533	7.1230	0.1630	0.3080	6.2114
13	07-08	0	1.89	1.89	34.33	3.78	38.11	36.22	0.1625	0.3072	6.1939	0.1401	0.2648	5.3399
14	08-09	0	1.89	1.89	34.33	3.78	38.11	36.22	0.1413	0.2671	5.3860	0.1205	0.2277	4.5907
15	09-10	0	1.89	1.89	34.33	3.78	38.11	36.22	0.1229	0.2323	4.6835	0.1036	0.1957	3.9466
16	10-11	0	1.89	1.89	34.33	3.78	38.11	36.22	0.1069	0.2020	4.0726	0.0890	0.1683	3.3929
17	11-12	0	1.89	1.89	34.33	3.78	38.11	36.22	0.0929	0.1756	3.5414	0.0765	0.1447	2.9169
18	12-13	0	1.89	1.89	34.33	3.78	38.11	36.22	0.0808	0.1527	3.0795	0.0658	0.1244	2.5076
19	13-14	0	1.89	1.89	34.33	3.78	38.11	36.22	0.0703	0.1328	2.6778	0.0566	0.1069	2.1558
20	14-15	0	1.89	1.89	34.33	3.78	38.11	36.22	0.0611	0.1155	2.3285	0.0486	0.0919	1.8533
21	15-16	0	1.89	1.89	34.33	3.78	38.11	36.22	0.0531	0.1004	2.0248	0.0418	0.0790	1.5933
22	16-17	0	1.89	1.89	34.33	3.78	38.11	36.22	0.0462	0.0873	1.7607	0.0359	0.0679	1.3698
23	17-18	0	1.89	1.89	34.33	3.78	38.11	36.22	0.0402	0.0759	1.5310	0.0309	0.0584	1.1776
24	18-19	0	1.89	1.89	34.33	3.78	38.11	36.22	0.0349	0.0660	1.3313	0.0266	0.0502	1.0124
25	19-20	0	1.89	1.89	34.33	3.78	38.11	36.22	0.0304	0.0574	1.1577	0.0228	0.0432	0.8703
		94.68	34.02	128.7	575.02	63.31	638.33			75.8234	85.1433		73.7118	73.3314
	PWC	75.82342							B/C RATIO	1.1229				
	PWB	85.1433												
	NPW	9.319875							IRR	16.32%				

Table 4.12: Financial Analysis of Khairana Project (with project)

									Discount Rate 15%			10.340%		
		COST			BENEFIT			NET CASH						
S.NO	YEAR	CAPITAL	MAINT	TOTAL	DIRECT	INDIRECT	TOTAL	FLOW	PWF	PWC	PWB	PWF	PWC	PWB
0	UP TO 96-97	30.879		30.879			0	-30.879	1.00	30.88	0.00	1.00	30.88	0.00
1	97-98	0.8		0.8			0	-0.8	0.87	0.70	0.00	0.91	0.73	0.00
2	98-99	29.88		29.88			0	-29.88	0.76	22.59	0.00	0.82	24.54	0.00
3	99-00	41.13		41.13			0	-41.13	0.66	27.04	0.00	0.74	30.62	0.00
4	00-01	17.35		17.35			0	-17.35	0.57	9.92	0.00	0.67	11.70	0.00
5	00-02	21.45		21.45			0	-21.45	0.50	10.66	0.00	0.61	13.11	0.00
6	02-03	27.02		27.02			0	-27.02	0.43	11.68	0.00	0.55	14.97	0.00
7	03-04	5	3.47	8.47			0	-8.47	0.38	3.18	0.00	0.50	4.25	0.00
8	04-05	0	3.47	3.47	9.36	1.03	10.39	6.92	0.33	1.13	3.40	0.46	1.58	4.73
9	05-06	0	3.47	3.47	18.72	2.06	20.78	17.31	0.28	0.99	5.91	0.41	1.43	8.57
10	06-07	0	3.47	3.47	37.44	4.12	41.56	38.09	0.25	0.86	10.27	0.37	1.30	15.54
11	07-08	0	3.47	3.47	37.44	4.12	41.56	38.09	0.21	0.75	8.93	0.34	1.18	14.08
12	08-09	0	3.47	3.47	37.44	4.12	41.56	38.09	0.19	0.65	7.77	0.31	1.07	12.76
13	09-10	0	3.47	3.47	37.44	4.12	41.56	38.09	0.16	0.56	6.75	0.28	0.97	11.57
14	10-11	0	3.47	3.47	37.44	4.12	41.56	38.09	0.14	0.49	5.87	0.25	0.88	10.48
15	11-12	0	3.47	3.47	37.44	4.12	41.56	38.09	0.12	0.43	5.11	0.23	0.79	9.50
16	12-13	0	3.47	3.47	37.44	4.12	41.56	38.09	0.11	0.37	4.44	0.21	0.72	8.61
17	13-14	0	3.47	3.47	37.44	4.12	41.56	38.09	0.09	0.32	3.86	0.19	0.65	7.80
18	14-15	0	3.47	3.47	37.44	4.12	41.56	38.09	0.08	0.28	3.36	0.17	0.59	7.07
19	15-16	0	3.47	3.47	37.44	4.12	41.56	38.09	0.07	0.24	2.92	0.15	0.54	6.41
20	16-17	0	3.47	3.47	37.44	4.12	41.56	38.09	0.06	0.21	2.54	0.14	0.48	5.81
21	17-18	0	3.47	3.47	37.44	4.12	41.56	38.09	0.05	0.18	2.21	0.13	0.44	5.26
22	18-19	0	3.47	3.47	37.44	4.12	41.56	38.09	0.05	0.16	1.92	0.11	0.40	4.77
23	19-20	0	3.47	3.47	37.44	4.12	41.56	38.09	0.04	0.14	1.67	0.10	0.36	4.32
24	20-21	0	3.47	3.47	37.44	4.12	41.56	38.09	0.03	0.12	1.45	0.09	0.33	3.92
25	21-22	0	3.47	3.47	37.44	4.12	41.56	38.09	0.03	0.11	1.26	0.09	0.30	3.55
		173.51	65.93	239.44	627.12	69.01	696.13	456.69	7.46	124.66	79.65	9.84	144.79	144.75
	PWC	124.6558							B/C RATIO	0.6389				
	PWB	79.64649												
	NPW	-45.0094							IRR	10.34%				

Table 4.13: Financial Analysis of Maheri Project (with project)

S.NO	YEAR	COST			BENEFIT			NET CASH FLOW	Discount Rate 15%			8.500%		
		CAPITAL	MAINT	TOTAL	DIRECT	INDIRECT	TOTAL		PWF	PWC	PWB	PWF	PWC	PWB
0	UP TO 98	11.61		11.61			0	-11.61	1.0000	11.6100	0.0000	1.0000	11.6100	0.0000
1	98-99	1.7		1.7			0	-1.7	0.8696	1.4783	0.0000	0.9217	1.5668	0.0000
2	99-00	22.36		22.36			0	-22.36	0.7561	16.9074	0.0000	0.8495	18.9938	0.0000
3	00-01	4.47		4.47			0	-4.47	0.6575	2.9391	0.0000	0.7829	3.4996	0.0000
4	00-02	37.8		37.8			0	-37.8	0.5718	21.6123	0.0000	0.7216	27.2755	0.0000
5	02-03	45.23		45.23			0	-45.23	0.4972	22.4873	0.0000	0.6650	30.0800	0.0000
6	03-04	11.62		11.62			0	-11.62	0.4323	5.0236	0.0000	0.6129	7.1224	0.0000
7	04-05	0	2.7	2.7	5.19	0.57	5.76	3.06	0.3759	1.0150	2.1654	0.5649	1.5253	3.2540
8	05-06	0	2.7	2.7	10.37	1.14	11.51	8.81	0.3269	0.8826	3.7626	0.5207	1.4058	5.9929
9	06-07	0	2.7	2.7	20.74	2.28	23.02	20.32	0.2843	0.7675	6.5437	0.4799	1.2957	11.0468
10	07-08	0	2.7	2.7	20.74	2.28	23.02	20.32	0.2472	0.6674	5.6902	0.4423	1.1942	10.1814
11	08-09	0	2.7	2.7	20.74	2.28	23.02	20.32	0.2149	0.5803	4.9480	0.4076	1.1006	9.3838
12	09-10	0	2.7	2.7	20.74	2.28	23.02	20.32	0.1869	0.5046	4.3026	0.3757	1.0144	8.6487
13	10-11	0	2.7	2.7	20.74	2.28	23.02	20.32	0.1625	0.4388	3.7414	0.3463	0.9349	7.9711
14	11-12	0	2.7	2.7	20.74	2.28	23.02	20.32	0.1413	0.3816	3.2534	0.3191	0.8617	7.3466
15	12-13	0	2.7	2.7	20.74	2.28	23.02	20.32	0.1229	0.3318	2.8290	0.2941	0.7942	6.7711
16	13-14	0	2.7	2.7	20.74	2.28	23.02	20.32	0.1069	0.2885	2.4600	0.2711	0.7320	6.2406
17	14-15	0	2.7	2.7	20.74	2.28	23.02	20.32	0.0929	0.2509	2.1392	0.2499	0.6746	5.7517
18	15-16	0	2.7	2.7	20.74	2.28	23.02	20.32	0.0808	0.2182	1.8601	0.2303	0.6218	5.3011
19	16-17	0	2.7	2.7	20.74	2.28	23.02	20.32	0.0703	0.1897	1.6175	0.2122	0.5731	4.8859
20	17-18	0	2.7	2.7	20.74	2.28	23.02	20.32	0.0611	0.1650	1.4065	0.1956	0.5282	4.5031
21	18-19	0	2.7	2.7	20.74	2.28	23.02	20.32	0.0531	0.1435	1.2231	0.1803	0.4868	4.1503
22	19-20	0	2.7	2.7	20.74	2.28	23.02	20.32	0.0462	0.1247	1.0635	0.1662	0.4487	3.8252
23	20-21	0	2.7	2.7	20.74	2.28	23.02	20.32	0.0402	0.1085	0.9248	0.1531	0.4135	3.5255
24	21-22	0	2.7	2.7	20.74	2.28	23.02	20.32	0.0349	0.0943	0.8042	0.1412	0.3811	3.2493
25	22-23	0	2.7	2.7	20.74	2.28	23.02	20.32	0.0304	0.0820	0.6993	0.1301	0.3513	2.9948
	TOTAL	134.79	48.6	183.39	347.4	38.19	385.59			89.2931	51.4346		115.4858	115.0240
	PWC	89.29305							B/C RATIO	0.5760				
	PWB	51.43461												
	NPW	-37.8584							IRR	8.50%				

Table 4.14: Financial Analysis of Hinauta Kharmau (with project)

S.NO	YEAR	COST			BENEFIT			NET CASH FLOW	Discount Rate 15%			16.850%		
		CAPITAL	MAINT	TOTAL	DIRECT	INDIRECT	TOTAL		PWF	PWC	PWB	PWF	PWC	PWB
0	97-98	75.5		75.5			0	-75.5	1.0000	75.5000	0.0000	1.0000	75.5000	0.0000
1	98-99	9.38		9.38			0	-9.38	0.8696	8.1565	0.0000	0.8558	8.0274	0.0000
2	99-00	29.57		29.57			0	-29.57	0.7561	22.3592	0.0000	0.7324	21.6568	0.0000
3	00-01	26.91		26.91			0	-26.91	0.6575	17.6938	0.0000	0.6268	16.8666	0.0000
4	01-02	21.96		21.96			0	-21.96	0.5718	12.5557	0.0000	0.5364	11.7792	0.0000
5	02-03	17.5		17.5			0	-17.5	0.4972	8.7006	0.0000	0.4590	8.0333	0.0000
6	03-04	0	2.11	2.11	15.51	1.71	17.22	15.11	0.4323	0.9122	7.4447	0.3929	0.8289	6.7649
7	04-05	0	2.11	2.11	31.02	3.41	34.43	32.32	0.3759	0.7932	12.9435	0.3362	0.7094	11.5754
8	05-06	0	2.11	2.11	62.04	6.82	68.86	66.75	0.3269	0.6898	22.5105	0.2877	0.6071	19.8124
9	06-07	0	2.11	2.11	62.04	6.82	68.86	66.75	0.2843	0.5998	19.5743	0.2462	0.5195	16.9554
10	07-08	0	2.11	2.11	62.04	6.82	68.86	66.75	0.2472	0.5216	17.0211	0.2107	0.4446	14.5104
11	08-09	0	2.11	2.11	62.04	6.82	68.86	66.75	0.2149	0.4535	14.8010	0.1803	0.3805	12.4180
12	09-10	0	2.11	2.11	62.04	6.82	68.86	66.75	0.1869	0.3944	12.8704	0.1543	0.3256	10.6273
13	10-11	0	2.11	2.11	62.04	6.82	68.86	66.75	0.1625	0.3429	11.1917	0.1321	0.2787	9.0948
14	11-12	0	2.11	2.11	62.04	6.82	68.86	66.75	0.1413	0.2982	9.7319	0.1130	0.2385	7.7833
15	12-13	0	2.11	2.11	62.04	6.82	68.86	66.75	0.1229	0.2593	8.4625	0.0967	0.2041	6.6610
16	13-14	0	2.11	2.11	62.04	6.82	68.86	66.75	0.1069	0.2255	7.3587	0.0828	0.1747	5.7004
17	14-15	0	2.11	2.11	62.04	6.82	68.86	66.75	0.0929	0.1961	6.3989	0.0708	0.1495	4.8784
18	15-16	0	2.11	2.11	62.04	6.82	68.86	66.75	0.0808	0.1705	5.5642	0.0606	0.1279	4.1749
19	16-17	0	2.11	2.11	62.04	6.82	68.86	66.75	0.0703	0.1483	4.8385	0.0519	0.1095	3.5729
20	17-18	0	2.11	2.11	62.04	6.82	68.86	66.75	0.0611	0.1289	4.2074	0.0444	0.0937	3.0577
21	18-19	0	2.11	2.11	62.04	6.82	68.86	66.75	0.0531	0.1121	3.6586	0.0380	0.0802	2.6168
22	19-20	0	2.11	2.11	62.04	6.82	68.86	66.75	0.0462	0.0975	3.1814	0.0325	0.0686	2.2394
23	20-21	0	2.11	2.11	62.04	6.82	68.86	66.75	0.0402	0.0848	2.7664	0.0278	0.0587	1.9165
24	21-22	0	2.11	2.11	62.04	6.82	68.86	66.75	0.0349	0.0737	2.4056	0.0238	0.0503	1.6401
25	22-23	0	2.11	2.11	62.04	6.82	68.86	66.75	0.0304	0.0641	2.0918	0.0204	0.0430	1.4036
	TOTAL	105.32	42.2	223.02	1163.25	127.88		1068.11	7.464149	151.532	179.023	6.813747	147.3564	147.4037
	PWC	151.532							B/C RATIO	1.1814				
	PWB	179.023												
	NPW	27.491							IRR	16.85%				

4.9.2 Performance in Ultimate Situation

Assuming that unirrigated area in rabi season may become irrigated in full operation stage, an exercise has been carried out to evaluate impact of improved irrigation on financial parameters. As observed in Table 4.15, marginal improvement in B/C ratio and IRR will occur if all rabi crops are irrigated. Even under this situation Khairana and Maheri projects will have B/C ratio less one and IRR will be less than 15%..

In the assessment of financial parameters additional expenditure which would be required to complete the remaining works now could not be accounted whereas all irrigated areas have been assumed to correspond to canal irrigation. Therefore in a more realistic evaluation of financial performance of these projects B/C ratio and IRR are expected to be lower than those given in Table 4.15 perhaps making all the projects financially infeasible.

Table 4.15 Impact on Financial Parameters

Scheme	As per Appraisal						As per Recent Data				
	PWC	PWB	NPV	B/C	IRR		PWC	PWB	NPV	B/C	IRR
Mahuakeha	NA	NA	NA	NA	NA	A	75.82	85.14	9.32	1.12	16.32
						B	75.82	97.57	21.75	1.29	17.80
Khairana	102.1	131.49	29.39	1.29	19.93	A	124.66	79.65	-45.01	0.64	10.34
						B	124.66	92.91	-31.75	0.75	11.90
Hianuta Kharmau	67.185	95.138	27.95	1.42	22.83*	A	151.53	179.02	27.49	1.18	16.85
						B	151.53	203.98	52.45	1.35	18.4
Maheri	57.03	58.758	1.728	1.03	15.56	A	89.29	51.43	-37.86	0.58	8.50
						B	89.29	58.87	-30.42	0.66	10.0

*During appraisal of Hinauta Kharmau project. Rs 75.5 lacs expenditure which was incurred before NABARD sanction was assumed as sunk cost and not considered in the appraisal

A= Existing Situation B=Ultimate Situation

4.9.3 Costs per Hectare of Annual Irrigation

Table 4.16 shows escalation in cost per hectare of designed annual irrigation in the four projects. As discussed in Section 4.5.3 NABARD had adopted Rs 90000/- per ha of annual irrigation as revised upper limit of acceptable cost. Actual cost per ha of designed annual irrigation has already exceeded this limit in case of Mahuakheda project (Rs 96527/- per ha).

In order to realize annual irrigation targets additional expenditures will be required to complete the remaining works Thus cost per ha is going to be higher than those shown in Table 4.16

Annual canal irrigation (area) in full operation stage could be quite different from the designed irrigation as seen from the analysis of crop areas in Table 4.4. Existing soyabean crop area in kharif season is significantly larger than designed. It is either under rainfed cultivation or being irrigated from other sources at present. A few more years data on annual irrigation is required for realistic assessment of cost per hectare.

Table 4.16: Cost per Hectare of Annual Irrigation

	Mahuakheda	Khairana	Maheri	Hinaut Kharmau
As per NABARC appraisal				
Annual Irrigation (ha)	200	295	131	248
Revised Cost(Rs lacs)	49.81	171.55	98.19	179.7
Cost per ha (Rs/ha)	24905	58153	74954	72460
As per Existing Situation				
Up to date cost (Rs lacs)	95.04	173.84	126.45	193.57
Cost per ha (Rs/ha)	47520	58929	96527	78052

4.10 CONCLUSIONS AND RECOMMENDATION

None of the four projects may be considered to be fully implemented, due to incomplete canal network and absence of on farm development works. And yet, continuous evaluation of financial performance (on seasonal and annual basis) can be useful to take corrective measures for improving project performance. This should help in improving construction methods as well as preparation of feasibility reports on projects under planning stage.

The cluster of four irrigation projects has had considerable time and cost overrun. Based on recent data on actual cost, cropping system and farm benefits (corresponding to existing and to full operation stage), financial parameters have been evaluated. Khairana and Maheri projects have become financially unviable.. Cost per ha of annual irrigation has exceeded upper acceptable limit in case of Maheri project. The projects are still not complete requiring additional investments. This will have negative impact on the performance of projects in future. Further delay in completing these tank irrigation projects will have adverse impact of the economic parameters.

CHAPTER- 5

IMPACT ON GROUND WATER RECHARGE AND ECONOMICS OF CONJUNCTIVE USE AND CANAL LINING

5.1 GENERAL

Conjunctive use of ground water in canal commands implies coordinated and harmonious use of surface and ground water for meeting the water requirements in time and space. Its scope includes (i) recharge of the ground water from natural surface water; (ii) artificial and induced recharge from surface water to ground water; (iii) use of shallow or deep wells in canal command areas for supplementary irrigation during periods of low canal supplies or canal closures. It can also take the form of irrigating pockets exclusively with ground water in a canal command; (iv) use of augmentation tube wells discharging directly into the canal and thereby supplementing the canal supplies.

Ground water is the main source of water supply for agriculture and drinking purpose in rural areas of Sagar district. With the increase in population and need for more water for irrigation, water demand is on a constantly increasing trend. In some areas where underlying litho units do not have sufficient porosity and permeability, the ground water draft exceeds ground water recharge; hence ground water cannot suffice the requirement for agriculture and drinking water. In this context, implementation of the four tank irrigation projects is significant for improving the ground water availability.

Several of the existing canal irrigation systems suffer from inadequate supplies. The available supply in most of the canal systems in India, for instance, is often only one –fourth to one-third of the amount needed for intensive agriculture. The total quantity of irrigation water is neither adequate nor is supplied satisfactorily in time. This calls for making combined or conjunctive use of surface and ground waters, wherever possible (Mousa-1995).

This chapter covers the following aspects improvements in the existing tank irrigation projects. The following possibilities are studied in detail and estimated their economic parameters.

1. Impact of tank storage on ground water in command area
2. Impact of concrete lining
3. Impact of conjunctive use of ground water using dug wells
4. Impact of conjunctive use of ground water using Tube wells
5. Combined Impact of conjunctive use and concrete lining

Economics of conjunctive use and lining is examined through study of Khairana tank irrigation project.

5.2 GROUND WATER STUDY OF SAGAR DISTRICT

National Institute of Hydrology (6) has carried out studies on ground water fluctuations and artificial recharge zoning in Sagar district. Sagar district experienced the severest drought of the last four decades in the year 1985. It was chosen as the base year to estimate water table fluctuations between the periods 1985 to 1990, 1985 to 1995 and 1985 to 2000 (all pre monsoon).

The characteristics relevant to ground water study in the command area of the four projects (geology, geomorphology, soil type, suitability for artificial recharge etc.) are shown in Table 5.1. The command areas of the four projects are in Deccan Trap. Characteristic geomorphology is Deccan Plateau and denudational hills.

Table 5.1: Ground Water Related Characteristics in Project Areas

Item & Unit	Mahuakheda	Khairana	Maheri	Hinauta Kharmau
Geology	Deccan Trap	Deccan Trap	Deccan Trap	Deccan Trap
Geomorphology	Denudational hills(volcanic)	Deccan plateau + Denudational hills	Deccan Plateau	Deccan Plateau
Soil	clay loam	clayloam, gravel sandyloam	Clay	Clay
Infiltration rate cm/hr	1.3	1.9	0.7	1.0
Saturated hydraulic conductivity cm/hr	0.713	0.55	0.491	0.101
Pre-monsoon GW fluctuation between 1985 to 2000	1 to 2m fall	2 to 3m rise	0 to 1m fall	0 to 1m fall
Pre to Post monsoon rise in G.W due to rainfall (average)	4 to 5 m	4 to 6 m	4 to 5m	4 to 5m
Suitability for artificial recharge	Suitable	Suitable	Moderately suitable	Moderately Suitable

5.3 THE IMPACT OF TANK STORAGE ON GROUNDWATER STATUS

The four irrigation tank projects have not been designed and implemented for conjunctive use of surface and ground water. However, water stored in the tanks has contributed to rise in water table leading to water logging and increased use of well water for irrigation and domestic water supply in downstream of tanks.

Available ground water data for observation wells in the command area of four tank irrigation projects and in vicinity has been collected from WRD. These data have been analysed to study impact of tank projects on ground water recharge as discussed below.

5.3.1 Mahuakheda Project Command

Even though water is stored in tank but canal irrigation has not yet started ground water table data for six years was available. 'Before project' (2000 to 2002) average water table rise (during May to Nov) was about 1.92 m. 'After project' average water table rise

increased to 4.3 m (table 5.2). Pre-monsoon water table is almost same before and after the project indicating that water table is not rising over the years and recharge due to rainfall as well as due to seepage from tank is being fully utilized. The lush green crops immediately down stream of the tank are due to well irrigation.

Table 5.2: Groundwater Data for Mahuakheda Project Command

Year	SARKHEDI (72)					BARODA SAGAR (76)				
	Water table (BGL)			Fluctuation		Water table (BGL)			Fluctuation	
	May	Nov	Jan*	May-Nov	May-Jan	May	Nov	Jan*	May-Nov	May-Jan
Average before project (2000-2002)	11.3	9.37	9.7	1.93	1.6	7.25	5.35	6.35	1.9	0.9
Average after project (2003-2005)	11.08	6.08	8.4	5.0	2.68	7.25	3.63	5.23	3.62	2.02

(*) In the month of January of next calendar year.

5.3.2 Khairana Project Command

Nala closure work was completed in June 2001. The ground water data of four observation wells in the vicinity of Khairana project command for six years (2000 to 2005) was analyzed. Canal irrigation in the command area is causing rise in water table. The average ground water level in the area has increased by 3.07m, 1.21m and 0.79m during pre-monsoon (May), post-monsoon (November) and rabi season

(January) respectively after the project came into existence (table 5.3). The average ground water fluctuation between pre to post monsoon is decreased by 1.86m and pre-monsoon to rabi season is decreased by 2.7m.

Table 5.3 Groundwater Data for Khairana Project Command

S. No	Item	Pre monsoon	Post monsoon	Rabi Season	Water table Fluctuations	
		(May)	(Nov)	(Jan)	May-Nov	May-Jan
1	Water table before irrigation project (BGL)	12.56 m	6.44 m	7.57 m	6.12 m	4.99 m
2	Water table after irrigation project (BGL)	9.47 m	5.23 m	6.78 m	4.26 m	2.7 m

5.3.3 Maheri Project Command

Six year water table data (2000 to 2005) for one well was analyzed. Canal irrigation is not yet practiced. Nala closure work was completed in June 2003. Thus storage during monsoon of 2003 helped in increasing recharge as is evident from the water table of Nov 2003 (3.3 m BGL) as against 5.7 m BGL in Nov of 2002. Additional recharge during monsoon due to tank storage is about 0.95 m.

Table 5.4: Groundwater for Maheri Project Command

Year	Ground water level (BGL)			Fluctuations	
	May	Nov	Jan of next year	May-Nov	May-Jan
Average before project 2000-2002	11.0	5.37	7.6	5.63	3.4
Average after project 2003-2005	10.63	4.42	5.58	6.21	5.05

5.3.4 Hinauta Kharmau Project Command

Data of observation wells at Padaua (93) and Prahladpura (95) for six years (2000 to 2005) are assumed to represent ground water position in command area (Table 5.5).

Part of command area is receiving canal water. Nala closure work was completed in June 2002. Therefore 'before project' condition is assumed to be represented by data of 2000 to 2002. Data for 2003 onward represents 'after project' condition. 2 to 3 m additional recharge is now occurring in monsoon season due to tank storage. Whereas water table position in May has remained nearly same before and after the project, water table at end of monsoon season (November) has risen significantly due to tank bed seepage.

Table 5.5: Groundwater Data for Hinauta Kharmau Project Command

Year	PADAUA (93)					PRAHLADPURA (95)				
	Water table (BGL)(m)			Fluctuation (m)		Water table (BGL) (m)			Fluctuation (m)	
	May	Nov	Jan	May-Nov	May-Jan	May	Nov	Jan	May-Nov	May-Jan
Av. Before project 2000-2002	11.4	6.61	7.12	4.79	4.25	10.77	6.87	6.98	3.9	3.79
Av. After project 2003-2005	10.93	3.07	6.52	7.86	4.41	10.22	4.87	7.03	5.35	3.19

5.3.5 Annual Ground Water Recharge in Khairana Project

The underground aquifers are supplemented from sources other, than rainfall such as seepage from canals and field canals, ponds , tanks, influent drainage from rivers, deep percolation from irrigated fields etc. In most of the canal irrigated areas, a substantial component of the water applied to fields percolates below the root zone and contributes to the ground water potential. A comprehensive and complete assessment of ground water recharge from canal seepage is possible only on the compilation and analysis of reliable data from systematic scientific studies. Base on annual average rainfall, lengths and wetted perimeter irrigation canals, area of water bodies and application efficiency of the irrigation water, the total possible annul recharge in command of Khairana is estimated as shown in table 5.6..

As per the preliminary survey conducted by the National Institute of Hydrology the water table available at a depth of 7 to 10 m and is suitable for shallow tube wells or dug wells.

5.4 IMPACT OF CANAL LINING

In a irrigation system, it is estimated that seepage loss in unlined canals are about 17% in main and branch canals, 8% in distributaries and 25% in water courses thus totaling to 45% of the water diverted for irrigation at the head. Again such seepage water causes the problem of water logging and soil salinity adversely affecting the cropping intensity and productivity of the land.(Singh-2006)

Seepage losses can be controlled only by means of lining the irrigation canals. Lining of irrigation canal has become important in case of water short system where low cropping intensity is prevailing. However, the initial cost of lining of a canal is high and so decision on lining needs careful economical study considering the cost benefit and IRR of lining.

Table 5.6: TOTAL ANNUAL RECHARGE CALCULATION- Khariana Project

A. Monsoon Recharge

i. Area sq .km	3.587
ii. Water table fluctuation (WTF) in m	4.26
iii. Specific yeild (Sy) (%)	9
iv. Rainfall (annual average) in mm	1394
v. Gross Kharif Draft(DW), Mcm/year	0

Monsoon Recharge, Mcm/year

(A x WTF x Sy)+ Dw - (Ris + Rigw + RS)		1.42
A x WTF x Sy	= Suitable area Sq.km X WL rise X S . Yield	1.37
Dw	= Gross Kharif Draft (Dw) Mcm/year	0.10
Rs	= Monsoon seepage from canal and tanks	0.05
Rigw	=Monsoon seepage from ground water irrigation	0
Ris	= Monsoon seepage from surfacewater irrigation	0

B **Recharge from surface sources**

1 **Recharge from canals**

Applied seepage factors		Unlined	2.5 Cumec/M sq.m			
		Lined	0.3 Cumec/M sq.m			
Wetted perimeter Msqm		Average Runing days		Seepage Mcm/year		Total
Unlined	Lined	Non-Monsoon	Monsoon	Non-monsoon	Monsoon	
0.0055	-	100	-	0.12	-	0.12

2 **Recharge from surface water irrigation**

Irrigation water applied =Area irrigated x Average depth of water applied

Seepage factor is 35% of the water applied

Area irrigaed ha		Average water depth applied m		Seepage Mcm/year		Total
Non monsoon	Monsoon	Non monsoon	Monsoon	Non monsoon	Monsoon	
232	-	0.311	-	0.25		0.25

3 **Recharge from surface water body**

Average water spread area sq.km	Seepage factor m	Seepage Mcm/year		Total
		Non monsoon	Monsoon	
0.38	0.6	-	0.23	0.23

C **Total Annual Recharge Mcm**

Type of recharge	From rain fall	From irrigation sources	Total
a.Monsoon Recharge	1.42	0	1.42
b.Recharge from surface water sources			
i. Recharge from canal	0	0.12	0.12
ii.Recharge from surface water irrigation	0	0.25	0.25
iii. Recharge from surface water body	0	0.23	0.23
Total			2.02

5.4.1 Basics of Canal Lining:

The main advantages of lining of canal are as follows.

(i) Lower seepage loss result in saving of water which can be utilized for irrigation of additional area. The cost of irrigation per unit area is therefore reduced.

(ii) Prevents water logging and salinity problem.

(iii) Low value of rugosity coefficient and hence higher velocity of flow and thus lower cross section for the same discharge.

(iv) Higher velocity of flow provides flatter bed slope and hence better commend for irrigation area and higher head in case of a power channel.

(v) Higher velocity and lower cross section reduces the evaporation loss.

(vi) Higher velocity reduces the problem of silting and weed growth and thus lesser the cost of maintenance.

(vii) Due to smaller section there is saving in cost of land, cost of earthwork, cost of structures etc.

(viii) Lining increases the stability of the canal slope, thus lesser possibility of canal breaching and erosion and hence reduces the cost of maintenance and hence easier to operate.

The main requirements of canal lining are Economy, Impermeability, Structural Stability, Durability, Repairability, Hydraulic efficiency, Resistance to erosion. The various types of lining with their relative advantages and disadvantages are briefly discussed as below.

1. Cement Concrete lining (in situ): It's consists of a layer of cement concrete laid in situ of required strength and thickness. Thickness of concrete varies from 50mm to 150mm and grade of concrete used is M100 to M150 (IS- 456) depending on the requirement. The lining is done as per specification laid in IS- 3873-1978.

Minimum thickness of Lining

Capacity of Canal in Cumec	Depth of water in (m)	Thickness of lining in (mm)
0 - 5	0 - 1	50 - 60
20 - 200	2.5 - 4.5	75 - 100
200 - 300	4.5 - 6.5	90 - 100
300 - 100	6.5 - 9.0	120 - 150

The main disadvantage of this type lining is its high initial cost, susceptibility to damage by temperature changes, settlement of subgrade, hydrostatic pressure.

2. Pre Cast Concrete Lining: Precast concrete slabs of concrete grade M 100 are centrally manufactured under controlled condition and hence stronger, durable and more impervious. They are thinner and of size 500mm X 300mm X 50mm and set at site in 1:4 to 1:6 motor. Better quality control can be exercised and take less time for laying. Risk of shrinkage crakes are eliminated and any damage occurring due to sub grade settlement could be easily repaired. They are laid as per IS-3860

3. Shotcrete Lining: In this type 1:4 cement mortar is applied pneumatically on the sub grade. The usual thickness of shotcrete lining is 40mm and may vary from 25mm to 65mm. The sand used is well graded with max size of 9.5mm. Sometimes wire mesh lining is used. This is particularly advantageous on rock surface and frequently used for resurfacing of damaged cracked old cement concrete lining. This is more costly and higher value of rugosity co-efficient due to surface roughness.

4. Cement Mortar Lining: In this a layer of cement mortar is applied on the compacted subgrade. The usual thickness is 25mm. The sand used should well graded. This type is structurally not sound and not commonly used.

5. Lime Concrete Lining: In this lime concrete is used where lime is locally available. They are comparably cheaper but performance is not satisfactory and hence not commonly used. They are done as per specification laid in IS-2873-1975.

6. Ferro Cement Lining: Ferro cement is a composite material of cement, steel, wire mesh, sand and water, and no coarse aggregate is used. Due to reduced amount of cracking it is suitable for lining. It is better than plain cement mortar in its strength and is cheaper than cement concrete lining.

7. Burnt Clay Tile Lining: It consist of a single or double layer of burnt clay tile in cement mortar. For handling convenience the size of tile restructured to 300mm X 150mm X50mm. The laying is as per IS- 3872-1966.
Its advantages are Low initial cost, No high skill labour required and no elaborate supervision required, No elaborate equipment required, No expansion joint required, Repairs easy and less time taking.

The disadvantages are More permeable than concrete lining, Comparatively low resistance to erosion, It is subject to availability of suitable material.

8. Brick Lining: It has the additional advantage of low cost, easier & quicker construction, no cracking due to close spacing joints, better bond due to close spacing joints, and better structural behavior due to higher thickness. From all above factors bricks lining appears to be superior to precast C.C. block or tile lining both from performance and economy point of view and are widely used for canal up to a discharge of 35 cumec.

9.0 Stone Blocks or Undressed Stone Lining: It consists of a layer of undressed stone or boulders set in 1:6 cement mortar on a well prepared sub grade. To reduce the roughness of surface 20mm thick plastering is provided at top. However suitable only where undressed stones, boulders are available locally in plenty. Lay as per IS-4515-1967. While selecting the type of lining the following factors should be taken in to account and IS – 5331- 1969 may be referred.

By considering all the above factors concrete lining is considered to be most suitable type of lining for the case study area under purview.

5.4.2 Estimation of Canal Seepage and Canal Water Budget

The various methods currently available for estimation of canal seepage. Estimation of canal seepage from lined and unlined canal provide a key input to economic analysis of canal lining.

Direct determination of Canal Seepage:

In Flow – Out Flow Method: The actual inflow entering at one end of the selected reach of canal and out flow going out at the other end of the reach are measured with the help of existing weir or flumes or by area velocity method with the help of current meter. The difference of inflow and outflow is the seepage. The limitation is that no of measurement are to be taken to find the average value and the error could be $\pm$10%.

Ponding Method: It is more accurate and a popular method and is generally used. In this method a reach of the canal is isolated by making suitable water tight barriers at both ends. Water is filled in the reach to form a pond. The fall in water level is noted at regular intervals or lost water is replaced so that constant level is maintained. It is

continued till steady state is reached. It is corrected for evaporation and precipitation if any. Thus rate of seepage per unit wetted area is evaluated.

Its limitations are.

1. Canal operation has to be discontinued for the experiment.
2. Deposition of sediment and growth of algae and fungi during experiment period reduce the seepage rate.
3. Changes in groundwater table due to stoppage of canal for the experiment will change seepage rate.

Empirical Methods:

They are only approximate relation and give only a rough estimate. No of such relations are available but only method used in Maharastra is discussed.

Studies on main canals in Maharashtra have given following results. Considering the similarities in geography and other factors, this method is used in calculation of seepage loss in irrigation canals in study area.

Seepage loss in unlined canal is 8cfs/Msft of wetted canal perimeter

Seepage loss in lined canal is 2cfs/Msft of wetted canal perimeter.

5.4.3 Canal Water Budget for Khairana Project.

Canal water budget for Khairana project is estimated as shown in table 5.7

Table 5.7 Canal Water Budget in Khairana Project

SI	Description	Without Canal Lining (Mcm)	With Canal Lining (Mcm)
01	Live Storage	1.466	1.466
02	Loss (evaporation and percolation)	0.293	0.293
03	Available to Canal	1.173	1.173
04	Operational Losses	0.234	0.176
05	Seepage Losses	0.137	0.029
06	Sub total	0.802	0.968
07	Water Course Losses	0.080	0.097
08	Sub total	0.722	0.871
09	Application Losses	0.144	0.174
10	Availability for Crop	0.578	0.697
11	Overall Efficiency	49.3	59.4
12	Water Supply Factor (%)	54	65.06

Computations are explained below

Line 02 - Water losses due to evaporation and percolation from water body

20 percent of line 01

Line 04- 20 percent of line 3 for unlined canals and 15 percent for lined canal

Line 05- Seepage Losses

Losses (Mm3)-

Flow loss rate (ft3/sec) (days operation) (seconds/ day)*10^{-6}

Loss rate

Unlined Canal – 8 Cfs/Msf

Lined Canal – 2 Cfs/Msf

Unlined wetted perimeter – 6482 m^2

Lined wetted perimeter – 5499 m^2

No of days canal operation in Rabi season = 100 days

Seepage Loss from unlined canal

= 8 x 6482 x 100x 24x 60x 60 x 10^{-12}/3.28

= 0.137 Mm^3

Seepage Losses from lined canal

= 2 x 5499 x 100x 24x 60x 60 x 10^{-12}/3.28

= 0.029 Mm^3

Line 07- Water cause losses

10 percent of line 06

Line 09- Application Losses

20 percent of line 08

Line 10- Available for Crop

Line8- line9

Line 11- Overall efficiency

Line 10/Line 3 x 100

Line 12- Existing canal irrigation cropping intensity 54% (table 4.1)

Irrigation cropping intensity after concrete lining

54/49.3*59.4=65.06%

5.4.4 Investment Cost & Benefits:

Investment Cost:

Area of concrete lining = 7047 m^2

Thickness of concrete lining =0.075m

Volume of 1:2:4 concrete = 528m^3

Earth work = allow 10 m^3 earth work for 100m length of canal before Placing concrete. (512 m^3)

SI	Description	Unit	Quantity	Rate	Amount
01	Cement concrete 1:2:4	M3	528	3030	1599840
02	Earth work	M3	512	150	76800
03	Sub total				1676640
04	Engineering and Administration (15%)				251300
	Total				1928000

Project Benefits:

SI	Description	Without Canal Lining	With Canal Lining
	Direct Benefits		
	Net Income		
	Kharif	1429563	1429563
	Rabi	5020071	5175930
	Total	6449634	6605493
	Net Incremental Income		155859
	Indirect benefit		
	11% of direct benefit		17.144
	Total Net Incremental Income		173003

5.4.5 Economic Analysis of Canal Lining in Khairana Project

The following assumptions were made in economic analysis of Khairana Project and analysis is shown in table 5.8.

I. The economic life of concrete lining is assumed as 25 years

II. The annual maintenance cost is reduced by 25% due to comparatively less maintenance work involves in concrete lining. This saving is treated as indirect benefit of concrete lining.

III. Benefit would occur from the second year of the investment and 50% of the ultimate benefit is assumed to occur during second year and 100% during the third year and continue throughout economic life.

IV. Cropping pattern of the project remains same even after the concrete lining.

V. 15% discount rate is taken to calculate net present cost (NPC), net present income (NPI), net present value (NPV) and Benefit cost ratio

VI. Situation prevailing after the NABARD investment is taken as "without project" condition in evaluation of the project.

5.5 IMPACT OF CONJUNCTIVE USE OF GROUND WATER USING SHALLOW WELLS

Irrigation wells differ from those used to supply water for domestic purposes because of the large volumes of water that have to be pumped from them for irrigating even small farms. Efficient and economical utilization of ground water through wells depend on the design of wells to best suit the characteristics of the water bearing formations, the number and extent of these formations, the elements of well design and the methods used for constructing and developing the wells.

5.5.1 Calculation of Head of Pumping

1. Static Head = Depth of water table average 9.0m
2. Delivery Head = 1.25m
3. Draw down calculation from the formula

$$Qp = \frac{2\pi TS}{2.3 \log (Re/Rw)}$$

Where Qp = discharge of pumping in m^3/sec

T = Coefficient of transmissibility in m^2 / sec = 0.0069m^2/sec

S = Draw down in well in m

Re = Radius of depression cone, taken 150m

Rw= Radius of pumping well = taken 3m

Table 5.8 Financial Analysis of Khairana Project(concrete lining)

									Discount Rate 15%			12.180%		
		COST			BENEFIT			NET						
S.NO	YEAR	CAPITAL	MAINT	TOTAL	DIRECT	INDIRECT	TOTAL	CASH	PWF	PWC	PWB	PWF	PWC	
0	07-08	19.28	0	19.28			0	-19.28	1.0000	19.2800	0.0000	1.0000	19.2800	
1	08-09	0	0	0	0.775	0.953	1.728	1.728	0.8696	0.0000	1.5024	0.8914	0.0000	
2	09-10	0	0	0	1.55	1.038	2.588	2.588	0.7561	0.0000	1.9569	0.7946	0.0000	
3	10-11	0	0	0	1.55	1.038	2.588	2.588	0.6575	0.0000	1.7017	0.7084	0.0000	
4	11-12	0	0	0	1.55	1.038	2.588	2.588	0.5718	0.0000	1.4797	0.6314	0.0000	
5	12-13	0	0	0	1.55	1.038	2.588	2.588	0.4972	0.0000	1.2867	0.5629	0.0000	
6	13-14	0	0	0	1.55	1.038	2.588	2.588	0.4323	0.0000	1.1189	0.5018	0.0000	
7	14-15	0	0	0	1.55	1.038	2.588	2.588	0.3759	0.0000	0.9729	0.4473	0.0000	
8	15-16	0	0	0	1.55	1.038	2.588	2.588	0.3269	0.0000	0.8460	0.3987	0.0000	
9	16-17	0	0	0	1.55	1.038	2.588	2.588	0.2843	0.0000	0.7357	0.3554	0.0000	
10	17-18	0	0	0	1.55	1.038	2.588	2.588	0.2472	0.0000	0.6397	0.3168	0.0000	
11	18-19	0	0	0	1.55	1.038	2.588	2.588	0.2149	0.0000	0.5563	0.2824	0.0000	
12	19--20	0	0	0	1.55	1.038	2.588	2.588	0.1869	0.0000	0.4837	0.2518	0.0000	
13	20-21	0	0	0	1.55	1.038	2.588	2.588	0.1625	0.0000	0.4206	0.2244	0.0000	
14	21-22	0	0	0	1.55	1.038	2.588	2.588	0.1413	0.0000	0.3658	0.2001	0.0000	
15	22-23	0	0	0	1.55	1.038	2.588	2.588	0.1229	0.0000	0.3181	0.1783	0.0000	
16	23-24	0	0	0	1.55	1.038	2.588	2.588	0.1069	0.0000	0.2766	0.1590	0.0000	
17	24-25	0	0	0	1.55	1.038	2.588	2.588	0.0929	0.0000	0.2405	0.1417	0.0000	
18	25-26	0	0	0	1.55	1.038	2.588	2.588	0.0808	0.0000	0.2091	0.1263	0.0000	
19	26-27	0	0	0	1.55	1.038	2.588	2.588	0.0703	0.0000	0.1818	0.1126	0.0000	
20	27-28	0	0	0	1.55	1.038	2.588	2.588	0.0611	0.0000	0.1581	0.1004	0.0000	
21	28-29	0	0	0	1.55	1.038	2.588	2.588	0.0531	0.0000	0.1375	0.0895	0.0000	
22	29-30	0	0	0	1.55	1.038	2.588	2.588	0.0462	0.0000	0.1196	0.0798	0.0000	
23	30-31	0	0	0	1.55	1.038	2.588	2.588	0.0402	0.0000	0.1040	0.0711	0.0000	
24	31-32	0	0	0	1.55	1.038	2.588	2.588	0.0349	0.0000	0.0904	0.0634	0.0000	
25	32-33	0	0	0	1.55	1.038	2.588	2.588	0.0304	0.0000	0.0786	0.0565	0.0000	
	TOTAL	19.28	0	19.28	37.975	25.86475	63.83975	44.55975	7.464149	19.280	15.9812	4.576556	19.2800	

PWC	19.280	B/C RATIC	0.8289
PWB	15.981		
NPW	-3.299	IRR	12.18%

$$S = \frac{2.3 \times Qp \times \text{Log}(Re/Rw)}{2 \times \pi \times T}$$

Taking Q = 15 lits / sec (small farmer) = $0.015 m^3/sec$

$$S = \frac{2.3 \times 0.015 \times \log(150/3)}{2 \times 3.14 \times 0.0069}$$

$$= 1.35m$$

4. Velocity head : limiting the velocity at delivery side as 2.0 m/sec

$$= V2 / 2g$$

$$= 2^2/2 \times 9.81$$

$$= 0.204m$$

5. Friction head:

Head loss due to friction in the pipe = $4 f l v^2 / (2 g d)$

Where l = total length of pipeline in meter

V = velocity of flow in the pipe in m/sec, taken as 2 m/sec

D = diameter of the pipe line in meter, taken as 0.125m

F = coefficient of friction, generally assumed as 0.006

$h_f = 4 \times 0.006 \times 11.6 \times 2^2/(2 \times 9.81 \times 0.125)$

$h_f = 0.45m$

losses at entry and bends taken as 25% of friction losses in pipe line $h_b = 0.11m$

$\therefore$ Total head of lifting = 9.0 + 1.25 + 1.35 + 0.204 + 0.45 + 0.11 m

= 12.364 m Say 12.40m

5.5.2 Calculation of Pumping Unit

Horse power of a motor $= \frac{w \times Q \times H}{75 \eta}$

Where

W = unit weight of water in kg/ m3

η = efficiency of the set which is generally taken as 60%

Q = discharge to be delivered in cumec

H = total head in meters against which the motor has to operate

$$HP = 1000 \times 0.015 \times 12.4/(75 \times 0.60)$$

$$= 4.13$$

Considering an extra cover of 20% for seasonal variation of load on motor

HP of motor 4.13 x 1.2 = 4.956

= Say 5 HP

5.5.3 Calculation of Number of Shallow Wells Required

Assuming 1000 hours working in a year

Annual yield per well in a year = 0.015 x 60 x 60 x 1000 / 1000000 Mcm

= 0.054 Mcm

Current water duty at farm outlet level = 0.0043Mcm/ha

Number ha proposed irrigate under GW = 76 ha

Ground water requirement = 0.33 Mcm

Number of wells required = 6.11

(with extra a well to facilitate sharing excess with neighboring farmers)

= Say 8 Nos

5.5.4 Calculation of Investment, Repair and Running Cost

(a) Investment Cost:

Construction of well including masonry structure and platform	=322,000
5HP electric motor with pump	= 10,000
125mm dia GI pipe @ 180/= per mt for 13m	= 2,340
100mm dia GI pipe @ 150/=per mt for 2 m	= 300
For bolts and base plate etc	= 1,000
Installation charges	= 2,000
Electric connecting poles etc	= 5,000
Total cost	=342,640
Total cost for eight irrigation wells (8x342, 640/=)	**= 2,741,120**

(b) Operation Cost

Cost of Minor Repairs and Maintenance per year = 5,000

Annual Running Cost:

Assuming 1000 hours working in a year and Cost of electricity as Rs2.50/= per unit (5 x 0.746 x 1000 x 2.50) = 9,325

Total operation cost =14,325

Total annual operation cost per eight irrigation wells **=114,600**

5.5.5 Project Benefits:

SI	Description	Without shallow well (Rs)	With shallow Well (Rs)
01	**Direct Benefits**		
	Net Income		
	Kharif	1429563	1429563
	Rabi	5021222	5752220
	Total	6450785	7,181783
	Net Incremental direct benefit		730,998
02	**Indirect Benefits**		
	Indirect Benefits (11% of dir benefit)		80,409
	Total Net Incremental Income		811,407

It is assumed that the cropping pattern and net benefit per ha remains same after the introduction of tube well to the project.

Existing water supply factor = 75.33 %

Anticipated water supply factor after the = 100 %

5.5.6 Economic Analysis of Shallow wells in Khairana Project

The following assumptions were made in economic analysis of Khairana Project and analysis is shown in table 5.9.

I. The economic life of civil work is assumed as 25 years and five year life of pump.

II. Benefit would occur from the second year of the investment and 25% of the ultimate benefit is assumed to occur during second year and 50% of the ultimate benefits is assumed to occur during third year and 100% during the fourth year and continue throughout economic life.

III. Cropping pattern of the project remains same even after the introduction of tube well.

IV. 15% discount rate is taken to calculate net present cost (NPC), net present income (NPI), net present value (NPV) and Benefit cost ratio

V. Situation prevailing after the NABARD investment is taken as "without project" condition in financial evaluation of the project.

Table 5.9 Financial Analysis of Khairana Project(Shallow wells)

									Discount Rate 15%			19.050%		
		COST			BENEFIT			NET						
S.NO	YEAR	CAPITAL	MAINT	TOTAL	DIRECT	INDIRECT	TOTAL	CASH	PWF	PWC	PWB	PWF	PWC	PWE
0	07-08	27.41	0	27.41			0	-27.410	1.000	27.410	0.000	1.000	27.410	0.0
1	08-09	0	1.15	1.15	1.83	0	2.030	0.880	0.870	1.000	1.765	0.840	0.966	1.7
2	09-10	0	1.15	1.15	3.66	0	4.060	2.910	0.756	0.870	3.070	0.706	0.811	2.8
3	10-11	0	1.15	1.15	7.31	1	8.114	6.964	0.658	0.756	5.335	0.593	0.682	4.8
4	11-12	0	1.15	1.15	7.31	1	8.114	6.964	0.572	0.658	4.639	0.498	0.573	4.0
5	12-13	0.96	1.15	2.11	7.31	1	8.114	6.004	0.497	1.049	4.034	0.418	0.882	3.3
6	13-14	0	1.15	1.15	7.31	1	8.114	6.964	0.432	0.497	3.508	0.351	0.404	2.8
7	14-15	0	1.15	1.15	7.31	1	8.114	6.964	0.376	0.432	3.050	0.295	0.339	2.3
8	15-16	0	1.15	1.15	7.31	1	8.114	6.964	0.327	0.376	2.653	0.248	0.285	2.0
9	16-17	0	1.15	1.15	7.31	1	8.114	6.964	0.284	0.327	2.307	0.208	0.239	1.6
10	17-18	0.96	1.15	2.11	7.31	1	8.114	6.004	0.247	0.522	2.006	0.175	0.369	1.4
11	18-19	0	1.15	1.15	7.31	1	8.114	6.964	0.215	0.247	1.744	0.147	0.169	1.1
12	19--20	0	1.15	1.15	7.31	1	8.114	6.964	0.187	0.215	1.517	0.123	0.142	1.0
13	20-21	0	1.15	1.15	7.31	1	8.114	6.964	0.163	0.187	1.319	0.104	0.119	0.8
14	21-22	0	1.15	1.15	7.31	1	8.114	6.964	0.141	0.163	1.147	0.087	0.100	0.7
15	22-23	0.96	1.15	2.11	7.31	1	8.114	6.004	0.123	0.259	0.997	0.073	0.154	0.5
16	23-24	0	1.15	1.15	7.31	1	8.114	6.964	0.107	0.123	0.867	0.061	0.071	0.4
17	24-25	0	1.15	1.15	7.31	1	8.114	6.964	0.093	0.107	0.754	0.052	0.059	0.4
18	25-26	0	1.15	1.15	7.31	1	8.114	6.964	0.081	0.093	0.656	0.043	0.050	0.3
19	26-27	0	1.15	1.15	7.31	1	8.114	6.964	0.070	0.081	0.570	0.036	0.042	0.2
20	27-28	0.96	1.15	2.11	7.31	1	8.114	6.004	0.061	0.129	0.496	0.031	0.065	0.2
21	28-29	0	1.15	1.15	7.31	1	8.114	6.964	0.053	0.061	0.431	0.026	0.030	0.2
22	29-30	0	1.15	1.15	7.31	1	8.114	6.964	0.046	0.053	0.375	0.022	0.025	0.1
23	30-31	0	1.15	1.15	7.31	1	8.114	6.964	0.040	0.046	0.326	0.018	0.021	0.1
24	31-32	0	1.15	1.15	7.31	1	8.114	6.964	0.035	0.040	0.283	0.015	0.018	0.1
25	32-33	0	1.15	1.15	7.31	1	8.114	6.964	0.030	0.035	0.246	0.013	0.015	0.1
	TOTAL	31.25	28.75	60	173.62	19	192.714	132.714	7.464	35.735	44.095	4.577	34.038	34.0

PWC	35.735	B/C RATIC	1.2339
PWB	44.095		
NPW	8.360	IRR	19.05%

5.6 IMPACT OF CONJUNCTIVE USE GROUND WATER USING TUBEWELLS

Tube well supplies differ from canal supplies in several aspects. Tube wells usually provide a steady supply of water for irrigation and it is easy to provide a steady supply of water for irrigation and it is easy to provide irrigation at optimum times with reference to the stage of growth of the crops, thus maximizing production. Canal supplies fluctuation and canal often remain closed for long periods. In the case of canals, the annual working expenses remain the same, in spite of the variations in the volume of water supplied. On the other hand, in tube wells the cost of power consumed in pumping and to some extent the maintenance cost are related to the volume of water pumped. In tube wells it is also possible to conveniently measure the discharge rate with a simple V- notch and also relate the volumetric discharge with power consumed. This facility and the high cost of tube wells and pumps make it desirable the tube well water are charged on the basis of water supplied to the individual farmers.

5.6.1 Calculation of Pumping Rate

Present water supply factor	= 75.33%
Proposed water supply factor with conjunctive use	= 100%
CCA	= 308ha
Irrigation duty at farm out let	= 0.43m
Extra quantity of water required	= $0.2467 \times 308 \times .43 \times 10^4/10^6$
	= $0.3267 Mm^3$
Conveyance losses (20%)	= $0.0653\ Mm^3$
Total pumping quantity	= $0.3920\ Mm^3$
Assuming Number of pumping hours as 1000 hours	
Required pumping rate	= $0.3920 \times 10^6 / 1000 \times 60 \times 60$
	= 0.1089 Cumec
H.P. of Motor	
Coarse sand strata (assumed)	= 40m to 70m
Thickness of confined aquifer	= 70m – 40m = 30m
Discharge required	= 6534 Lit/min
i. Casing and well screen diameter	
Casing diameter	= 45cm (table 14.1 Varshney-1997)
Optimum diameter of well screen	= 30cm (Fig 14.12 Varshney-1997)

ii. Length of strainer and slot size

- 70% to 80% of aquifer depth may be screened for confined well
- Assume 75% length of screen = 30 x 75/100 = 22.5m
- Slot size = 2.0mm

iii. Discharge of well

The maximum depression head permitted is between 9m to 40m

$$q = \frac{2\pi kb(H - hw)}{2.3\log(R/rw)}$$

Where K= 0.09 cm/sec =9 x 10^{-4} m/sec

b= 22.5m

H-h_w= 31m

R = 400m (assumed)

R_w= 0.15m

Q = 2*π* 9*10^{-4} *22.5*31/(2.3*$\log_{10}$ (400/0.15)) =0.5005 cumec

=30,003 Lit/min

The well is capable of discharging much higher discharge than required.

iv. Screen entrance velocity

Assume 20% of slot area, the screen entrance velocity when discharging 0.11cumec is given by

π x 30 x 20/100 x 22.5 x 100 x V = 110 x 1000

V = 2.59 m/sec

Since screen entrance velocity is within admissible limit (ie < 3 m/sec) the assembly is O.K.

v. H.P. of Motor

Horse power of a motor is given by =H.P. = w q H/ 75 η

Velocity through casing pipe = 0.11x 4/ (π x $.30^2$) = 1.56 m/sec

Velocity head = 1.56^2/(2x 9.81) = 0.12m

Loss of head due to friction in pipe =4f l v^2/ (2 g d)

Where f = Coefficient of friction assumed as 0.006

l = Length of pipe including horizontal length =75m

d= diameter of pipe in m = 0.30m

h_f = 4 x 0.006 x 75 x 1.56^2 / (2 x 9.81 x 0.3) = 0.74m

Assuming entry losses in strainer and bend as 25% of friction loss = 0.19m

Total head loss = 9 + 31 + 012 + .74 + 0.19 = 41.0m

H.P. required = 1000 x 0.11 x 41 /(75 x 0.7) = 85.9 Say 90 Hp

5.6.2 Investment, Maintenance & Operation cost and Project Benefits

a. Investment Cost:

SI	Item of Work	Qty	Rate Rs	Amount Rs	Total Rs (lac)
01	Preliminary Survey	1 job	5000	5000	0.050
02	Civil work				
I	Pump House	1job	73,000	73,000	
II	Delivery tank/Head sump etc	1 job	53,000	53,000	
III	PVC pipe	200m	369.00	73.800	1.998
3	Drilling by Percussion Rig Mech Procurement and lowering of assembly				
I	Drilling by Percussion Machine lowering and extraction of pipe	70hr	12648	885,360	
III	Transportation	1job	25000	25,000	
IV	Housing pipe	40m	3500	140,000	
V	Slotted pipe	30m	3960	118,800	
VI	Reducer	1no	3000	3,000	
VII	Well cap	1no	1000	1,000	
VIII	Clamp	1no	2600	2,600	
iX	Development of tube well with air compressor and pump	15hr	2236	33,540	
X	Procurement, transportation and packing of gravels	34m^3	1400	47,600	12,569
04	Pump set and accessories				
I	Submersible pump set with cable	1no	150,000	150,000	
II	Column pipe	15m	1,160	17,400	
III	Auto-starter	1no	11,160	11,160	
IV	TP switch	1no	3,000	3,000	
V	Capacitor	1no	1,650	1,650	
VI	Base Plate	1no	1,872	1,870	
VII	Delivery pipe, sluice value, reflex valve, switch board, and Misc	1job	20,000	20,000	
VIII	Nut and bolt etc	1job	4,000	4,000	2,091
05	Engineering and Administration	1 no	112,000	112,000	2.792
	Grand total				19,500

b. Maintenance & Operation Cost per Year

Operation (running cost) Cost:

Horse Power of the pump =90HP

Pumping Capacity = 90 x 0.746

= 67,14 KW

Pumping hours per year =1000hrs

Consumption of electricity = 67,14 x 1000 KWH/year

= 67,140 KWH/year

Electricity Charges per year = 2.0 x 300 + 2.5 x 66840

= Rs 167,700

Electricity Charges first 300 units @ 2.00 rupees and for excess of first 300 units @ rupees 2.50 (As per the Notice published by Madhya Pradesh Electricity Regulatory commission on 10-11-2006.)

SI	Item of work	Qty	Rate	Amount
A	**Maintenance Cost**			
01	Rewinding of burnt motor and & repair of pump	1job	10,000	10,000
02	Lifting and lowering of assembly	1job	4,000	4,000
03	Maintenance & repair of starter/ T.P switch	1job	4,000	4,000
B	**Operation Cost**			
	Electricity charrges	67140 kwh	2.50	167,700
	Total expenditure per year			185,700
	Say			190,000

c. Project Benefits:

SI	Description	Without tube well	With tube well
	Direct Benefits		
	Net Income		
	Kharif	1429563	1429563
	Rabi	5021222	5752220
	Total	6450785	7,181783
	Net Incremental direct benefit		730,998
	Indirect Benefits		
	Indirect Benefits (11% of dir benefit)		80,409
	Total Net Incremental Income		811,407

It is assumed that the cropping pattern and net benefit per ha remains same after the introduction of tube well to the project.

Existing water supply factor = 75.33 %

Anticipated water supply factor after the = 100 %

5.6.3 Economic Analysis of Tubewell in Khairana Project

The following assumptions were made in economic analysis of Khairana Project and analysis is shown in table 5.10.

I. The economic life of civil work is assumed as 25 years and five year life of pump.

II. Benefit would occur from the second year of the investment and 25% of the ultimate benefit is assumed to occur during second year and 50% of the ultimate benefits is assumed to occur during third year and 100% during the fourth year and continue throughout economic life.

III. Cropping pattern of the project remains same even after the introduction of tube well.

IV. 15% discount rate is taken to calculate net present cost (NPC), net present income (NPI), net present value (NPV) and Benefit cost ratio

V. Situation prevailing after the NABARD investment is taken as "without project" condition in financial evaluation of the project.

5.7 IMPACT OF COMBINATION OF CANAL LINING AND TUBEWELLS

5.7.1 Investment Cost, O&M Cost and Project Benefits

a.Investment Cost:-

Investment cost for concrete lining:

SI	Description	Unit	Quantity	Rate	Amount
01	Cement concrete 1:2:4	M3	528	3030	1599840
02	Earth work	M3	512	150	76800
03	Sub total				1676640
04	Engineering and Administration (15%)				251360
	Total				1928000

Table 5.10 Financial Analysis of Khairana Project(Tube well)

									Discount Rate 15%			21.600%		
		COST			BENEFIT			NET						
S.NO	YEAR	CAPITAL	MAINT	TOTAL	DIRECT	INDIRECT	TOTAL	CASH	PWF	PWC	PWB	PWF	PWC	PWI
0	07-08	19.5	0	19.5			0	-19.5	1.0000	19.5000	0.0000	1.0000	19.5000	0.0
1	08-09	0	1.9	1.9	1.82	0.2	2.02	0.12	0.8696	1.6522	1.7565	0.8224	1.5625	1.6
2	09-10	0	1.9	1.9	3.65	0.4	4.05	2.15	0.7561	1.4367	3.0624	0.6763	1.2850	2.7
3	10-11	0	1.9	1.9	7.31	0.804	8.114	6.214	0.6575	1.2493	5.3351	0.5562	1.0567	4.5
4	11-12	0	1.9	1.9	7.31	0.804	8.114	6.214	0.5718	1.0863	4.6392	0.4574	0.8690	3.7
5	12-13	2.091	1.9	3.991	7.31	0.804	8.114	4.123	0.4972	1.9842	4.0341	0.3761	1.5011	3.0
6	13-14	0	1.9	1.9	7.31	0.804	8.114	6.214	0.4323	0.8214	3.5079	0.3093	0.5877	2.5
7	14-15	0	1.9	1.9	7.31	0.804	8.114	6.214	0.3759	0.7143	3.0504	0.2544	0.4833	2.0
8	15-16	0	1.9	1.9	7.31	0.804	8.114	6.214	0.3269	0.6211	2.6525	0.2092	0.3975	1.6
9	16-17	0	1.9	1.9	7.31	0.804	8.114	6.214	0.2843	0.5401	2.3065	0.1720	0.3269	1.3
10	17-18	2.091	1.9	3.991	7.31	0.804	8.114	4.123	0.2472	0.9865	2.0057	0.1415	0.5646	1.1
11	18-19	0	1.9	1.9	7.31	0.804	8.114	6.214	0.2149	0.4084	1.7440	0.1163	0.2210	0.9
12	19--20	0	1.9	1.9	7.31	0.804	8.114	6.214	0.1869	0.3551	1.5166	0.0957	0.1818	0.7
13	20-21	0	1.9	1.9	7.31	0.804	8.114	6.214	0.1625	0.3088	1.3188	0.0787	0.1495	0.6
14	21-22	0	1.9	1.9	7.31	0.804	8.114	6.214	0.1413	0.2685	1.1467	0.0647	0.1229	0.5
15	22-23	2.091	1.9	3.991	7.31	0.804	8.114	4.123	0.1229	0.4905	0.9972	0.0532	0.2124	0.4
16	23-24	0	1.9	1.9	7.31	0.804	8.114	6.214	0.1069	0.2030	0.8671	0.0438	0.0831	0.3
17	24-25	0	1.9	1.9	7.31	0.804	8.114	6.214	0.0929	0.1766	0.7540	0.0360	0.0684	0.2
18	25-26	0	1.9	1.9	7.31	0.804	8.114	6.214	0.0808	0.1535	0.6557	0.0296	0.0562	0.2
19	26-27	0	1.9	1.9	7.31	0.804	8.114	6.214	0.0703	0.1335	0.5701	0.0243	0.0462	0.1
20	27-28	2.091	1.9	3.991	7.31	0.804	8.114	4.123	0.0611	0.2439	0.4958	0.0200	0.0799	0.1
21	28-29	0	1.9	1.9	7.31	0.804	8.114	6.214	0.0531	0.1009	0.4311	0.0165	0.0313	0.1
22	29-30	0	1.9	1.9	7.31	0.804	8.114	6.214	0.0462	0.0878	0.3749	0.0135	0.0257	0.1
23	30-31	0	1.9	1.9	7.31	0.804	8.114	6.214	0.0402	0.0763	0.3260	0.0111	0.0211	0.0
24	31-32	0	1.9	1.9	7.31	0.804	8.114	6.214	0.0349	0.0664	0.2835	0.0092	0.0174	0.0
25	32-33	0	1.9	1.9	7.31	0.804	8.114	6.214	0.0304	0.0577	0.2465	0.0075	0.0143	0.0
	TOTAL	27.864	47.5	75.364	173.6	19.092	192.692	117.328	7.4641491	33.723	44.0780	4.576556	29.4655	29.5

PWC	33.723	B/C RATIO	1.3071
PWB	44.078		
NPW	10.355	IRR	21.60%

Investment cost for Tube well:

SI	Item of Work	Qty	Rate Rs	Amount Rs	Total Rs lakh
01	Preliminary Survey	1 job	5,000	5,000	0.050
02	Civil work				
I	Pump House	1job	73,000	73,000	
II	Delivery tank/Head sump etc	1 job	53,000	53,000	
III	PVC pipe	200m	369.00	73.800	1.998
3	Drilling by Percussion Rig Mech Procurement and lowering of assembly				
I	Drilling by Percussion Machine				
	lowering and extraction of pipe	70hr	12648	885,360	
	Transportation	1job	25000	25,000	
III	Housing pipe	40m	3500	140,000	
IV	Slotted pipe	30m	3960	118,800	
V	Reducer	1no	3000	3,000	
VI	Well cap	1no	1000	1,000	
VII	Clamp	1no	2600	2,600	
VIII	Development of tube well with air compressor and pump	15hr	2236	33,540	
IX	Procurement, transportation and packing of gravels	$34m^3$	1400	47,600	12,569
04	Pump set and accessories				
I	Submersible pump set with cable	1no	150,000	150,000	
II	Column pipe	15m	1,160	17,400	
III	Auto-starter	1no	11,160	11,160	
IV	TP switch	1no	3,000	3,000	
V	Capacitor	1no	1,650	1,650	
VI	Base Plate	1no	1,872	1,872	
VII	Delivery pipe, sluice value, reflex valve, switch board, and Misc	1job	20,000	20,000	
VIII	Nut and bolt etc	1job	4,000	4,000	2,091
05	Engineering and Administration	1 no	112,000	112,000	2,792
	Grand total				**19,500**

b. Maintenance & Operation Cost per Year

Present water supply factor	= 75.33%
Water supply factor with concrete lining	= 86.39%
Water supply factor with combine of concrete lining and tube well	= 100%
CCA	= 308ha
Irrigation duty at farm outlet level	= 0.43m
Extra quantity of water required from ground water	= 0.19Mm

As change in wetted perimeter is a negligible, assumed conveyance loss as zero for water pump from ground.

∴ Total quantity of water pump	=0.19Mm
Number of pumping hours (= 0.19 x 10^6/(0.1089 x 60 x 60)	=484hrs Say 500hrs

Operation (running cost) Cost:

Horse Power of the pump	=90HP
Pumping Capacity	= 90 x 0.746
	= 67.14 KW
Pumping hours per year	=500hrs
Consumption of electricity	= 64.14 x 500 KWH/year
	= 33570 KWH/year
Electricity Charges per year	= 2.0 x 300 + 2.5 x 33270
	= Rs 83,775

Electricity Charges first 300 units @ 2.00 rupees and for excess of first 300 units @ rupees 2.50 (As per the Notice published by Madhya Pradesh Electricity Regulatory commission on 10-11-2006.)

SI	Item of work	Qty	Rate	Amount
A	**Maintenance Cost**			
01	Rewinding of burnt motor and & repair of pump	1job	10,000	10,000
02	Lifting and lowering of assembly	1job	4,000	4,000
03	Maintenance & repair of starter/ T.P switch	1job	4,000	4,000
B	**Operation Cost**			
	Electricity charges	9922 kwh	2.50	83,775
	Total expenditure per year			101,775
	Say			105.000

Total investment cost = 3,878, 000.00
Annul maintenance cost = 105,000.00

c. Project Benefits

SI	Description	Without tube well	With tube well
	Direct Benefits		
	Net Income		
	Kharif	1429563	1429563
	Rabi	5021222	5752220
	Total	6450785	7,181783
	Net Incremental direct benefit		730,998
	Indirect Benefits		
	Indirect Benefits (11% of dir benefit)		80,409
	Total Net Incremental Income		**811,407**

5.7.2 Economic Analysis of Combination of Canal Lining and Tubewell in Khairana Project

The following assumptions were made in economic analysis of Khairana Project and analysis is shown in table 5.11.

I. The economic life of civil work is assumed as 25 years and five year life of pump.
II. Benefit would occur from the second year of the investment and 25% of the ultimate benefit is assumed to occur during second year and 50% of the ultimate benefits is assumed to occur during third year and 100% during the fourth year and continue throughout economic life.
III. Cropping pattern of the project remains same even after the introduction of tube well.
IV. 15% discount rate is taken to calculate net present cost (NPC), net present income (NPI), net present value (NPV) and Benefit cost ratio
V. Situation prevailing after the NABARD investment is taken as "without project" condition in financial evaluation of the project.

Table 5.11 Financial Analysis of Khairana Project(Combination of Concrete lining and Tube well)

									Discount Rate 15%			15.810%		
		COST			BENEFIT			NET						
S.NO	YEAR	CAPITAL	MAINT	TOTAL	DIRECT	INDIRECT	TOTAL	CASH	PWF	PWC	PWB	PWF	PWC	
0	07-08	38.78	0	38.78			0	-38.78	1.0000	38.7800	0.0000	1.0000	38.7800	
1	08-09	0	1.05	1.05	1.82	1.0677	2.8877	1.8377	0.8696	0.9130	2.5110	0.8635	0.9067	
2	09-10	0	1.05	1.05	3.65	1.269	4.919	3.869	0.7561	0.7940	3.7195	0.7456	0.7829	
3	10-11	0	1.05	1.05	7.31	1.6716	8.9816	7.9316	0.6575	0.6904	5.9055	0.6438	0.6760	
4	11-12	0	1.05	1.05	7.31	1.6716	8.9816	7.9316	0.5718	0.6003	5.1353	0.5559	0.5837	
5	12-13	2.091	1.05	3.141	7.31	1.6716	8.9816	5.8406	0.4972	1.5616	4.4654	0.4800	1.5078	
6	13-14	0	1.05	1.05	7.31	1.6716	8.9816	7.9316	0.4323	0.4539	3.8830	0.4145	0.4352	
7	14-15	0	1.05	1.05	7.31	1.6716	8.9816	7.9316	0.3759	0.3947	3.3765	0.3579	0.3758	
8	15-16	0	1.05	1.05	7.31	1.6716	8.9816	7.9316	0.3269	0.3432	2.9361	0.3091	0.3245	
9	16-17	0	1.05	1.05	7.31	1.6716	8.9816	7.9316	0.2843	0.2985	2.5531	0.2669	0.2802	
10	17-18	2.091	1.05	3.141	7.31	1.6716	8.9816	5.8406	0.2472	0.7764	2.2201	0.2304	0.7238	
11	18-19	0	1.05	1.05	7.31	1.6716	8.9816	7.9316	0.2149	0.2257	1.9305	0.1990	0.2089	
12	19--20	0	1.05	1.05	7.31	1.6716	8.9816	7.9316	0.1869	0.1963	1.6787	0.1718	0.1804	
13	20-21	0	1.05	1.05	7.31	1.6716	8.9816	7.9316	0.1625	0.1707	1.4598	0.1484	0.1558	
14	21-22	0	1.05	1.05	7.31	1.6716	8.9816	7.9316	0.1413	0.1484	1.2694	0.1281	0.1345	
15	22-23	2.091	1.05	3.141	7.31	1.6716	8.9816	5.8406	0.1229	0.3860	1.1038	0.1106	0.3474	
16	23-24	0	1.05	1.05	7.31	1.6716	8.9816	7.9316	0.1069	0.1122	0.9598	0.0955	0.1003	
17	24-25	0	1.05	1.05	7.31	1.6716	8.9816	7.9316	0.0929	0.0976	0.8346	0.0825	0.0866	
18	25-26	0	1.05	1.05	7.31	1.6716	8.9816	7.9316	0.0808	0.0848	0.7258	0.0712	0.0748	
19	26-27	0	1.05	1.05	7.31	1.6716	8.9816	7.9316	0.0703	0.0738	0.6311	0.0615	0.0646	
20	27-28	2.091	1.05	3.141	7.31	1.6716	8.9816	5.8406	0.0611	0.1919	0.5488	0.0531	0.1668	
21	28-29	0	1.05	1.05	7.31	1.6716	8.9816	7.9316	0.0531	0.0558	0.4772	0.0458	0.0481	
22	29-30	0	1.05	1.05	7.31	1.6716	8.9816	7.9316	0.0462	0.0485	0.4150	0.0396	0.0416	
23	30-31	0	1.05	1.05	7.31	1.6716	8.9816	7.9316	0.0402	0.0422	0.3608	0.0342	0.0359	
24	31-32	0	1.05	1.05	7.31	1.6716	8.9816	7.9316	0.0349	0.0367	0.3138	0.0295	0.0310	
25	32-33	0	1.05	1.05	7.31	1.6716	8.9816	7.9316	0.0304	0.0319	0.2728	0.0255	0.0268	
	TOTAL	47.144	26.25	73.394	173.6	40.7835	214.3835	140.9895	7.464149	47.509	49.6874	4.576556	47.0800	

PWC	47.509	B/C RATIC	1.0459
PWB	49.687		
NPW	2.179	IRR	15.81%

5.8 SUMMARY

In this chapter, attention has been focused to study the possible future investments to improve the performance of the Khairana tank irrigation project and their corresponding financial performance. Results of the financial performance pertaining to possible future investment and their implications are discussed as follows.

Financial performance of Khairana project in connection with concrete lining and conjunctive use of surface and ground water are given in table below.

Source	PWC	PWB	NPV	B/C	IRR
Surface Irrigation	124.66	79.65	-45.01	0.64	10.34
Concrete lining	19.28	15.981	-3.299	0.83	12.18
Shallow well	35.735	44.078	8.36	1.23	19.05
Tube well	33.725	44.078	10.355	1.31	21.60
Combination of concrete lining and Tube well	47.509	49.689	2.179	1.05	15.8

Financial parameters such as B/C ratio and IRR for concrete lining at 15% discount rate are 0..83 and 12.18 respectively. Therefore concrete lining in entire canal length is infeasible. Limited concrete lining where seepage losses are high along with some management improvements such as rotational water issues can further improve financial parameters.

Conjunctive use of surface and ground water in the form of shallow well, Public Tube well and combination of concrete lining and tube well has become economically feasible. B/C ratio and IRR at discount rate 15% corresponding to above three cases are 1.23, 1.31, 1.05 and 19.05%, 21.6%, 15.8% respectively.

Lining of water conveyance system has greatly contributed to the equitable distribution of water which is the prime objective of any efficient and proper water management. Seepage losses in canal filling sections and in high permeable soils are very high compare with canal cutting sections. Management improvement such as rotational water issues can influence the number of canal operation days per week. Therefore head reaches require running longer periods than middle and tail reaches. Limited concrete lining may economically justifiable in case of tank irrigation projects.

At farm level Dug well and tube wells have lower capital cost but higher running cost than canal water. Canal schemes are public owned, capital cost of canal construction and often running cost are met by government and canal water is therefore subsidized.

Tube wells are usually privately owned and farmers face full capital and running cost as well as depreciation and replacement. This disparity can make supplementary tubewell irrigation an expensive option.

Farmers, who own wells, therefore need consistently higher incomes to justify their investment and stable prices for inputs and outputs (chancellor- Weale, 1989). The major source of variation in annual cost is the fluctuating demand for groundwater which is largely dependent on reliability of surface supply. Farmers who purchase groundwater face higher price in drought years. Irrigators are also affected by the supply and price fluctuation for fuel and spare parts.

Cost of a tubewell unit and its associated structures (pump house, canals) is commonly beyond the means of small farmers. Therefore collective and corporative ownership will have been managed by the government to protect interest of small farmers. Inequity, unreliability and untimeliness are the major issues in surface irrigation projects. Conjunctive use of surface and ground water can improve efficiencies in lower reaches by surface water is used to irrigate land close to the canal and ground water to irrigate land which is further away.

The reduced uncertainty of poor or irregular supply from surface water and allows farmers to risks investment in water intensive and higher value crops, HYV seeds, and associated inputs like fertilizer and pesticides.

CHAPTER-6
CONSIDERATION OF ECONOMIC PRICES (IRRIGATION REHABILITATION PROJECTS SRI- LANKA)

6.1 INTRODUCTION

In the earlier chapters, evaluation has been carried out using financial prices. Economic evaluation could not be carried out as sufficient data on economic prices for the tank irrigation project were not available. Further the analysis was focused on whether financing by NABARD (domestic donor) contributed to improvement in project performance. This illustrates procedure for economic analysis considering economic prices as is required by international donor. Hambantota irrigation rehabilitation project in Sri Lanka is taken up for economic analysis.

Requirement of financial and economic analysis are more rigorous in case of international financing. This study differs from the evaluation of four tank projects in terms of followings.

1. It is a rehabilitation project of medium size (> 1000ha)
2. It is internationally funded
3. Economic price prices have been worked out (Shadow prices, Labour pries, Opportunity cost of the capital)

6.2 THE PROJECT BACKGROUND

The District of Hambantota located in the southern province of Sri Lanka is mainly agricultural area. The land area is 2496 sq.km and the population density is 220 persons per sq.km. The district is located in the dry zone and average annual rainfall is about 1050mm.

Having realized the need for rectifying regional backwardness in agricultural sector, with view of upgrading the living standard of the farmer community the Government of Sri Lanka requested the assistance from the Government of Japan to carryout a Master Plan study of irrigation and drainage schemes in southern Sri Lanka which needs rehabilitation. Consequently JICA carried out a study from January 1995 to

April 1996. The initial survey revealed that a facility rehabilitation project comprising Muruthawela, Liyangastota and Badagiriya is well within the government's irrigation development policy and feasibility study was carried out in these schemes between April 1995 – August 1996. The total area to be rehabilitated under this study was 11667ha and the total cost was estimated at Rs 2.3 billion.

Since the Government wished to obtain foreign assistance in implementing the proposed rehabilitation program the total cost was reduced to at Rs 1.0 billion with out bringing down the expected benefits substantially. This was compatible with the prorate cost of similar rehabilitation program implemented in other parts of the country.

Subsequently an agreement was signed between the GOSL and the Kuwait Fund for Arab Economic Development (KFAED) in May 1999 for rehabilitation of Muruthawela, Liyangastota and Badagiriya schemes with improved O&M facilities, developed farmer institutions etc. (HIRP-May 2000)

6.3 PROJECT AREA

The project area map gives an idea of where these schemes are situated. The total command area benefited by each scheme is given below.

Scheme	**Sub-scheme**	**Area (ha)**	**Total (ha)**	**Source of water**
Liyangastota	Ridiyagama	2452		Liyangastota anicut
(>100 yrs ago)	WRB	2554	5007	and Walawa river
Muruthawela	Muru LB	1700		Uruboku Oya
(1971)	Urubokka Oya	2262		
	Kirama Oya	1510	5472	
Badagiriya				
(1957)		686	686	Malala Oya
		Total	**11666**	

6.3.1 Liyangastota Scheme

The scheme is located 15 km west of Hambantota. It comprises of two schemes located on either banks of the river called Walawa Left Bank (Ridiyagama) and Walawa Right Bank (WRB). The main source of water comes from the Liyangastota anicut constructed in 1889 across Walawa river which has the 6th largest catchment in the island. The Ridiyagama Reservoir was constructed in 1927 on the Left Bank connected to the Walawa river by 6.6 km feeder canal.

6.3.2 Muruthawela Scheme

The project comprises of 3 sub- schemes namely Muruthawela LB, Uruboku Oya and Kirama Oya. In the case of latter two sub schemes, prior to the construction of Muruthawela reservoir in 1971 in upper reaches of Uruboku oya each scheme diverted water independently. With the construction of Muruthawela reservoir a new LB intake was incorporated for the diversion of water to Muruthawela LB scheme and to the Uruboku sub scheme. The RB intake works were intended to divert discharge along a newly constructed canal to Kirama Oya sub-scheme. Thereafter the three sub schemes together referred as Muruthawela Irrigation Scheme.

6.3.3 Badagiriya Scheme

The scheme is located in the lower basin of the Malala Oya at the boundary of south east dry zone. The river basin has one of the lowest average annual rainfalls around 800mm; and since inception in 1957 the upper catchment of Badagiriya has been exploited by constructing number of minor tanks. The result of this and the deteriorated nature of canals within the scheme, has led to a serious water shortage problem for the area. Consequently 92 ha at the tail end of the system has been abandoned.

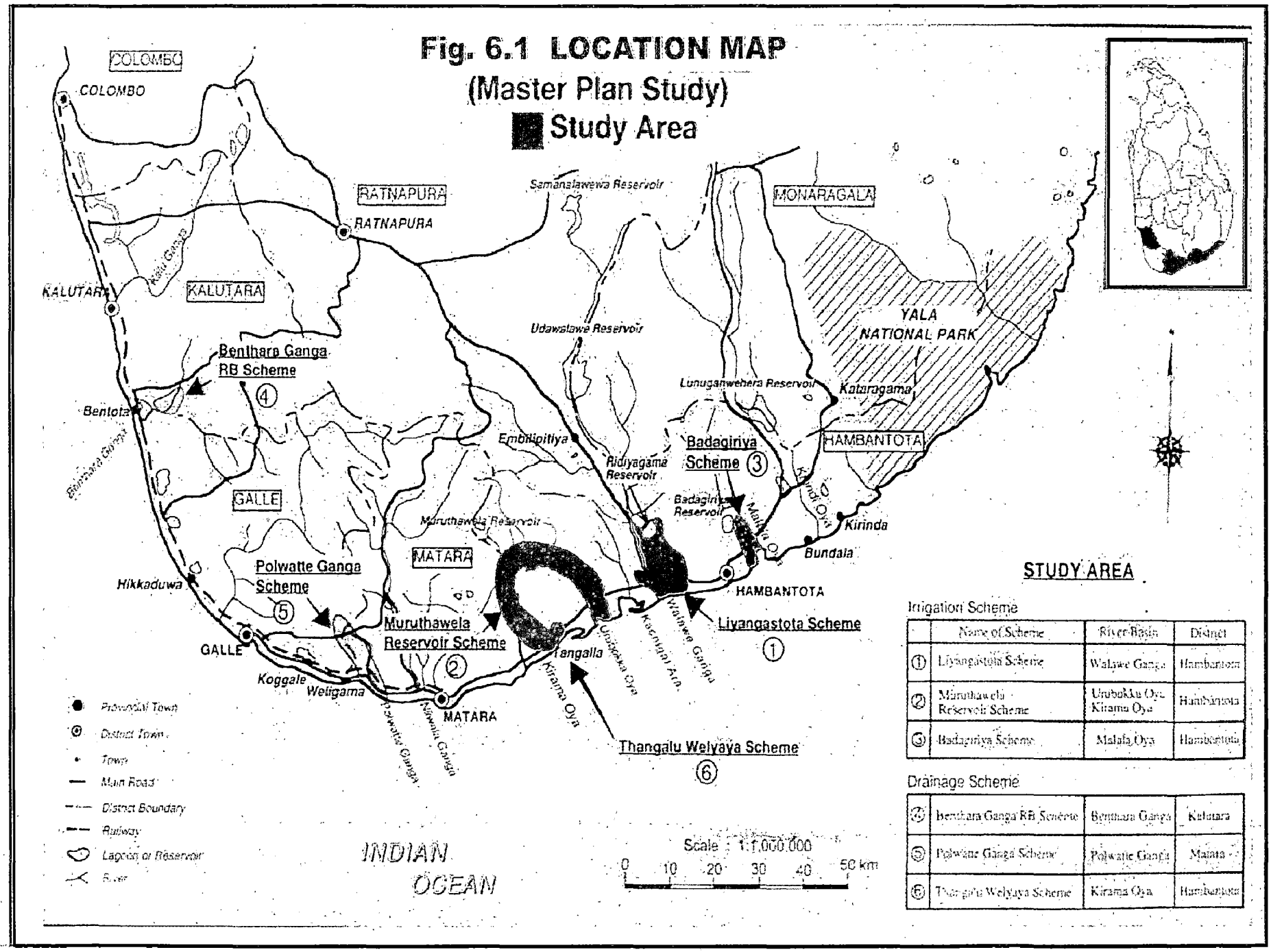


Fig. 6.1 LOCATION MAP
(Master Plan Study)
Study Area
COLOMBO
COLOMBO
RATNAPURA
RATNAPURA
KALUTARA
KALUTARA
GALLE
MATARA
MONARAGALA
HAMBANTOTA
Samanalawewa Reservoir
Udawalawe Reservoir
Lunuganwehera Reservoir
Ridiyagama Reservoir
Badagiriya Reservoir
Muruthawela Reservoir
YALA
NATIONAL PARK
Kataragama
Embilipitiya
Bentota
Hikkaduwa
Koggale
Weligama
Tangalla
Kirinda
Bundala
Kalu Ganga
Bentara Ganga
Kirama Oya
Urubokka Oya
Kaduganga Ara
Walawe Ganga
Nilwala Ganga
Malala Oya
Benthara Ganga
RB Scheme
④
Badagiriya
Scheme ③
Polwatte Ganga
Scheme
⑤
Muruthawela
Reservoir Scheme
②
Liyangastota Scheme
①
Thangalu Welyaya Scheme
⑥
Provincial Town
District Town
Town
Main Road
District Boundary
Railway
Lagoon or Reservoir
River
INDIAN
OCEAN
Scale : 1:1,000,000
0 10 20 30 40 50 km
STUDY AREA
Irrigation Scheme
Name of Scheme
River Basin
District
① Liyangastota Scheme — Walawe Ganga — Hambantota
② Muruthawela Reservoir Scheme — Urubokka Oya, Kirama Oya — Hambantota
③ Badagiriya Scheme — Malala Oya — Hambantota
Drainage Scheme
④ Benthara Ganga RB Scheme — Benthara Ganga — Kalutara
⑤ Polwatte Ganga Scheme — Polwatte Ganga — Matara
⑥ Thangalu Welyaya Scheme — Kirama Oya — Hambantota

6.4 TARGETS

(i) It has been established that once rehabilitation work is over the intensive of paddy cultivation could be enhanced in the project area as follows.(HIRP-May 2000)

Scheme	**crop**	**present**	**After Project**
Liyangastota	Paddy & OFC	190%	200%
Muruthawela	Paddy	131%	157%
Badagiriya	Paddy &OFC	138%	170%

(ii) It is also forecasted that the increasing agricultural production could be achieved with rehabilitation in place with improved extension services provided under this project.(HIRP –May 2000)

Scheme	**crop**	**before project**	**after project**
Muruthawela	Paddy	3.7 t/ha	5.5t/ha
Liyangastota	Paddy	3.7 t/ha	5.5t/ha
Badagiriya	Paddy	3.7 t/ha	5.5t/ha

(iii) Economic Returns

The evaluation of the economic return of the rehabilitation project with a base cost of Rs 999million is satisfactory. Economic parameters at the project evaluation stage are as follows. (HIRP-May 2000)

Scheme	Liyangastota	Muruthawela	Badagiriya
NPV(10%) Rs M	398	616	121
B/C ratio	2.36	2.68	2.48
EIRR	19.03	22.3	24.25

Sensitivity Analysis

The following three cases were assumed to analyze the impact on the profitability indicators for the project resulting from uncertain economic factors.

Case 1 : Total Project cost increases by 10%

Case 2 : Project benefit drops by 10%

Case 3 : Case 1 and 2 occur simultaneously

Results of sensitivity analysis on the basis of the above cases are indicated in the table below:

Scheme	EIRR (%)		
	Case 1	Case 2	Case 3
Liyangastota	17.5	17.36	15.97
Muruthawela	20.48	20.32	18.66
Badagiriya	21.22	21.71	19.65

6.5 ESTIMAED TOTAL COST ESTIMATE

Total estimated cost (revised) is given below (HIRP- May 2000)

Description	Rs Million
1. Physical Rehabilitation	
Liyangastota	297.33
Muruthawela	315.07
Badagiriya	69.60
GST	85.25
2. O&M Capacity Strength	69.32
3. Institutional Development	40.95
4. Engineering Supervision	48.82
5. Training for Officers	23.91
6. Land Acquisition	13.64
7. General Items	220.35
Total	**1184.23**

6.6 ECONOMIC EVALUATION BASED ON RECENT DATA

Project evaluation comprises financial and economic evaluation. The purpose of the former is to assess the profitability of a particular project on its on merit while the latter assess the project in term of its contribution to the national economy.

6.6.1 Method of Project Evaluation

On the basis of benefit and cost comparison for two cases of (i) future without project (FW/O) and (ii) future with project (FW), the profitability of the project is examined in terms of the three criteria of net present value, B/C ratio and economic rate of return (EIRR). Financial evaluation centered on farm management analysis.

Improvements made in economic analysis in comparison to analysis of tank irrigation projects in Sagar District (MP- India) are shown in table below.

Item	Financial Analysis	Economic Analysis
Cost of Input and Out Put	Market prices at farm gate level	Financial prices at farm gate multiplied by conversion factor
Project Status	Compare "Pre- Investment" and "Post investment" condition	Compare "with project" and "without project" condition
Cost of Land	Not a feature in financial analysis	Economic value of land (in rehabilitation project no new lands involve)
Family labour	Not considered	Considered as cost to product
Discount Rate	Market rate of interest	Opportunity cost of capital

6.6.2 Financial and Economic Evaluation

Basic Evaluation Criteria

(i) Interpretation of Future Without Project Case

For the FW/O case, it is assumed that cropped area and unit yield will decrease in future as a result of progressive deterioration of existing facilities and increased discharge conveyance loss along canals. Accordingly, based on discussion with the related agencies, it has assumed that in decrease in cropped area of 5% and unit yield of 10% in the FW/O case would occur after 10 years from start of project construction.(JICA-1996)

(ii) Evaluation Period

The evaluation period for the project is set 25 years considering the utility life of the rehabilitation facilities.

(iii) Benefit and Cost

Under financial evaluation, benefit and cost are expressed in terms of market prices, and as border prices (economic prices) under economic evaluation.

(iv) Input and out put

Financial prices of traded goods (agriculture products, fertilizer, etc.) were based on 2007 domestic market prices, while 2007 international market prices were adopted for economic prices.

(v) Discount Rate

The world Bank's estimated value of 10% for Sri Lanka was applied as the opportunity cost of capital. (JICA-Sept 1996)

(vi) Labour

The nominal mage rate is applied under financial evaluation. Under economic evaluation, the SCF is applied to the opportunity cost of skilled labour and in the case of unskilled labour, the SFC adjusted by a factor of 0.9 (quoted from Word Bank report "NIRP, May 1991") has been applied.

(vii) Standard Conversion Factor

Standard conversion factor of 0.85 is applied for investment cost (JICA- Sept 1996)

6.6.3 Total Project cost

The total project cost comprises the irrigation and drainage system rehabilitation cost, cost for strengthening O&M institutional capacity, cost of strengthening and support to farmer organizations, training cost, and the operational cost.

In calculating project cost, it was found difficult to cost of strengthening O&M institutional capacity, cost of strengthening and support to farmer organizations, training cost and the operational cost in scheme basis. To overcome this problem cost incurred by the project for those items are divided proportionately base on the benefited area. As the salvage value of the project facilities rehabilitated is small, it was not included in the

calculation. Total 6.1 shows the annual budget over the construction period. The outstanding payments to be made are indicated within the bracket.

Table 6.1 Annual Budgets over the Construction Period

Scheme	2000	2001	2002	2003	2004	2005	2006	Total
Liyangstoto	27.11	54.82	63.89	126.47	93.99	93.57	48.94 (30.2)	508.78
Muruthawela	19.30	36.61	47.78	114.22	101.70	107.82	83.85 (48.20)	511.29
Badagiriya	2.67	3.61	2.79	14.45	22.02	4.68	7.93 (6.70)	58.14

6.6.4 Project Benefit

The benefits generated by the project are diverse, however, the quantifiable incremental benefit due to increased cropping area and yield were computed as the benefit under the project.

a. Crop Yield

At the project evaluation stage, it was assumed target crop yield the project to be achieved in 4 year from the 1st year of cultivation possible in the rehabilitated scheme areas. But rehabilitation work was carried out during the off season without interrupting the normal cultivation calendar. Therefore in this study has done based on the maximum yield achieved by year 2005. Present crop yields have been taken from average of crop cut survey results carried out last four seasons by jointly irrigation department and statistic department. Average annual yields are shown in Table 6.2. Average yield in the benefited area at the time of project evaluation has been taken as 3.7 t/ha which is less than the statistic data at the time implementation. Therefore data at the time of implementation are considered as before project yields.

Table 6.2 Annual Average Yields (Base on Crop Cut Survey Results) in t/ha

Scheme	Average Yield According to evaluation report	Target	Before project	Resent crop survey result
Liyangastota	3.7	5.5	4.65	5.1
Muruthawela	3.7	5.5	4.5	4.9
Badagiriya	3.7	5.5	4.3	4.8

b. Cropping Intensity

The present cropping intensities in the benefited areas are determined by averaging the last four seasons cropping intensities and assumed remained this trend during the balance period of project life. Based on the record maintained by irrigation department, present average cropping intensities are shown in table 6.3.

Table6.3 Average Cropping Intensities (%).

Scheme	Before Project	Target	Recent crop survey result
Liyangastota	190%	200%	200%
Muruthawela	131%	157%	146%
Badagiriya	138%	170%	156%

c. O&M Cost

There is considerable savings in operation and maintenance cost as a result of implementation of rehabilitation project. This savings is counted as a benefit of projects. The budget allocation for operation and maintenance work in irrigation project in Sri Lanka is Rs 380 per ha in year 2005. It is assumed that 25% of the O&M cost will save as a result of project benefit for the balance project life.

The benefit from increased production of agriculture product and cropping area are calculated in terms of the net value increase base on comparison of future with project and future without project.

6.7 FARM INCOME

Average cost of production of paddy and average farm income are given in table 6.4 and table 6.5 respectively. In financial Analysis Production cost and production benefits are measured at farm out let. As the characteristic of project benefited areas are almost similar, production cost of the paddy is assumed to be equal.

Table 6.5 Average Farm Income (Rs/ha)

Scheme	**Liyangastota**	**Muruthawela**	**Badagiriya**
Gross Income	84800/-	83104/-	81408/-
Production cost	39920/-	39920/-	39920/-
Farm Income (Rs/ha)	44880/-	43184/-	41488/-

Table 6.4 Average Cost of Paddy Production (Rs/ha)

Item	Material				Machinery				Labour			Total cost /ha
	Unit	Rate	Qty/ha	Cost/ha	Unit	Qty/ha	Rate	Cost/ha	Rate	Qty/ha	Cost/ha	
1. Land Preparation												
Clearing of bunds	Lit	520	3	1560					350	3	1050	2610
Ploughing					Times	2	3075	6150	350	1	350	6500
Reshaping									350	9	3150	3150
2.Crop Establishing												
Seed bed preparation and sawing	Kg	30	110	3300					350	6	2100	5400
3.Fertilizer Application												
V1	Kg	32	63	2016					350	1	350	2366
Urea	Kg	13	149	1937					350	2	700	2637
TDM	Kg	18	44	792					350	1	350	1142
4. Weed Control	Lit	500	4	2000					350	1	350	2350
5. P & D Control	Lit	550	2.5	1375					350	1	350	1725
6. Irrigation									350	20	7000	7000
7.Harvesting									350	23	8050	8050
Threshing					Contract H/C thresher			6000	350	3	1050	7050
8. Transport	Bags	8	100	800	Tractor & trailer			500	350	2	700	2000
Total with family labour				12220				12650	350	73	25550	50420
Total w/o family labour				12220				12650	350	43	15050	39920

6.8 Economic Analysis

In economical analysis, production benefits and cultivation cost are measured at the farm level and accounted economic values by adopting appropriate conversion factors and methodology adapted are given in table 6.5. 10% Discount rate has been taken to calculate net present cost (NPC), net present benefit (NPB), net present value (NPV), and cost benefit ratio (BCR). Based on the conversion factors given in table 6.5, economic values of farm outputs and inputs for Liyangastota, Muruthawela, and Badagiriya schemes are calculated as Tables 6.6 to 6.8. The economic parameters assessed during the project appraisal are shown in table 6.9 to table 6.11.

Economic price of Rice

World market price of rice FOB	US$	= 285
Less quality adjustment 30%	US$	= 85.5
Quality adjusted FOB	US$	= 199.5
International freight and Insurance	US$	= 50
Colombo Harbor CIF	US$	= 249.5
Transport and Handling to Hambantota	US$	= 10
Hambantota CIF	US$	= 259.5
Hambantota CIF	**SLR**	**= 27247**
Fright to and from mill (paddy)	SLR	= 17000
Processing rate		= 0.7
Processing cost	SLR	= 1000
Freight to farm gate	SLR	= 1000
Farm gate price	SLR	= 25571
Conversion factor		**= 1.06**

Economic Price of Fertilizer

Urea

World Market Price FOB	US$	= 273
International freight and insurance	US$	= 50
Colombo CIF	US$	= 323
Freight and Handling to Hambantota	US$	= 10
Hambantota Wholesale CIF price	US$	= 333
Hambantota wholesale CIF price	SLR	= 34965

Transport and Handling to farmgate	SLR	= 350
Farmgate price	**SLR**	**= 35315**
Price of Urea at market	SLR	=20200
Transport and Handling to farmgate	SLR	= 350
Present price of Urea at farmgate	SLR	=20550
Conversion factor	**SLR**	**=1.7**

Conversion Factors:

Description	Financial Value	Economic value	Conversion Factor	Methodology
Labour	400	360	0.9	Agricultural labour index
Paddy	25571	27247	1.06	As per analysis
Fertilizer	20550	35315	1.7	As per analysis
Project Investments			0.85	JICA-September 1996
Farm Equipment			0.9	Assumed, based on transport conversion factor 0.814 feasibility study on Katunayaka –Anuradhapura Road- March 1996
Chemicals			0.8	Assumed

6.8.1 Summary of Economical Parameters as per Recent Data

The economic parameters evaluated based on recent data are summarized in the following table.

Scheme	Liyangastota	Muruthawela	Badagiriya
NPV(10%) Rs Mn	601.6	509.38	75.01
B/C Ratio	2.19	2.03	2.26
EIRR	20.1	19.8	22.04

Note:-year 2005 is taken as the base year

able 6.6 Agricultural Net income Rs/ha for Liyangastota Project.

	Financial Analysis				Economic Analysis			
em	Material	Machinary	Lobour*	Total	Material	Machinary	Lobour*	Total
and Preparation	1560	6150	4550	12260	1248	5535	4095	10878
rop Establishment	3300		2100	5400	3498		1890	5388
ertilizer	4745		1400	6145	8066.5		1260	9326.5
Weed Control	2000		350	2350	1600		315	1915
&D Control	1375		350	1725	1100		315	1415
igation			7000	7000			6300	6300
arvesting & Threshing		6000	9100	15100		5400	8190	13590
ransport	800	500	700	2000	800	450	630	1880
ota Input	13780	12650	25550	51980	16312.5	11385	22995	50692.5
ut Put (kg)B/P	4650	16	1	74400				78864
ut Put(kg) wop	4185	16	1	66960				70977.6
ut Put(kg)actual	5000	16	1	80000				84800

*without family labour

able 6.7 Agricultural Net income Rs/ha for Muruthawela Project.

	Financial Analysis				Economic Analysis			
em	Material	Machinary	Lobour	Total	Material	Machinary	Lobour	Total
and Preparation	1560	6150	4550	12260	1248	5535	4095	10878
rop Establishment	3300		2100	5400	3498		1890	5388
ertilizer	4745		1400	6145	8066.5		1260	9326.5
Weed Control	2000		350	2350	1600		315	1915
&D Control	1375		350	1725	1100		315	1415
igation			7000	7000			6300	6300
arvesting & Threshing		6000	9100	15100		5400	8190	13590
ransport	800	500	700	2000	800	450	630	1880
ota Input	13780	12650	25550	51980	16312.5	11385	22995	50692.5
ut Put (kg)B/P	4500	16	1	72000				76320
ut Put(kg) wop	4050	16	1	64800				68688
ut Put(kg)actual	4900	16	1	78400				83104

* without family labour

able 6.8 Agricultural Net income Rs/ha for Badagiriya Project.

	Financial Analysis				Economic Analysis			
em	Material	Machinary	Lobour	Total	Material	Machinary	Lobour	Total
and Preparation	1560	6150	4550	12260	1248	5535	4095	10878
rop Establishment	3300		2100	5400	3498		1890	5388
ertilizer	4745		1400	6145	8066.5		1260	9326.5
Weed Control	2000		350	2350	1600		315	1915
&D Control	1375		350	1725	1100		315	1415
igation			7000	7000			6300	6300
arvesting & Threshing		6000	9100	15100		5400	8190	13590
ransport	800	500	700	2000	800	450	630	1880
ota Input	13780	12650	25550	51980	16312.5	11385	22995	50692.5
ut Put (kg)B/P	4300	16	1	68800				72928
ut Put(kg) wop	3870	16	1	61920				65635.2
ut Put(kg)actual	4800	16	1	76800				81408

* without family labour

Table 6.9 Economic Analysis of Liyangastota Irrigation Rehabilitation Project

Amount in SL Rupees Millions

no	Year	Cost	Economic value of investment (cf=..85)	Benefit		total benefit	Present worth factor (i=10%)	PWC	PWB	EIRR		
				Net output	O&M savings					1.20101	Pwc	Pwb
5	2000	21.107	17.94			0	1.6105	28.8941	0	2.50	44.83	0.00
4	2001	54.823	46.60			0	1.4641	68.2264	0	2.08	96.95	0.00
3	2002	63.888	54.30			0	1.3310	72.2797	0	1.73	94.08	0.00
2	2003	126.467	107.50			0	1.2100	130.0713	0	1.44	155.06	0.00
1	2004	93.991	79.89			0	1.1000	87.8816	0	1.20	95.95	0.00
0	2005	93.568	79.53	68.38	0.47	68.85	1.0000	79.5328	68.8500	1.00	79.53	68.85
1	2006	48.938	41.60	68.38	0.47	68.85	0.9091	37.8157	62.5909	0.83	34.64	57.33
2	2007			68.38	0.47	68.85	0.8264	0.0000	56.9008	0.69	0.00	47.73
3	2008			68.38	0.47	68.85	0.7513	0.0000	51.7280	0.58	0.00	39.74
4	2009			68.38	0.47	68.85	0.6830	0.0000	47.0255	0.48	0.00	33.09
5	2010			157.22	0.47	157.69	0.6209	0.0000	97.9131	0.40	0.00	63.11
6	2011			157.22	0.47	157.69	0.5645	0.0000	89.0119	0.33	0.00	52.54
7	2012			157.22	0.47	157.69	0.5132	0.0000	80.9199	0.28	0.00	43.75
8	2013			157.22	0.47	157.69	0.4665	0.0000	73.5635	0.23	0.00	36.43
9	2014			157.22	0.47	157.69	0.4241	0.0000	66.8760	0.19	0.00	30.33
10	2015			157.22	0.47	157.69	0.3855	0.0000	60.7963	0.16	0.00	25.25
11	2016			157.22	0.47	157.69	0.3505	0.0000	55.2694	0.13	0.00	21.03
12	2017			157.22	0.47	157.69	0.3186	0.0000	50.2449	0.11	0.00	17.51
13	2018			157.22	0.47	157.69	0.2897	0.0000	45.6772	0.09	0.00	14.58
14	2019			157.22	0.47	157.69	0.2633	0.0000	41.5247	0.08	0.00	12.14
15	2020			157.22	0.47	157.69	0.2394	0.0000	37.7497	0.06	0.00	10.11
16	2021			157.22	0.47	157.69	0.2176	0.0000	34.3179	0.05	0.00	8.42
17	2022			157.22	0.47	157.69	0.1978	0.0000	31.1981	0.04	0.00	7.01
18	2023			157.22	0.47	157.69	0.1799	0.0000	28.3619	0.04	0.00	5.83
19	2024			157.22	0.47	157.69	0.1635	0.0000	25.7836	0.03	0.00	4.86
	Total	502.782	427.36					504.7016	1106.3034		601.04	599.63

Present worth of benefits	1106.30	B/C ratio	2.19
Present worth of cost	504.70	EIRR	20.1
Net present value(10%)	601.60		

Table 6.10 Economic Analysis of Muruthawela Rehabilitation Project

Amount in SL Rupees Millions

no	Year	Cost	Economic value of investment (cf=.85)	Benefit		total benefit	Present worth factor (i=10%)	PWC	PWB	EIRR		
				Net output	O&M savings					1.198	Pwc	Pwb
5	2000	19.301	16.41			0	1.6105	26.4218	0	2.47	40.48	0.00
4	2001	36.614	31.12			0	1.4641	45.5656	0	2.06	64.11	0.00
3	2002	47.785	40.62			0	1.3310	54.0616	0	1.72	69.84	0.00
2	2003	114.222	97.09			0	1.2100	117.4773	0	1.44	139.34	0.00
1	2004	101.698	86.44			0	1.1000	95.0876	0	1.20	103.56	0.00
0	2005	107.815	91.64	70.96	0.52	71.48	1.0000	91.6428	71.4800	1.00	91.64	71.48
1	2006	83.852	71.27	70.96	0.52	71.48	0.9091	64.7947	64.9818	0.83	59.49	59.67
2	2007			70.96	0.52	71.48	0.8264	0.0000	59.0744	0.70	0.00	49.80
3	2008			70.96	0.52	71.48	0.7513	0.0000	53.7040	0.58	0.00	41.57
4	2009			70.96	0.52	71.48	0.6830	0.0000	48.8218	0.49	0.00	34.70
5	2010			135.45	0.52	135.97	0.6209	0.0000	84.4267	0.41	0.00	55.10
6	2011			135.45	0.52	135.97	0.5645	0.0000	76.7515	0.34	0.00	45.99
7	2012			135.45	0.52	135.97	0.5132	0.0000	69.7741	0.28	0.00	38.39
8	2013			135.45	0.52	135.97	0.4665	0.0000	63.4310	0.24	0.00	32.05
9	2014			135.45	0.52	135.97	0.4241	0.0000	57.6646	0.20	0.00	26.75
10	2015			135.45	0.52	135.97	0.3855	0.0000	52.4223	0.16	0.00	22.33
11	2016			135.45	0.52	135.97	0.3505	0.0000	47.6567	0.14	0.00	18.64
12	2017			135.45	0.52	135.97	0.3186	0.0000	43.3242	0.11	0.00	15.56
13	2018			135.45	0.52	135.97	0.2897	0.0000	39.3857	0.10	0.00	12.99
14	2019			135.45	0.52	135.97	0.2633	0.0000	35.8052	0.08	0.00	10.84
15	2020			135.45	0.52	135.97	0.2394	0.0000	32.5501	0.07	0.00	9.05
16	2021			135.45	0.52	135.97	0.2176	0.0000	29.5910	0.06	0.00	7.55
17	2022			135.45	0.52	135.97	0.1978	0.0000	26.9009	0.05	0.00	6.30
18	2023			135.45	0.52	135.97	0.1799	0.0000	24.4554	0.04	0.00	5.26
19	2024			135.45	0.52	135.97	0.1635	0.0000	22.2322	0.03	0.00	4.39
	Total	511.287	434.59					495.0514	1004.4336		568.46	568.43

Present worth of benefits	1004.43	B/C ratio	2.03
Present worth of cost	495.05	EIRR	19.8
Net present value (10%)	509.38		

Table 6.11 Economic Analysis of Badagiriya Tank Irrigation Rehabilitation Project

Amount in SL Rupees Millions

no	Year	Cost	Economic value of investment (cf=.85)	Benefit		total benefit	Present worth factor (i=10%)	PWC	PWB	EIRR		
				Net output	O&M savings					1.2204	Pwc	Pwb
5	2000	2.266	1.93			0	1.6105	3.1020	0	2.71	5.21	0.00
4	2001	3.607	3.07			0	1.4641	4.4889	0	2.22	6.80	0.00
3	2002	2.79	2.37			0	1.3310	3.1565	0	1.82	4.31	0.00
2	2003	14.45	12.28			0	1.2100	14.8618	0	1.49	18.29	0.00
1	2004	22.021	18.72			0	1.1000	20.5896	0	1.22	22.84	0.00
0	2005	4.685	3.98	10.57	0.06	10.63	1.0000	3.9823	10.6310	1.00	3.98	10.63
1	2006	11.925	10.14	10.57	0.06	10.63	0.9091	9.2148	9.6645	0.82	8.31	8.71
2	2007			10.57	0.06	10.63	0.8264	0.0000	8.7860	0.67	0.00	7.14
3	2008			10.57	0.06	10.63	0.7513	0.0000	7.9872	0.55	0.00	5.85
4	2009			10.57	0.06	10.63	0.6830	0.0000	7.2611	0.45	0.00	4.79
5	2010			10.57	0.06	10.63	0.6209	0.0000	6.6010	0.37	0.00	3.93
6	2011			18.19	0.06	18.25	0.5645	0.0000	10.3016	0.30	0.00	5.52
7	2012			18.19	0.06	18.25	0.5132	0.0000	9.3651	0.25	0.00	4.53
8	2013			18.19	0.06	18.25	0.4665	0.0000	8.5138	0.20	0.00	3.71
9	2014			18.19	0.06	18.25	0.4241	0.0000	7.7398	0.17	0.00	3.04
10	2015			18.19	0.06	18.25	0.3855	0.0000	7.0362	0.14	0.00	2.49
11	2016			18.19	0.06	18.25	0.3505	0.0000	6.3965	0.11	0.00	2.04
12	2017			18.19	0.06	18.25	0.3186	0.0000	5.8150	0.09	0.00	1.67
13	2018			18.19	0.06	18.25	0.2897	0.0000	5.2864	0.08	0.00	1.37
14	2019			18.19	0.06	18.25	0.2633	0.0000	4.8058	0.06	0.00	1.12
15	2020			18.19	0.06	18.25	0.2394	0.0000	4.3689	0.05	0.00	0.92
16	2021			18.19	0.06	18.25	0.2176	0.0000	3.9717	0.04	0.00	0.75
17	2022			18.19	0.06	18.25	0.1978	0.0000	3.6107	0.03	0.00	0.62
18	2023			18.19	0.06	18.25	0.1799	0.0000	3.2824	0.03	0.00	0.51
19	2024			18.19	0.06	18.25	0.1635	0.0000	2.9840	0.02	0.00	0.41
	Total	61.744	52.48					59.3958	134.4088		69.75	69.75

Present worth of benefits	134.41	B/C ratio	2.26
Present worth of cost	59.40	EIRR	22.04
Net present value(10%)	75.01		

6.9 Summary

Financial and economic evaluation for with project and without project conditions shows that all the three projects are financially viable and economically feasible. In case of Liyangastota scheme, all the three economic parameters have increased considerably when compare with other two projects.

The original targets stipulated at project formulation stage have not been achieved in the projects. But there is a marginal improvement in both yield and cropping intensity. Cropping intensity and yield have improved as shown in table 6.2 and 6.3. There has been significant increase in price (more than the target) which has resulted in better economic performance.

There have been numerous social and environmental benefits facilities such as good linkage between farms and hamlets by providing bridges across main canals, easy assess to water for bathing by providing bathing steps at suitable locations, good agricultural road network, farmer meeting halls, establishment of farmers' company etc. These will provide a considerable boost to development of the rural economy in the area.

CHAPTER-7

SUMMARY & CONCLUSIONS

SUMMARY:

1. Evaluation as a Management Tool

I. Evaluation is an important management tool, but in order for it to play its role, there needs to be careful consideration of evaluation recommendation as a basis for management decision. While there is formal systematic process in place for integral evaluations that are presented to the responsible authorities, the same rigorous consideration of evaluation recommendations has not systematically taken place. As a result, evaluation has become a formal procedure to fulfill requirements of the funding agency or of the few interested groups.

II. Evaluation is often viewed by project managers as a threat rather than useful tool. In conducting any type of evaluation, areas of potential resistance should be identified ahead of time and try to address them before commencement of evaluation process.

III. There should be formal procedure for acceptance, implementation, and assignment of responsibilities and awareness of learning effects, time frame for the better utilization of evaluation recommendation.

IV. The outcomes of the project evaluation need to be disseminated to all stake holders and outsiders (people representatives, NGO's, donor agencies)

2. Evaluation of Implementation of Sample Irrigation Projects (Sagar District- India)

I. The time overrun is common in irrigation projects. However, it is found to be abnormally high in the sample projects. The percentage time overrun in Mahuakheda, Khairana, Maheri, and Hinauta Kharmau are 207%, 275%, 303% and 224% respectively.

II. Cost overrun is a common phenomenon in irrigation pr
percentage increase in cost overrun in irrigation projects in S
in India is comparatively very high. In case of Hinauta I
Maheri projects, percentage cost overrun are 726% & 690%
which do not appear to be justified only on the basis of increase in price of labour and materials. There appear to be unexplained reasons such as malpractice etc which are beyond scope of this study.

III. Thin spreading of funds over the years results in time overrun and cost over run.

3. Farm Income and Benefit Cost Analysis of Tank Irrigation Projects (India and Sri Lanka)

I. Upper limit of acceptable cost of balance works as per criteria of NABARD is based on Rs.90000/ha of annual irrigation or service area whichever (area) is more in Sagar tank irrigation projecct. A distinction is possible in acceptable cost for head works and canal works. Further, realization of irrigation benefits (by the formers) is possible only if on-farm development works are also financed and implemented by the government or the donor agency.

II. On farm development works (outlets, watercourses, field channels, field drainage, and tail end escape channel) are necessary (i) to achieve equity in water distribution, (ii) to improve project efficiency, (iii) to increase project output and (iv) to minimize risk of waterlogging.

III. There is tendency to shift to labour intensive cash crops in Sagar project area and thereby increase in cropping intensity, direct and indirect benefits have significantly improved. In case of sample projects in Sri Lanka farmers follow traditional paddy cultivation.

IV. None of the irrigation projects have achieved desired crop yields envisaged at the project formulation stage. However, there is a slight improvement in crop yields and this can be due to improvement in irrigation facilities and agricultural technology improvement.

V. There is significant difference in per hectare farm income in both the countries. Per hectare net farm income in Sagar district varies from US$ 475 to US$ 519 while corresponding value pertaining to study area in Sri Lanka varies from US $ 387 to US$ 419. Highest per hectare net farm income is recorded in Mahuakeda project which is US$ 519.

VI. In terms of the economic parameters anticipated at the project appraisal stage and as of now based on the recent data, all the seven sample projects (India and Sri Lanka) are not able to achieve the desired economic targets. But still Hinauta Kharmau, Mahuakheda Liyangastota, Muruthawela, and Badagiriya schemes have become financially and economically feasible while Khairana and Maheri projects have become financially unviable. Hinauta Kharmau and Mahuakheda projects shall also expectedly be financially unviable due to their incomplete nature even after loan invested by NABARD.

VII. Farmers' perception of irrigation projects and irrigation service is not encouraging. They need to be involved in implementation and maintenance of works (particularly water distribution net work).

4. Economics of Conjunctive use and Concrete Lining

I. Concrete lining in entire canal length is infeasible. Limited concrete lining where seepage losses are high and with some management improvements such as rotational water issues can further improve financial parameters.

II. At farm level, Dug well and tube wells have lower capital cost but higher running cost than canal water. Canal schemes are public owned. Capital cost of canal construction and often running cost are met by government and canal water is therefore subsidized. Tube wells are usually privately owned and farmers bear full capital and running cost as well as depreciation and replacement. This disparity makes supplementary tube well irrigation an expensive option. Farmers, who own wells, therefore need consistently higher incomes to justify their investment and stable prices for inputs and outputs

CONCLUSIONS:

1. Several assumptions are involved in economic analysis. Incremental production difference between two large hypothetical future flows (production with project and production without project) that depend on several assumptions that can't be readily validated. If crop prices, incremental yield, irrigation efficiency or cropping patterns are adjusted even modestly, the impact on ERR can be significantly large. Moreover, in physical terms, production almost anywhere could increase substantially.
2. The time overrun and cost overrun have become common phenomena in irrigation projects in countries all over the Asia. Political interference at local level, self interest of the concerned parties, corruption, and lack of accountability appear to be the main reasons for poor performance in irrigation projects. This may lead to some irrigation projects becoming financially non viable and economically non feasible.
3. Strict enforcement of accountability for time and cost overrun is necessary.
4. There are numerous environmental and social benefits & cost associated with irrigation projects. Unfortunately, standard procedures/guidelines are not available to evaluate those benefits. The methodology of integrating the costs and benefits of environmental charges in economic analysis is still evolving. Methodologies available, today, are highly cost and time consuming events.
5. Development history of irrigation projects indicate that in general, there has been shortfall in achieving the design area for irrigation. Observed social phenomenons are mainly responsible for underperformance of the irrigation projects.
6. Feasibility studies often fail to account for water in a basin context. Repeated re-use of water, recharge ground water from canal seepage are the plus points in economic terms to be considered in feasibility studies.
7. Further, the upper limit of acceptable cost for canal work without inclusion of on farm development is unrealistic as achievement of annual irrigation target is physically not possible without implementation of on farm development work.

8. Close monitoring of each project is necessary so that public investm economically and efficiently. Simple and standard yardsticks, proced be evolved for rapid evaluation exercises (computerized) by indepen in collaboration with implementing agencies.
9. There should be a proper mechanism to report the findings of evaluation, acceptance, and remedial action and follow up actions. Recommended procedure for management response and follow up action is given annexure 7.1
10. Realistic cropping pattern and cropping intensity need to be adopted in project design. These have major impact on direct benefits and other financial parameters.
11. Centralized decision making and inadequate delegation of authority to lower level are partly responsible for delay in projects' implementation. Redundant hierarchical levels should be excluded from decision-making process.
12. Heavy investment of canal lining could be avoided if canals are laid and maintained properly free from vegetation by regular maintenance. However, economical saving of surface water losses by concrete lining is recommended for certain percentage of canal length (50%-70%) and this has to be justified by an experienced professionals.
13. Cost of a tubewell unit and its associated structures (pump house, canals) is commonly beyond the means of small farmers. Therefore collective and corporative ownership should be encouraged and supervised by the government to protect interest of small farmers.
14. Inequity, unreliability and untimeliness are the major issues in surface irrigation projects. Conjunctive use of surface and ground water can improve efficiencies in lower reaches by surface water is used to irrigate land close to the canal and ground water to irrigate land which is further away.
15. Irrigation projects in developing countries serve various social aims such as food security, poverty alleviation, employment generation etc. These are also important in evaluation of impact of irrigation project in addition to financial and economic evaluation.

Annexure7.1

Management response and Follow up Reporting on Evaluation

There should be formal procedure for acceptance of evaluation report, implementation, and assignment of responsibilities and awareness of learning effects, time frame for the better utilization of evaluation recommendation. Following formal procedure is recommended for obtaining response of project manager on evaluation study and follow up action.

i. The Management Response

The management response on evaluation results and recommendation plays vital role in project management. There should be proper understanding between evaluation team and management regarding the results and recommendations produced by the evaluation.

In preparing the response, input should be sought from all parties to whom specific evaluation recommendations are addressed. This should be done on a format as given below.

Format for Management Response to Recommendation

Recommendation	Acceptance by Management			Comment on recommendation	Action to be taken		
	Accepted	Partly accepted	rejected		Action	timing	Responsibility
Recommendation1							
Recommendation2							

ii. Follow up Reporting

The purpose of follow up report is to ensure compliance with agreed recommendation and, if necessary, account for any variation between actions decided in the management response and those actually implemented.

The follow up report should follow the format below and may be supplemented with additional text as required.

Format for Reporting on follow up action

Recommendation	Action Agreed	Action taken with dates	Comment / Explanations
Recommendation 1			
Recommendation 2			

iii. Awareness of Learning Effects

The following learning points are recommended so as to minimize the shortfall in planning and implementation of future projects.

a. Evaluation is made available at website
b. Conducting seminar to share the experience and aware the learning effects.
c. Distribution of copies of evaluation findings and the learning effects among interesting parties/ agencies including responsible media and NGOs etc.

REFERENCES

1. Asian Development Bank (ADB), 2002, "Project Performance Audit Report on Raptic Irrigation Project in Napal" Manila. Website: www.adb.org.
2. Asian Development Bank (ADB), 2006, "Rehabilitation and Management of Tanks in India" A Study of select states, Publication Stock No 122605.Manila.
3. Chaube. U.C., 1997, "Economic Analysis, Budget Planning and Project Management", Course Package Centre for Continuing Education ,IIT-Roorkee (Unpublished)
4. Economic and Development Resource Center (EDRC), 1997, "Guidelines for the Economic Analysis of Projects" Website: www.vita.virginia.gov.
5. Food and Agricultural Organization (FAO), 2002, "How Design, Management and Policy Affected the Performance of Irrigation Projects" FAO publication, Bangkok Thailand.
6. Govt. of Sri Lanka (GOSL), 2000, "Hambantota Irrigation Rehabilitation Project", Project Report, Irrigation Department, Govt. of Sri Lanka, Colombo.
7. ICID, 1999, "Guide Line for Rehabilitation and Modernization of Irrigation Projects" International Commission on Irrigation and Drainage.
8. Japan International Cooperation Agency (JICA), 1996, "The Feasibility Study on the Rehabilitation of Irrigation and Drainage System in the River Basins of Southern- Sri Lanka", Feasibility Report, Tokyo, Japan.
9. Japan International Cooperation Agency (JICA), 2004, " Guideline for Project Evaluation" Practical methods for project evaluation, Office of Evaluation, Planning, and Coordination Department, Japan International Corporation Agency, Tokyo, Japan
10. Japan International Cooperation Agency (JICA), 2006, "Integrated Management in Irrigation Sector in Sri Lanka", Feasibility Report, Tokyo, Japan.
11. Jeremy.B., 2002, " Economic Evaluation: Why is it so often unsatisfactory" with reference to the irrigation projects, ICEA meeting.

12. Khan.S.U., 1993, "Implementation of Conjunctive use of Management Plan- A Case Study", M.Tech Dissertation, Department of Water Resources Development and Management, IIT-Roorkee.
13. Krzyszt. J., 2002, "Internal Project Monitoring and Evaluation System and Development of Evaluation Capacity" a paper on experience of the word bank funded Rural Development Project.
14. Mousa. A. K.F., 1995, "Conjunctive use Management of Surface and Ground Water" Ph.D. Thesis, Water Resources Development and Management, IIT-Roorkee.
15. NABARD, 2006, Project Report "Evaluation Study of Rural Infrastructure Irrigation Project" in Sagar District (M.P), Prepared by Department of Water Resources Development and Management, IIT- Roorkee for National Bank of Agricultural and Rural Development Mumbai.
16. Overseas Development Institute (ODI), 1991, "Conjunctive Water Use for Irrigation: Good Theory, Poor Practice", Network Paper 12, Regent's Park, London, England.
17. Overseas Development Institute (ODI), 1992, " The equity Impact of Deep Tubewells- Evidence from the IDA Deep Tubewell II Project", Network Paper 12, Regent's Park, London, England.
18. Singh. R.P., 2006," Modernization and Rehabilitation of Water Courses and Field Canals" Professor, Technical Paper, Department of Water Resources Development and Management, IIT- Roorkee.
19. Suryannarayana.T.M.V., 2006, "Determination of Optimal Cropping Pattern and Release Policy for Conjunctive use of Surface and Ground Water" , Ph. D. Thesis, Case Study of Kakrapur LBMC Command Area.
20. USAID- New Delhi, 1982, "Maharashtra Irrigation Technology and Management VOL- I & VOL-II" Project Paper, Agency for International Development, Washington, D.C. 20523.
21. Varshney.R.S, 1992, "Theory & Design of Irrigation Structures Vol: I Channel and Tubewells" a book.

22. Vijayamohanan. N., 2001, "Time and Cost Overrun of Power project in Kerala" Working paper No 320, Center for Development Studies – Thiruvananthapuram-India.
23. Word Bank (WB), 1983, "Second Uttar Pradesh Public Tubewells Project" Staff Appraisal Report, Report No 4167- IN. South Asia Projects Department, Irrigation II Division.