

**ECONOMIC EVALUATION OF THE
LIFT IRRIGATION SCHEMES
IN MAHARASHTRA**

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CHAPTER I

INTRODUCTION

1.1 Importance of the Study

Irrigation has a very important role to play in the development of Indian agriculture. Intensive agriculture based on improved seeds and high levels of fertiliser application, which goes under the current strategy of 'Green Revolution', requires an assured supply of irrigation as a necessary precondition. However, about 75 per cent of India's cropped area depends exclusively upon rainfall, which is concentrated in a few months in the year, and moreover, about 70 per cent of the cropped area receives inadequate or uncertain rain even during the main crop season to allow intensive cultivation. Irrigation is, therefore, an important pre-requisite for the spread and success of the green revolution - a symbol of agricultural development.

The Fifth Five Year Plan estimated that out of the total cultivable area of 175 million hectares in the country, ultimately about 107 million hectares, that is, only 61 per cent of the total cultivable area of the country can be irrigated by all the sources of irrigation.¹

¹Government of India, Planning Commission, Draft Fifth Five Year Plan, 1974-79, Part II, New Delhi, 1973, p. 105.

Thus, it is apparent that irrigation is both a very important and scarce resource in India and its allocation as between uses and users will have significant welfare effects. For this reason irrigation projects are regarded as monuments to the country's economic development, and there is constant pressure on the administration to give high priority to them in the plans.

When the era of planning began in 1950-51, the total irrigation potential already developed was around 22.6 million hectares.² Thereafter, additional irrigation potential of 30.9 million hectares has been developed by 1977-78,³ leaving a balance of 53.5 million hectares (50 per cent) to be developed in the future plan periods.

To create the balance of the irrigation facility in future, one may conceive of a number of alternative irrigation projects which promise to serve the same specific objective, i.e., increased agricultural production, and compete with each other for being selected. A faulty selection of the project will entail enormous loss to the economy where capital is a scarce factor. Though there are often admittedly important social and political factors involved in taking decision on an irrigation

²Ibid.

³Ibid.; and also see Government of India, Planning Commission, Draft Five Year Plan, 1976-81, New Delhi, 1976, pp. 135 and 137.

project, the economic criteria remain equally important.

For any irrigation project, the ultimate interest is with the productivity or total return to the society of all the resources devoted to it. This is a measure of the social benefit of the project. On the other hand, every one of the individual entities which participate in a project--farmers, organisations, co-operatives or whosoever--is concerned with the return to the resources it contributes. This is the financial return of the project.

Policy makers must be interested in knowing which among the alternative projects generate high social benefits, while participants are concerned about the return to the resources they contribute to the project. This is true whether the resources committed are being invested by the Government directly or by individuals within the economy. The project analysis techniques help in identifying the projects which render maximum return to the growth of the economy as well as to capital contributed by the participants. Of course, "any national investment decision must be a political act summing up the best judgement of those responsible. The function of project analysis is not to replace this judgement; rather it is to provide one more tool (a very effective one, we hope) by which judgement can be sharpened and the likelihood of error narrowed."⁴

⁴ J. Price Gittinger, Economic Analysis of Agricultural Projects, The John-Hopkins University Press, Baltimore, 1972, p. 3.

In a country like India where water as well as capital resources are extremely scarce, the importance of economic evaluation of irrigation projects can hardly be over-emphasised.

1.2 The Problem

The problem dealt with in this study has two facets. The first deals with the development and application of a proper criterion for the study of social benefit-cost and the financial profitability of irrigation projects.

The criterion for the economic evaluation and choice of irrigation projects for investment by the Government underwent basic change in 1964. For almost a century prior to 1964, the traditional method of choice of public investment in irrigation projects in India was the possibility of a specified rate of return on capital invested.⁵ However, dissatisfaction with this criterion of selection had been frequently voiced in the past mainly on the ground that many indirect benefits to the country and the Government were unaccounted on the credit side making it too rigorous a test.⁶ A new alternative approach to the

⁵National Council of Applied Economic Research, Criteria for Fixation of Water Rates and Selection of Irrigation Projects, New Delhi, 1959, p. 9.

⁶Government of India, Ministry of Irrigation and Power, Report of the Irrigation Commission 1972, Vol. I, New Delhi, 1972, p. 280.

economics of irrigation began with Gadgil's study on the economic benefits of the Godavari and Pravara Canal in the early 1940s.⁷ The first systematic attempt at spelling out social benefit-cost measure of a proposed irrigation project was the Hirakud study.⁸ This was followed by a series of five studies sponsored by the Research Programmes Committee of the Planning Commission. The results of these were summed up by the Committee of Direction of the R.P.C. which recommended the benefit-cost ratio criterion and the detailed method for this,⁹ which was subsequently officially accepted and adopted, and the financial productivity criterion of the past was finally abandoned. Besides these, a large number of studies have been made on this aspect by individual scholars, financial institutions and Government Departments, not all of which are published.

The recent discussions on this aspect and a review of this literature, which we undertake in Chapter II,

⁷ D.R. Gadgil, Economic Effects of Irrigation, Gokhale Institute of Politics and Economics, Poona, 1948.

⁸ N.V. Sovani, and N. Rath, Economics of a Multiple-Purpose River Dam, Gokhale Institute of Politics and Economics, Poona, 1960.

⁹ Research Programmes Committee, Planning Commission, Government of India, Criteria for Appraising the Feasibility of Irrigation Projects, New Delhi, 1965, p. 68.

bring out two important points: (1) The method of estimating the social benefits and costs, and consequently the procedure for calculating the benefit-cost ratios of the irrigation projects adopted in India, reveal certain inconsistencies and errors. (2) Moreover, the exclusive concern with social benefit-cost calculus has resulted in attention not being paid to the possibility of financial returns to the investment in the projects, the possibility of different types of farmers finding it possible to use water profitably, and their ability to bear the cost of irrigation. This has been noted and emphasized by the financial institutions which finance private (including co-operative) investment in irrigation, but it has been completely neglected in public irrigation projects.

In the present context, therefore, it should be of some general interest to review the current method of economic evaluation of irrigation projects in India and suggest improvements in the methodological framework adopted in estimating the benefit-cost ratios and financial profitability of proposed irrigation projects.

The second aspect of the study relates to the problems faced in the formulation and implementation of lift irrigation projects in the dry agricultural regions of Maharashtra, projects which we propose to study to apply the proper project evaluation techniques.

Maharashtra is one of the states with a preponderantly

dry agricultural region, and with less irrigation potentiality than any other state. The Irrigation Commission (1972) pointed out that water resources over a large part of the State were extremely limited compared to the needs of irrigation and that it would be possible to bring under irrigation only 30 per cent of the net cultivated area after tapping all the surface as well as underground water resources,¹⁰ of which about 87 per cent is exclusively from surface irrigation. In view of these limitations it would be necessary to utilise all the surface water resources by installing lift irrigation schemes on rivers, rivulets, etc.¹¹ In trying to make best use of the available sources of water at the quickest possible time, great emphasis has been put on lifting water from rivers and streams with the help of pumps to irrigate neighbouring lands. Large amount of public and private funds are currently tied up in such projects. The Land Development Bank, Agricultural Refinance Corporation, Commercial Banks, etc., are playing an important role in advancing funds to the lift irrigation schemes.

It is, however, felt that the execution and working

¹⁰Government of India, Ministry of Irrigation and Power, Report of the Irrigation Commission 1972, Vol. II, New Delhi, 1972, p. 232.

¹¹Government of Maharashtra, Report of the Maharashtra State Irrigation Commission, 1962, pp. 40-41.

of these projects have in many instances turned out to be highly unsatisfactory. Many schemes have remained incomplete inspite of the receipt of the necessary finance; in other instances, the full capacity of schemes which have been completed and are in operation have not been utilised. Some schemes have been locked up after the physical plants have been put up, while some others have been taken over by the State. Nevertheless, the suitability of lift irrigation projects in general for increasing agricultural production in the State cannot be questioned. The losses involved in such projects make the financing institutions and the State Government hesitate to promote these in still larger numbers. Under the circumstances, it is necessary to examine the possible economics of a few such schemes to highlight the problems faced by them.

1.3 The Objectives

To be precise, the major objectives of the thesis are two-fold: Firstly, to estimate social benefit-cost and the financial profitability of the lift irrigation schemes by improving upon the methodology followed by most of the studies in India so far, and secondly, to study the problems faced in the formulation and implementation of the lift irrigation schemes in Maharashtra State. The following will be particularly taken care of:

- (a) To review the present method of economic evaluation of irrigation projects in India

and formulate a proper procedure to be adopted in this study.

- (b) To assess the social benefit-cost and the financial profitability of the lift irrigation schemes, and
- (c) to highlight the problems faced in execution of the lift irrigation schemes.

1.4 The Plan of Work

This study includes in all ten chapters. The second chapter is devoted to reviewing the current official method of economic evaluation of irrigation projects in India and simultaneously adopt a proper methodological framework for the procedure followed in this study. In the third chapter, we discuss the design of the survey, selection of the lift irrigation schemes and the beneficiaries and the collection of the farm data. In Chapter four, we present important aspects of the economy of the sample farms as revealed by the survey for the selected lift irrigation schemes. In Chapter five, we estimate the financial profitability of the lift irrigation schemes. An attempt is made in Chapter six to assess the designed repayment pattern of the loans of the schemes. In Chapter seven, we estimate the social returns and costs of the schemes and consequently calculate the respective benefit-cost ratios. In Chapter eight, we

examine the question whether the water used by the lift irrigation projects as designed is the best use of the water for irrigation from the social point of view.

In Chapter nine, we highlight the problems associated in the formulation and implementation of the lift irrigation schemes. The tenth is the concluding chapter.

CHAPTER II

A REVIEW OF ECONOMIC EVALUATION OF IRRIGATION PROJECTS IN INDIA, AND METHODOLOGY OF THE STUDY

In this chapter it is proposed to review the current official method of economic evaluation of irrigation projects in India and examine possible improvements in the methodological framework for the purpose of this study. After giving a brief history of the criteria used in selecting the irrigation projects and an account of some of the important studies in the economics of irrigation projects in the country, we discuss the various methodological problems relating to project analysis, estimation of costs and benefits of irrigation, the rate of discounting, choice of an appropriate benefit-cost ratio. The approach to formulating the schedule of repayment of loan and estimating the repayment capacity of the farmers are also discussed in this chapter.

2.1 History of the Criteria and Some Important Studies

There has to be some criterion for selecting an irrigation project to be undertaken by the State. Prior to 1854, there was no such criterion in India. It was only since 1854, when separate accounts were kept for various irrigation works, did it become possible for the

Government to evolve a criterion for investment in irrigation.¹

It is recorded that after much thought and discussion the question was settled by the Select Committee of the House of Commons in 1879, which stated: "The financial results of works of irrigation are, in the opinion of the Committee, the best test of their utility."² Thereafter, until 1964, the financial productivity test was rigidly applied in the country for the selection of irrigation projects undertaken by the Government. The test was, the Government's anticipated revenue from sale of water should show a positive rate of return on the sum - at-charge (i.e., capital cost plus accumulated interest, if any) after meeting the maintenance and interest charges from the tenth year after its opening.³ During this period, between 1879 and 1964, only the mandatory rate of return, i.e., rate of interest, was changed from time to time. It was fixed at 4 per cent for works sanctioned before 1919, 5 per cent for works sanctioned between 1919 and 1921; and 6 per cent for all works sanctioned after 1921. It was then lowered from 6 per cent to 3.75 per cent in 1949 to make it possible

¹National Council of Applied Economic Research, Criteria for Fixation of Water Rates and Selection of Irrigation Projects, New Delhi, 1959, p. 9.

²Ibid.

³Ibid., p. 10.

for many irrigation projects to be included in the development plans.⁴

However, some engineers and administrators were not happy with this criterion mainly on the ground that a large amount of indirect benefits to the society was unaccounted on the income side.⁵ As a result of this, the Central Board of Irrigation passed a resolution at its Seventh Annual Meeting in 1939, stating that, "as the expansion of irrigation is seriously handicapped by the restricted view taken of the value of irrigation, an economic survey should be carried out with a view to estimating the direct and indirect financial benefits accruing to the Central and Local Governments from Irrigation Projects."⁶ After this, a new approach towards the economics of irrigation began with the exercise on the economic benefits of the Godavari and Pravara Canal in Bombay Deccan in early 1940s.⁷ In the post-war period the move to change the criterion gathered momentum, not only

⁴Ibid.

⁵Government of India, Ministry of Irrigation and Power, Report of the Irrigation Commission 1972, Vol. I, New Delhi, 1972, p. 250.

⁶Criteria for Fixation of Water Rates and Selection of Irrigation Projects, op. cit., p. 12.

⁷D.R.Gadgil, Economic Effects of Irrigation, Gokhale Institute of Politics and Economics, Poona, 1948.

in India but also, in foreign countries like the U.S.A., Ceylon, Taiwan, etc.⁸ The study conducted by the National Council of Applied Economic Research in 1959 suggested that "the appropriate criteria for economic appraisal should be the probable contribution to the national income, in terms of social benefits and social costs."⁹ The Water and Power Commission initiated such a study for the Hirakud Dam Project on the Mahanadi:¹⁰ the first systematic study in spelling out the social benefit-cost measure of a proposed irrigation project. Following this study the Planning Commission's Research Programmes Committee (R.P.C.) initiated studies of five major irrigation projects under a Committee of Direction.¹¹ The aim of these studies was to assess the overall benefits and to find out a better criterion for deciding whether various irrigation projects ought to be undertaken. This Committee in its final report recommended the benefit-cost ratio as the criterion for selection of the irrigation

⁸Criteria for Fixation of Water Rates and Selection of Irrigation Projects, op. cit., p. 12.

⁹Ibid., Preface, p. vii.

¹⁰N.V.Sovani and N. Rath, Economics of a Multiple-Purpose River Dam, Gokhale Institute of Politics and Economics, Poona, 1960.

¹¹Research Programmes Committee of the Planning Commission set up in 1959 had initiated studies of five major irrigation projects, viz. Sarada Canal, Gang Canal, Tribeni Canal, Damodar Canal and Cauvery Mettur Project.

projects and detailed method for this.¹²

The criterion for the choice of irrigation projects for investment in the country underwent basic changes in 1964 when the Committee to Suggest Ways and Means of Improving Financial Returns from Irrigation Projects set up by the Government of India, recommended the benefit-cost ratio as the criterion for selection of irrigation projects.¹³ Further, the Irrigation Commission in 1972 approved of the decision to adopt this approach, which is now the criterion for selection of irrigation projects in the country.¹⁴ The Irrigation Commission after approving the benefit-cost ratio as the criterion for selecting irrigation projects goes on to add: "The application of the benefit-cost criterion in recent years has, however, had certain undesirable effects. It minimises the importance of securing an adequate return from investments on irrigation projects. We feel that this trend must be checked. We recommended, therefore, that at the time of

¹²Research Programmes Committee, Planning Commission, Government of India, Criteria for Appraising the Feasibility of Irrigation Projects, New Delhi, 1965.

¹³Government of India, Ministry of Irrigation and Power, Report of Committee to Suggest Ways and Means of Improving Financial Returns from Irrigation Projects, Parts I and II, New Delhi, 1964.

¹⁴Report of the Irrigation Commission, 1972, Vol. I, op. cit., p. 252.

considering a project for acceptance, the financial returns of the projects should also be carefully examined."¹⁵ This raises the problem of the relationship between the criterion of financial analysis and that of the benefit-cost ratio. This problem is discussed at length in N. Rath's paper presented in a Seminar on the Role of Irrigation in the Development of India's Agriculture at Bangalore in 1974.¹⁶

The Irrigation Commission, after a review of the various past studies, has also broadly laid down the items to be included in the benefits and costs of an irrigation project and the method by which the benefit-cost ratio is to be calculated.¹⁷ Besides the studies mentioned above, a large number of other studies has been made on this aspect. A review of these studies points out that not only have these studies been exclusively concerned with the calculation of social benefits and costs without any attention to financial profitability of the projects, but

¹⁵ Ibid., p. 253.

¹⁶ N. Rath, "The Current Method of Choosing Irrigation Projects in India: A Review", Role of Irrigation in the Development of India's Agriculture, The Indian Society of Agricultural Economics, Bombay, and the Institute for Social and Economic Change, Bangalore, Seminar Series XIII, 1976, pp. 124-126.

¹⁷ Report of the Irrigation Commission, 1972, Vol. I, op. cit., p. 256.

also the procedure of estimating the benefit-cost ratio has not been properly followed in these past studies in the country.¹⁸ /

2.2 Points of View in Project Analysis

In a project analysis, distinction has to be drawn between two complementary points of view: the social or economic returns and the financial returns. Benefit-cost ratio is used most commonly as a measure of social returns and helps in identifying the irrigation project which renders maximum contribution to the society. / On the other hand, financial analysis (which is also called the financial profitability calculus) is used to assess whether the project would be financially worthwhile, for the project authorities as well as to the farmers who participate in the project. / Mere calculation of the benefit-cost ratio neglects the financial aspect of the project. A project justified on social benefit-cost considerations, therefore, may not necessarily be financially worthwhile / and may not provide enough incentives to the farmers to participate in the project. It is, therefore, necessary to discuss the costs and benefits that enter into social

¹⁸N. Rath, op. cit., pp. 116-126, and also see his "Benefit-Cost Analysis of Agricultural Projects", Indian Journal of Agricultural Economics, Jan.-Mar., 1974, Vol. XXIX, No. 1, pp. 22-25.

benefit-cost analysis and into financial analysis of irrigation projects. The methodology of comparing costs and benefits discussed here is the same whether we are seeking the economic or financial returns. The difference lies essentially in what is defined as a cost and what is considered as a benefit.

An important point to remember is that in the case of irrigation projects most of the time one is not starting from nothing. Without irrigation there was some income from the same land. Therefore, to estimate the benefits of irrigation, one has to deduct the net income without irrigation from the net income with irrigation. This with-without estimation is important in agricultural projects, unlike in industrial projects. This is of course common to both financial and economic analysis.

2.3 Costs of Irrigation

The total costs of an irrigation project are divided into two groups: (a) the project costs, and (b) the associated costs. Project costs are "the sum of installation costs; operation, maintenance, and replacement costs;..."¹⁹ For instance, the irrigation work itself. Costs of cultivation under irrigated condition are often

¹⁹J. Price Gittinger, Economic Analysis of Agricultural Projects, The John Hopkins University Press, Baltimore, 1972, p. 64.

referred to as the associated costs of an irrigation project, and are "the value of goods and services over and above those included in project costs needed to make the immediate products or services of the project available for use or sale."²⁰ For instance, seed, fertiliser, and manure, labour, fodder, etc., are part of associated costs of the project.

The difference between the social benefit-cost and financial analysis lies in valuing inputs and outputs. In financial analysis, it is at prices as paid by the project authorities as well as farmers. In social benefit-cost analysis, these are at social opportunity cost. This implies that firstly taxes on commodities (whether inputs or outputs) are to be excluded from and subsidies are to be included into the prices. For, they are mere transfer payments. Secondly, the market prices, net of taxes/subsidies may not always indicate social opportunity cost. The Little-Mirrlees Valuation Method,²¹ followed by Deepak Lal,²² essentially prices everything which is importable

²⁰Ibid.

²¹I.M.D. Little and J.A. Mirrlees, Manual of Industrial Project Analysis in Developing Countries, Vol. II, Social Cost-Benefit Analysis, OECD, Paris, 1969.

²²Deepak Lal, Wells and Welfare, Development Centre of the Organisation for Economic Co-operation and Development, Paris, 1972.

at international prices to reflect its true social value. Mishan²³ takes this approach to task and points out that it runs counter to the principle of opportunity costing. He presents several examples, under various institutional set-ups, and in each case shows that the proper social value is domestic value (with due allowances for all the relevant distortions) of the resources given up (gained) in order to increase imports (exports). After all, if Government for reasons of security or self sufficiency in food wants a crop to be produced domestically rather than to import it, the estimated import price (or foreign exchange price) is irrelevant.

2.3.1 Project Costs

These costs include capital, maintenance and operation costs of the project. Unlike the stream of benefits received and associated costs and also the operation and maintenance costs incurred over the life period of the project, the capital costs of the project are incurred in a few years in the beginning. These costs include not only the costs of material and labour used to put up the project, but also the cost of preparatory surveys and investigations. These latter items are sometimes not

²³E.J.Mishan, "Cost-Benefit Rules for Poorer Countries", Benefit-Cost Analysis 1971, An Aldine Annual, ALDINE-ATHERTON Chicago, New York, 1972, p. 15.

included in capital costs of the project. In regard to labour cost in total project costs, it is necessary to estimate the social opportunity cost of the labour used for constructing the project. For economic analysis of the project, the social opportunity cost of skilled workers like machine drivers, engineers, supervisors, etc., used in project construction may reasonably be considered to be equal to their prevailing market wages or salaries. The same procedure of valuation may be adopted for other categories of labour as well. However, the problem of pricing unskilled human labour will be taken up in the subsequent discussions.

Electric power is one of the major items of the operation costs where water is lifted for irrigation with the help of electric motors. The actual cost of electricity to the society is an important cost to be taken into account while estimating the benefit-cost ratio. It is mentioned in the Report of Study Group IV, Power Economy Committee that the prevailing rates of power supply (1972-73) in most of the states, except Maharashtra, appear to be lower than their actual costs.²⁴ For, the rates in most of the states have not been fixed on economic consi-

²⁴Government of India, Ministry of Irrigation and Power, Power Economy Committee, Report of Study Group IV, New Delhi, 1974, p. 38.

deration but as a result of various other factors such as state policies and historical background. It is also mentioned in the report that the average actual cost of power delivered to the agricultural sector in Maharashtra worked out to about 18 paise per KWh. That was equal to the prevailing power supply rate charged by the Maharashtra State Electricity Board in 1972-73 (excluding electricity duties) and hence in social benefit-cost calculus 18 paise per KWh may be considered as the social cost of electricity. In financial analysis, the cost of electricity to the farmers and their society, would include electricity duty as well. Electricity duty was one paisa per KWh in 1972-73. Therefore, in financial profitability calculus in this study, the cost of electricity to the farmers is taken as 19 paise per KWh.

Replacement cost is the cost of replacing a durable capital equipment during the life of a project if that equipment's life is shorter than that of most other items. For example, in a lift irrigation scheme the pipeline for distributing water is expected to last about 30 years, but the electric pumpset has a life of only ten years. In this study we have therefore considered the replacement cost of the pumpsets which will take place twice within 30 years. (Life period of a lift irrigation scheme may be considered to be equal to the life period of its rising main, i.e., the pipeline).

At the end of the life of a project there may be some salvage value of some of the equipments. The way to cope with this is to treat the salvage value of any capital item as a benefit received by the project during the last year of the project analysis. In this study, we have neglected the salvage value of any equipment as the present value of the salvage value at the discount rates considered in the analysis over a period of 30 years will be insignificant.

Apart from all these project costs, there is one more item of expenditure, that is, expenditure on land levelling. It is a capital cost incurred by the farmers or Government in levelling and making the land suitable for irrigated farming. The Committee of Direction set up by the R.P.C. had suggested that this capital cost should be treated as a part of the project costs, but with a life period of only ten years.²⁵ The Irrigation Commission suggested that this cost should be treated as an associated cost and only an interest on this should be charged for the entire duration of the life of the project.²⁶ Calculating interest on this capital cost for the entire

²⁵Criteria for Appraising the Feasibility of Irrigation Projects, op. cit., p. 64.

²⁶Report of the Irrigation Commission 1972, Vol. I, op. cit., p. 255.

life period of the project appears more reasonable since such land development will last indefinitely into future. But treating this cost as an associated cost is not proper, since it is essentially in the nature of capital cost. Of course, inclusion of this cost into associated costs or project costs would make no difference to benefit-cost ratio, if the costs in the denominator include all costs. Otherwise, it would affect the ratio. For the purpose of uniformity in the procedure, it would be better to include this cost in the project costs.

2.3.2. Associated Costs

In economic analysis, associated costs like seeds, manure and fertilizers, insecticides, fodder, repair charges on implements as well as depreciation on livestock, machinery and implements are actual costs of consumption of goods and services of the society. Moreover, their opportunity cost is considered to be equal to their market prices. However, this may not be true in case of the materials where there is an element of tax or subsidy in their prices. For this purpose one has to add subsidy into and deduct taxes from the market prices of the inputs to reflect the actual social cost of the materials.

In financial analysis, all these items of expenditure are valued at their market prices, and therefore, such adjustments are unnecessary; taxes are treated simply as a cost and subsidy as a return. In economic analysis,

the items like land revenue, local funds, educational cess, etc., are simply the different types of tax, and therefore are not included as cost, while in financial analysis, all these taxes are included as cost.

Rent on land is essentially its opportunity cost. Using the net value of production foregone is the best measure of such cost for land to be irrigated. Since it is already being estimated in the net value of the produce, to deduct rent again would amount to double counting. The matter is further complicated in some of the past studies by estimating rent under irrigation condition as a proportion of gross produce, which is not the opportunity cost of the land used for irrigated farming. Therefore, it is best to ignore rent as a separate cost in economic analysis. This is also true for financial calculus, except that if rent is actually paid by the tenant cultivator to the land owner then the amount of rent paid outside the farm is the cost.

The maximum variability in all the past benefit-cost studies has been observed in pricing human labour. There has been a continuous discussion about the nature of opportunity cost of agricultural labour in the country. Suggestions have ranged between a zero shadow price of labour at one extreme and prevailing market wage rate at the other. Intermediate positions have also been suggested by taking the existing market wage rate at the time of

peak employment period and zero wage rate at other times. The Irrigation Commission and most of the studies considered the social opportunity cost of hired labour equal to its prevailing market wage rate, while that of farm family labour equal to zero.²⁷ This is inconsistent treatment of hired and farm family labour. It is important to remember that the labour, hired or of farm family, should be priced at equal wage rates to represent their real cost to the society.

For calculation of financial profitability, it is appropriate to value hired labour at the going wage rate. The same wage rate may also be imputed to family labour employed on the family farm [A preferable basis of imputation would be the daily wage rate of the annual farm servants. However, since such farm servants are rare in these villages, we have used the daily wage rate of farm servants for imputation]. For calculation of social cost and benefit, however, it is necessary to estimate the social opportunity cost of farm labour. The opportunity cost of labour may be viewed as its 'reservation price', that is the average daily cost of living of the worker in his family.²⁸ The worker would not be willing to go out

²⁷ Ibid., p. 256.

²⁸ Arnold C. Harberger, "On Measuring the Social Opportunity Cost of Labour", Benefit-Cost Analysis 1971, An Aldine Annual, ALDINE-ATHERTON, Chicago, New York, 1972, p. 88.

to work at a wage less than this. This would imply different reservation price for different groups of labour or even individuals. However, for purposes of imputation it would be necessary to have a single wage rate for unskilled farm labour. Under Indian conditions the cost of subsistence, that is, the cost of getting food that provides the required calories plus the other necessities, like clothing, etc., may be considered as the proper retention price of farm labour. In the essay "Poverty in India", this level of expenditure was used to demarcate the poor from the rest of the population. It is interesting to see that according to this study, the average daily wage of the agricultural labour in India turned out to be the wage that enables the rural households to get just the subsistence living.²⁹ Therefore, we may consider the prevailing wage rate in rural areas as the wage rate that is approximating the retention price of rural labour. Of course, there are a few states, like the Punjab and Haryana in which the prevailing wage rate is higher than the cost of subsistence. But the area under study is not one such. Similarly, it is well known that the average per capita expenditure of the bulk of rural landless labour is below this subsistence level. But that is because at the going wage rate they do not get employment

²⁹ V.M. Dandekar and N. Kath, Poverty in India, Indian School of Political Economy, Poona, 1971, p. 125.

for the whole year. Giving the pattern of rural employment, therefore, the prevailing wage rate reflects the sub-subsistence cost of living of these classes of workers as well. We therefore have used the prevailing wage rate of casual farm labour as an approximation of its social opportunity cost. Finally, if this turns out to be higher, than the proper opportunity cost, this would only mean that the estimated social benefit-cost ratio of the irrigation projects would be somewhat underestimated. We shall keep this in mind in interpreting our results.

There is one more point to be cleared relates to the water charges in the irrigation projects. Water charges are payments towards the project costs, and hence to avoid double counting in estimating whether the returns can cover the costs of irrigation and more, water charges are not added to the total costs of the project in the analysis. It may incidentally be useful to remember that if one is interested in the projects from the view point of the organisations and co-operative societies (for instance, in the case of co-operative lift irrigation schemes) which are legally and financially empowered to contract loans and obliged to serve their beneficiaries from the income they derive from the sale of water, for them water charges are the receipts towards the project costs.

2.4 Benefits of Irrigation

In social cost-benefit analysis, benefits arising from the capital work, say, an irrigation project, are usually classified into primary, secondary, etc. The classification rests mainly on the chronological sequence in which the benefits arise and the closeness of their connection with the investment whose effects are being studied. Primary benefits, i.e., net increase in farm income due to irrigation, are estimated to reflect the impact of the project on the agricultural economy while secondary benefits are designed to reflect the impact of the project on the rest of the economy. Therefore, it is argued that both the benefits should be taken into account in assessing the effects of irrigation on the national economy as a whole. While pointing out this, it is mentioned in the R.P.C.'s report that unlike the former, the latter benefits are extremely difficult to estimate.³⁰

But the inclusion of these 'secondary' benefits, or what have been categorised as 'stemming' and 'induced' benefits, in the total social benefits of an investment project appears to be based on a misunderstanding. The 'stemming' benefits measure the profits expected to accrue to "all other enterprises between the farmers and the final

³⁰ Criteria for Appraising the Feasibility of Irrigation Projects, op. cit., p. 37.

consumers, from handling, processing and marketing...", while the 'induced' benefits represent "the profits of all enterprises from supplying goods and services for increase in farm purchases for family living and production expenses."³¹ In other words, it is the profit earned on the purchases made by the project, as well as on sale of the ^{project's} output. Now, since these benefits are derived from the primary benefits and the market demand for agricultural produce, say wheat, is a derived demand, it reflects the value of stemming and induced benefits (or for that matter costs) of the project. Therefore, there is no need for making separate allowance for such benefits as they are automatically taken care of in the value of outputs.

To sum up, we quote Prest and Turvey, "... therefore, that if the conditions for optimal resource allocation are fulfilled in the rest of the economy the estimate of benefits obtained by using the price of wheat and the price of farmers' inputs constitutes an adequate measure. Putting the matter the other way round, we need worry about secondary benefits (or for that matter, costs) only to the extent that market prices fail to reflect marginal

³¹ Otto Eckstein, The Economics of Project Evaluation, Water Research Development, Harvard University Press, Cambridge, Massachusetts, 1958, p. 204.

social costs and benefits."³²

However, there is another set of benefits which may be considered as secondary benefits and would logically have a place in the calculation of the total benefits of the project. There are benefits like overcoming the uncertainties and low incomes arising out of droughts, or the change in income distribution of the people in the affected area. There are no two views on their importance. But these are secondary benefits from the regional and not from the national point of view.³³ The real difficulty concerning these benefits (as well as costs) arises only when one has to choose among alternative projects. In the circumstances of capital constraints in India, however, the problem of choice rarely arises because very few projects fully estimated are available at any time from which one may have to choose. The present practice of approving the project on the basis of economic efficiency, therefore, may be continued only with the clear knowledge that where such benefits accrue and to which project priority is

³²A. R. Prest and R. Turvey, "Cost-Benefit Analysis: A Survey", Surveys of Economic Theory, Vol. III, Resource Allocation, edited by the American Economic Association, the Royal Economic Society, New York, 1967, p. 162.

³³Otto Eckstein, op. cit., p. 213.

to be given. This is a more political rather than an economic problem and should be left to the decision of the politicians. Of course, this problem does not arise in the financial analysis as the benefits are accounted only at the farm level.

Similarly, it was noted that while estimating the benefits and costs of an irrigation project, its direct impact on others should be considered as part of the direct benefit or cost. Thus, if a lift irrigation scheme is likely to increase the water level in the existing wells in the command area, then the results of the increased water supply in the wells should be counted as a benefit of the scheme. This direct benefit can be automatically counted in the benefit stream if we include the command areas of the wells in the project area and make comparison between with and without irrigation situations of the same project area. In this study we have included the command areas of wells, wherever they exist in the project area.

For valuation of gross produce (Main produce + by-product), the harvested outputs are valued at their estimated relative domestic prices for the reason mentioned earlier. If the Government has imposed levy on certain foodgrain crops like jowar, rice, etc., then the farmers get a lower price for the quantity of foodgrains sold to the Government as levy. In financial analysis, there-

fore, the two prices have to be used: one is procurement or levy price, and the other is the market price for the rest of the output. On the other hand, since the Government purchases the outputs from the cultivators at the lower prices which in effect means that the producers pay a tax, in social benefit-cost analysis the accounting price should be used for the valuation of the entire produce.

An important aspect relates to the estimation of produce to which all past studies and debates have drawn attention. In area where irrigation is to be introduced, crops grown under unirrigated conditions are subject to considerable fluctuation in yield from year to year. Therefore, what is needed is an estimated average yield rate under unirrigated condition to be compared with that under irrigated condition. But very few studies in India have actually tried to make such an estimate; they take only a particular, mostly the survey year's yield estimates. Naturally, the yield rate would refer only to that particular year's weather condition which may result in unintended over or under-estimation of the required average yield. A more appropriate average yield rate of individual crops under unirrigated condition in the command area of the project can be estimated by taking the average for a sufficient number of years continuously in the past. This is not always easy to obtain. The average

yield figures for the district as a whole cannot be appropriate for small projects covering the area of one or two villages only.* To overcome this problem, we have estimated the yields under unirrigated condition by taking the average yield rates of good, bad and indifferent agricultural years in the past in the command area on the basis of information gathered from the farmers in the villages. This average estimated yield under unirrigated condition is considered as the normal situation in the command area.

2.5 Comparability in Prices of Inputs and Outputs

The recent discussions on the subject and the R.P.C.'s report have pointed out that the valuation of costs and returns should be made at comparable prices.³⁴ For example,

* We tried to see if yield data relating to the districts in which the surveyed villages were located would give a fair estimate for the villages. The average yield rates of individual crops under unirrigated condition for the last ten years in the Pune and Satara districts (1959-69) were compared with the yield rates in the command areas obtained in the farm business surveys. It was observed from the data that the average yield rates were not at all comparable owing to the very different situation of the surveyed villages.

³⁴Criteria for Appraising the Feasibility of Irrigation Projects, op. cit., p. 58.

valuation of investment cost in, say, 1970 prices and returns at 1972 prices would be incorrect. What is important is to estimate and take account of the changes in relative prices and not in absolute prices. It is preferable to take prices for estimating all costs and returns of a particular year unless one has reasons to anticipate changes in relative prices of inputs and outputs in future.

An attempt has been made in this study to estimate the relative price structure of the outputs.* It is seen from this exercise that the estimated past relative

* In attempting the relative price structure of the outputs in future, annual average wholesale price data of last 15 years (1960-74) of agricultural commodities at the selected market centres in Maharashtra were obtained from three different sources: (1) The data for the period 1960-69 were obtained from the Statistical Abstract of Maharashtra State, Government of Maharashtra, Bureau of Economics and Statistics, Bombay, Vol. I to VIII. (2) For the period 1970-74, Monthly Bulletin of Market Intelligence, Maharashtra State, Bombay, Vol. 14 to 16, and (3) Sugar-cane prices were obtained from the 20th Annual Report (1972-74) of the Rahuri Co-operative Sugar Factory, Ltd., Ahmednagar, and the annual reports of the Yashwant Co-operative Sugar Factory, Theur, Pune. From these data, average relative prices of all the commodities for the period (1960-74) were worked out by taking bajra price for all the years as the base price (as bajra is the second most important crop of the region and of which market price for all the years was available) with suitable

continued....

price structure of outputs did not differ much from the output prices current in 1972-73 in the region. Hence, we assumed that the relative price structure in 1972-73 was fairly stable and therefore could be used as the prices for the future estimations. The current prices of inputs have been used to estimate the costs in the projects in future. In the case of the project's capital costs, the absolute costs which had been incurred earlier to 1972-73, are revalued at the prices of 1972-73. Similarly, the estimated physical inputs and outputs of the project without irrigation have been valued at the respective prices of inputs and outputs.

2.6 Estimates of Benefits and Costs Over the Project Life

The stream of benefits we are here concerned with begins to flow after an irrigation project is completed and continues over its life period. Even after the capital project is completed it requires a certain period for the command area to adapt itself to the new conditions.

adjustments wherever felt necessary. The estimated relative price structure of outputs did not differ much from the output prices current in 1972-73 in the region. Therefore, we assumed that the relative price structure of 1972-73 was a fairly stable and was not affected by an extraordinary conditions during the year.

The farmers have to follow new method of farming, new crops and to make necessary supplementary investment. The full potential annual benefits, therefore, do not appear right from the first year; they come rather slowly and accumulate steadily. Since the project takes quite some years to reach the stage of maturity so far as reaping of the potential annual benefits is concerned, it is necessary to estimate the stream of benefits and costs as well from the first year of its completion to the end of the project life. This point is mentioned in some of the past studies but most of the studies have not given due attention to it in estimating the future benefits. An effort has been made in this study to estimate the different levels of benefits as the development of the command area takes place from the first year of completion of the project to the stage of maturity, which might take 5, 6 or 7 years. Thereafter, a constant stream of annual benefits begins to flow till the end of the life of the project. This estimation has been made on the basis of available information pertaining to the area brought under levelling, land use, crop pattern, etc., and the different levels of returns of various crops at different stages of land development, in the areas under the command of the projects.

The most important exercise in estimating the benefits and costs of an irrigation project is the estimation of

an economically efficient crop pattern after irrigation. This deserves greater care than is often given to it. For estimating the economically efficient crop pattern under irrigation, various factors like irrigation water requirements of the crops and water supply from the project, suitability of soils for growing different crops, season of sowing and harvesting, availability of labour, crop rotation within a year, fodder and food grain consumption needs on the farms, etc., have to be taken into account. Failure to do this often leads to a wide gap between the estimated and actual crop patterns in the project area, even without further technical or relative price changes.

In addition to all the factors mentioned above, input-output levels and technical know-how about different crops were also taken into account in order to estimate which among the alternative crop patterns would give the farmers the best income. Besides, use was also made of the estimates by the farmers about the future crop pattern under irrigated conditions on their lands. It would be more appropriate to discuss this aspect in detail in Chapter V since each of the selected lift irrigation scheme would require separate discussion.

As mentioned earlier, capital cost of the project is incurred in a few years in the beginning. What remains of the cost side of the project is the maintenance and

operation cost over the life of the project. Like benefits, the stream of the project repair and maintenance cost would also have to be estimated.

2.7 Discounting Technique

All the three official reports mentioned above as well as all other studies have failed to take into account the time factor in estimating the benefits and costs of the projects, leading to over or under-estimation of the benefit-cost ratios. We propose to illustrate this point and explain the use of discounting measure in order to overcome the common weakness.

An error made in most of the studies, as has been pointed out by N. Rath relates to calculation of the annual equivalent of the capital cost incurred at the beginning.³⁵ As the benefits are estimated on an annual basis over the life of the project, it was concerned necessary in these studies to convert the capital cost into an annual stream for comparison. All the past studies calculated it by taking a straight line depreciation of the original capital cost and adding to it interest on the original capital at a specified rate. This is a gross error, "since such a cost stream over the life of the

³⁵ N. Rath, "The Current Method of Choosing Irrigation Projects in India: A Review", op. cit., pp. 120-121.

project discounted to the present (beginning) at the specified rate would give a present value of the cost that will be larger than the actual project capital cost."³⁶ This has resulted in under-estimation of the benefit-cost ratio.

To avoid this error, calculation of annuity series of the capital cost at a specific rate of interest over the life of the project may be suggested for comparison with the annual stream of benefits. However, this procedure is also not free from difficulties, because the irrigation projects do not achieve their full potential annual benefits in a single year immediately after their completion. They take quite a number of years to achieve their full annual benefits. Most of the studies have mentioned this; but have failed to account for it. They have estimated either a single annual benefit figure relevant for the years when the full potentiality of irrigation would be achieved or at the most two: one for the earlier period, when the irrigation is partly developed and the other for the later period when the irrigation is fully developed. Taking the annual benefits in the fully developed stage as the proper annual benefit would lead to overestimation of the overall benefits of the project.³⁷ In view of this, N. Rath holds that "neither

³⁶Ibid., p. 121.

³⁷Ibid.

the one nor the other annual net benefit by itself is appropriate for comparison with the annual cost of the project. The proper thing to do is to discount the annual stream of benefits, with whatever variations anticipated, to the present at the specified rate for comparison with costs."³⁸ By ignoring the differential stream of benefits from irrigation in different time periods, one is likely to over-estimate the benefit-cost ratio.

He has also pointed out a similar problem in calculation of the capital cost of the project. That is, in the present method, total capital cost of the completed project is taken into account without considering the period required for its completion. "The capital locked up over the years of construction is considered costless: no interest is charged. This is both improper and inconsistent with the subsequent calculations."³⁹ Interest on capital during the construction period should be taken into account. The existing practice, by leaving out of account the interest on the capital locked up over the construction period under-estimates the capital cost.

Besides, the discounting technique highlights the costs of project in two directions: (1) The capital cost which an economy or an individual participant incurs by

³⁸Ibid.

³⁹Ibid.

prolonging the gestation period of the project; and (2) by extending the period of full utilisation of irrigation potentials over a longer period. The high cost that the society bears as a result of delay in construction of the project and fuller utilisation of the irrigation potentials is often very large. The present method of calculating the annual capital cost of the project and estimating the single annual benefit figure over the life of the project does not help in highlighting these problems.

Since the undiscounted procedure of project analysis fails to take into consideration the time factor involved in the flows of benefits and costs over the life of the project, this study takes resort to the discounting method in order to overcome the common errors discussed above. The technique of discounting the streams of benefits and costs is the same whether we are estimating the social or financial returns. Only the rate of discount used is different.

2.8 The Discount Rate

It is often argued that the proper rate of interest (rate of discount) for discounting and compounding in social benefit-cost calculus should be a social rate of interest, i.e., opportunity cost of capital, which is not necessarily the same as the rate charged by the financing

agencies in the country. Now, the real problem is how best to estimate the opportunity cost of capital.

For calculations of the benefit-cost ratio and net present worth we have assumed a 15 per cent rate to represent the opportunity cost of capital. In 1971, Dave and Bhatt estimated the opportunity cost of capital for industrial projects in India to be about 15 per cent, consistent with the targets (to raise the industrial production in the country at the rate of 8 to 10 per cent per annum) and the overall economic objectives as laid down in the Fourth Plan.⁴⁰ The same would appear to be valid for agricultural projects at the present time as well. In this context, the present practice of using the discount rate of 10 per cent⁴¹ appears too low to justify the social rate of return on capital in India where capital is a scarce factor.

In the case of private investment calculus, this problem does not arise, since for discounting and compounding the interest rate actually charged by the financing institutions is used.

⁴⁰ S.A. Dave and V.V. Bhatt, "Criteria for Evaluation for Capital Projects" Economic and Political Weekly, Vol. VI, No. 35, August 1971, P. M-105.

⁴¹ Report of the Irrigation Commission 1972, Vol. I, op. cit., p. 253.

2.9 Discounting Methods

We shall calculate the present worth of the estimated benefits and costs to arrive at the benefit-cost ratio, the net present worth, and as well as estimate the internal rate of return of the projects. It should be noted that of the three methods of the project analysis, the benefit-cost ratio is never calculated for the financial profitability calculus because the ratio has no particular relevance from the view point of the individual farmers. The net present worth and the internal rate of return are calculated for both social as well as private investment analysis.

2.9.1 Benefit-Cost Ratio: There are two ways in which the present worth of the benefits and costs can be compared for computation of benefit-cost ratio. One is to compare the present worth of the additional gross value of the produce with the present worth of the additional gross costs. The other is to compare the present worth of the additional net benefits with the present worth of the project cost. The official reports appear to approve the second method, though both the methods have been used in the country. If one wishes to rank the projects, these alternative methods would give different ranking. It is, therefore, desirable that all analyses should follow a uniform procedure in deriving this ratio.

2.9.2 Net Present Worth : The netting out convention

of the costs and benefits in net present worth is the same as in the computation of benefit-cost ratio except that in net present worth, present worth of the cost stream is subtracted from the present worth of the benefit stream. According to this criterion, if the total net present worth of the project at a predetermined discount rate is positive, the project would pass the test and could be selected. Unlike in the benefit-cost ratio, ranking of acceptable alternative projects is not meaningful with net present worth method as this criterion would always favour the larger and more durable projects.

2.9.3 Internal Rate of Return: Internal rate of return is defined as that rate of discount which would equate the present worth of costs to the present worth of benefits during the life of the project. If the internal rate of return is greater than the predetermined cut-off discount rate, the project would pass the test and could be selected. Like benefit-cost ratio and net present worth, ranking of the projects by the internal rate of return is also not free from the complications.

2.10 Choice of an Appropriate Benefit-Cost Ratio

The Committee of the Ministry of Irrigation and Power has recommended in its report that only the projects with a benefit-cost ratio of 1.5 should be selected.⁴²

⁴²Report of Committee to Suggest Ways and Means of Improving Financial Returns from Irrigation Projects, Parts I and II, op. cit., p. 31.

This raises a problem of choice of an appropriate benefit-cost ratio. The Irrigation Commission 1972, while accepting the decision of the Committee, goes on to add: "We are informed that projects with a benefit-cost ratio of less than 1.5 are generally not considered for acceptance, although theoretically a ratio of unity should meet the criterion. We consider this to be a prudent precaution. We have come across several instances where project costs have increased two fold or even more while the rise in commodity prices have been much less. A lower benefit-cost ratio than 1.5 would in these circumstances lead to the acceptance of marginal projects which may later prove to be economically unsound."⁴³

The circumstances stated above as reasons for cut-off benefit-cost ratio of 1.5 may arise if the project is not prepared in all its details before its economic evaluation is undertaken. The Committee of the Ministry of Irrigation and Power has pointed out that the substantial increase in project's estimated cost due to improper planning of the project at its initial stage is a common phenomenon in the irrigation planning in the country. Under the circumstances, as additional funds are not available at any time due to capital constraints, the

⁴³Report of the Irrigation Commission 1972, Vol. I, op. cit., p. 253.

project takes a long time to complete than the estimated period. This increases the cost far beyond the initial estimates.⁴⁴ Besides, overtime the relative prices of inputs and outputs of the project move against the latter. It is not surprising then if the actual cost of the project increases two fold or even more than what was originally estimated.

These are interrelated reasons for many fold increase in the project cost. This deserves more careful and detailed planning of the projects after which their economic evaluation should be undertaken. It is certainly improper to avoid this by taking a precautionary measure like specifying the minimum benefit-cost ratio to be 1.5. This decision may adversely affect the projects which have been carefully planned and estimated at the initial stage. Of course, even after taking proper care of all the reasons the problem of uncertainty and risk remains unsolved. It is best to make allowance for them in the estimated costs and benefits of the project rather than evading it by fixing a cut-off benefit-cost ratio of 1.5. For this the method of sensitivity analysis can be used to test the economic feasibility of the project under the changing

⁴⁴ Report of Committee to Suggest Ways and Means of Improving Financial Returns from Irrigation Projects, Parts I and II, op. cit., p. 3.

circumstances of time period, inputs/outputs and their relative prices. To sum up, under the given circumstances, we do not find any strong reason which would require a minimum benefit-cost ratio of 1.5 rather than of unity for acceptance of a project.

N. Rath sees an altogether different possible reason for such upward revision of benefit-cost ratio recommended by the Committee. He pointed out that "a social B/C (benefit-cost ratio) properly estimated may be greater than unity which the project may not provide enough incentive for the farmers to take to irrigated farming. This amounts to saying that a project with a B/C of greater than unity may not be financially a worthwhile proposition. That such a proposition may be at the back of the suggestion is indicated by the related suggestion of the Government's Committee and the Irrigation Commission that projects which do not satisfy the suggested test may yet be taken up if they are of a protective nature in, say, a chronically drought affected area."⁴⁵ He also showed the relationship between the criterion of financial analysis and that of the benefit-cost ratio and lamented over the exclusive concern with the social benefit-cost analysis in selecting the irrigation projects in the country that

⁴⁵N. Rath, "The Current Method of Choosing Irrigation Projects in India: A Review", op. cit., p. 124.

resulted in no attention being given to the possibility of financial profitability of the project.⁴⁶ The Irrigation Commission has recognised the undesirable effects of the exclusive concern with the social benefit-cost analysis and suggested that in addition to the benefit-cost ratio further financial returns of the irrigation projects should be examined. Moreover, it has suggested that the impact of the projects on irrigation revenues of the state should be examined and upward revision of water rates should be made if they do not cover the working expenses and interest charges on investments.⁴⁷ Now, it should be noted that there is absolutely no necessity of making such an upward revision of the benefit-cost ratio of unity to take care of these circumstances if the project is carefully planned in all its details and systematically analysed from the view point of the society as well as from the view point of the individual participants.

The social benefit-cost calculation by itself can say nothing definite about the financial profitability of a project; but this is sometimes lost sight of in evaluating projects to be financed by financing institutions where the double criteria is necessary.

⁴⁶Ibid., p. 125.

⁴⁷Report of the Irrigation Commission 1972, Vol. I, op.cit., p. 253.

2.11 Repayment of Loan

In the financial analysis, if the internal rate of return is greater than the predetermined discount rate, the project would pass the test and could be selected. Or, similarly, the present worth of the income stream is greater than the present worth of the cost stream means, the project is financially a worthwhile proposition to undertake. This, however, may not always settle the question for the financing agency (and therefore for the beneficiaries) which has provided the loan for construction of the project. This may happen for two reasons. Firstly, the farmers may not be able to divert their net income towards the repayment of loan after meeting their minimum level of living and other essential needs; and secondly, the financing agency might like the recovery of its loan in a shorter period than the life of the project.

This point may be illustrated by taking hypothetical illustration. To say that the net present worth of the project is positive means, the beneficiaries can pay the full cost of the project from the incomes. But when it comes to actual payment, this may not always be feasible. If a farmer finds that he is not left with much surplus that enables him to attain at least a minimum level of living after repaying the loan instalments every year, he may not be very enthusiastic about the project or, what is more likely, he may not care to repay the loan. This

may happen even if the project is financially a worthwhile proposition. The problem would be further complicated if the financing agencies want to recover their loans in a shorter period than the life of the project considered in the financial analysis.

To avoid this situation, one has to ensure two things. Firstly, the investment proposed for the project should be justified on the financial considerations, and secondly, the project should be self-liquidating in character.⁴⁸ These calculations would help the financing agencies to estimate how soon they can reasonably expect to recover the loan and whether any flexibility in this regard is necessary. This has been noted and emphasised by the financing agencies which finance private (including co-operative) investment in irrigation.

The procedure of the former criterion, i.e., the financial returns of the project, is already discussed. The latter criterion considers repayment of loan. For this purpose, one has to estimate the repayment capacity of the farmers, i.e., how much annual net income of the farmers

⁴⁸ V. M. Jakhade and M. V. Gadgil, "Production-and-Repayment-Capacity Oriented Lending for Farm Investment", R.B.I. Bulletin, Vol. XXIV (1), Jan., 1970, p. 56.

can be diverted towards the repayment of loan after meeting their minimum consumption needs and other essential expenses. Now the question to be answered is, how best to estimate the repayment capacity of the farmers.

2.12 Repayment Capacity of the Farmers

The repayment capacity of the farmers may be considered in terms of the following four factors:

(1) Repayment capacity should be measured exclusively in relation to the total current income of the farm family.

(2) It should take into account the minimum consumption needs of the farm family.

(3) A desirable margin to take care of improvement in the level of living, adverse weather, cost-price relation, increase in liabilities, etc., has to be provided, and

(4) Repayment obligations in respect of pre-existing liabilities have to be taken into account. These four factors of the repayment need more explanation.

The farm family receives income from the farm business as well as from off-farm activities. The farm business income includes income expected from the command area after completion of the project plus income from the land outside the project. Income from off-farm activities may be in the nature of wages, salaries, hired

charges, etc. In estimating the annual off-farm income during the repayment period, proper attention should be paid to changes of such incomes especially from wage earning on small farms as a result of irrigation. Scope for repayment of loan from out of fresh borrowing or from disinvestment or dissaving should, of course, be disregarded.

The second factor, minimum annual need-based level of living, considers the cost of subsistence as is calculated in the essay "Poverty in India" to demarcate the poor from the rest of the population. The essay has calculated that 616 grams of foodgrains are the daily consumption requirement of a member of rural household and its expenditure on other items of consumption requirement like cooking oil, vegetables, sugar, milk, clothing, etc. is around 67 per cent of its total expenditure on consumption of foodgrains.⁴⁹ This means, minimum need-based level of living of a member of rural household is 1.67 times of its expenditure on consumption of foodgrains. Major foodgrains like jowar, bajra and wheat are mainly consumed by the farm families in the region and it is estimated that these are consumed at 60 per cent, 30 per cent and 10 per cent respectively of the total consumption of the foodgrains. In money terms, it amounts to Rs. 312

⁴⁹ V.M.Dandekar and N. Rath, op. cit., p. 6.

per capita per annum at the estimated prices of these foodgrains. Therefore, the annual minimum need-based level of living of a member of farm family is 1.67 times this sum, i.e., Rs. 521. If this amount is multiplied by the number of members in the family then we can arrive at the annual minimum need-based level of living of a farm family. For estimating this, we have assumed that the number of members in the family would remain unchanged during the repayment period. At this juncture, it is to be mentioned that while estimating the repayment capacity of the farmers, the estimated net farm income of the family would be gross of the farm family labour income, which will not be treated as an item of farm cost.

The third factor makes provision for increase in the level of living as a result of irrigation, and against adverse situations like change in input-output prices, bad weather, increase in liabilities, etc., in the repayment capacity. This is largely a matter of judgement, and we have considered a desirable margin to take care of such factors to be 10 per cent of the total current income of the farm family.

The fourth factor, pre-existing liabilities of the farm family may consist of three forms. Loan borrowed for: (1) current or capital expenditure in farm business, (2) off-farm business activity; and (3) household expenditure. The estimated annual instalments of the repayment

of these loans are taken into account while estimating the repayment capacity of the farmers.

Now we can define the annual repayment capacity (E) as the excess of a farmer's total estimated annual current income (A) over the sum of expenditure on minimum annual need-based level of living (B), the margin to take care of increased consumption, etc., (C), and the repayment due on pre-existing liabilities (D) during the period of repayment of the project's loan. It may be expressed symbolically as:

$$E = [A - (B + C + D)]$$

If the estimated 'E' is equal or greater than the annual repayment means that the farmers can repay the loans of the project.

Now it can be said that from the view point of the financing agencies only those loan proposals which satisfy both the tests of financial analysis and repayment of loan, are feasible. Advancing loan to the projects on the basis of these tests can confer two advantages to the financial institutions. (1) The procedure will help the agencies to have a realistic idea of the surplus in the borrower's current income which can be reasonably diverted towards the repayment; and (2) the period of recovery of loan can be varied from one borrower to another, of course, subject to the maximum period for repayment admissible under the rules of the financing agencies. It

will help the agency to achieve a quicker turnover of funds and thereby provide credit to a larger number of the farmers. Financing agencies sometimes get into difficulties since they do not have this data before them.

2.13 Repayment Schedule

There is one more point to be discussed regarding the present repayment schedule prescribed by the financial institutions in the country. According to the financial institutions, the repayment of loan should be made in certain, say, 5 to 10, equated annual instalments from the date of disbursement of the loan. This means that the agencies safely assume that once the money is made available for construction of the irrigation project, the benefits of irrigation, too, accrue to all concerned in the first year itself. However, this does not happen because development of irrigation is a slow process. It may be very well agreed that though irrigation water is made available, all the potential beneficiaries may not be in a position to avail of the facility immediately. When the irrigation water is released for irrigation one can visualise that despite irrigation facility having been made available, the potential beneficiaries have yet to develop their land to get the benefits of irrigation. Therefore, the total area gets irrigation water only after

a lapse of time. Thus, the benefits from a given irrigation project accrue to different farmers from different dates and also in respect of a given farmer for varying periods for different parts of his total irrigable area. In these circumstances, to expect the repayment of loan from the farmers who have not been able to avail of the irrigation facility is improper.

In the light of the above, the financing agency's repayment schedule often looks rigid. To avoid this, one should take into account the area likely to be irrigated every year from the beginning and the period over which such benefits will accrue to the different farmers, without extending the period of repayment prescribed by the agency. We shall explain this point by taking a hypothetical example. If a farmer has three acres within the irrigable command area and avails of the irrigation on one acre in the first year, two acres in the second year and all the three acres in the third year, then his first acre gets the irrigation over the life of the project, say, in our lift irrigation scheme, 30 years, the second acre for 29 years and the third acre for 28 years. Therefore, the total amount of loan (principal) to be repaid should be distributed among the farmers (rather ~~their~~ plots of land) on the basis of the area to be irrigated and the period over which such benefits would accrue to them. The farmers who are to receive irrigation from

the project for a longer period will have to repay a larger amount of the total loan on a per acre basis. Since the repayment is to be related to the time period of the benefits, the equated annual instalments of loan for the above mentioned three acres need to be related to the irrigation facility availed of for each acre separately. Repayment period for the lift irrigation scheme is say, 7 years. Thus, the amount of loan on the first acre will be repaid in seven equated annual instalments, on the second acre into six equated annual instalments and on the third acre into five equated annual instalments.

This proposed repayment schedule is likely to give some relief to the farmers who begin receiving irrigation water late in two ways. Firstly, relief in the total amount of principal to be repaid, and secondly, the necessary staggering in the year from which the first instalment would be due from the farmers. In this sense, this repayment schedule would be more equitable than the present schedule followed by the bank. On the other hand, some hardship may be caused to the cultivators who begin repayment late, say, in the 5th, 6th or the 7th year in as much as they have to repay the total loan in 3, 2 or even a single year. Of course, how difficult this may prove to be can be assessed only after estimating the repayment capacity of the farmers. It is also proposed to take into account the shortcoming mentioned in the present repayment schedule and accordingly calculate the repayment of loan.

CHAPTER III

SURVEY OF THE LIFT IRRIGATION SCHEMES

In this chapter we discuss the design of the survey, the selection of the lift irrigation schemes, selection of the beneficiaries and the collection of the farm data.

3.1 Need for the Survey

Lift irrigation schemes with the help of diesel or electric pumps were introduced on a large scale throughout Maharashtra State quite a few years ago. However, very few published studies or data pertaining to the investment and working of such schemes are available, barring information on the area under lift-irrigation. In any case, the use of the appropriate methodology for studying financial profitability as well as social benefit-cost analysis of lift irrigation schemes necessitates collection of relevant data for selected projects.

3.2 Selection of the Lift Irrigation Schemes

In view of the limited time and investigational resource available, it was decided to select four or five lift schemes from the area within Pune District, with differing number of beneficiaries and different command areas. The total number of sample farms was to be

around 200.

The total of five lift irrigation schemes - four from Haveli Taluka of Pune District and one from Khandala Taluka of Satara District - were selected for the investigation. Three conditions were laid down for selection of the schemes from Haveli Taluka.*

* Maharashtra Government had launched a special Rabi Campaign Programme for development of irrigation in the famine affected regions of the State during 1966. Under this programme, the Government disbursed taccavi loans to the extent of Rs. 400 lakhs to the individual farmers for construction of small irrigation projects like wells, lift irrigation schemes, etc., at the rate of Rs. 375 per acre of the irrigable command area under such projects. However, it was not possible for many of the farmers in Haveli Taluka who had lands near river banks to sink wells because inspite of their being near the river, their lands were located at higher levels where underground water was at a very great depth. Therefore, construction of the lift irrigation schemes was the only choice for the farmers in this region to create irrigation potentialities on their farms. Construction of lift irrigation scheme requires large amount of investment and joint effort. At this juncture, some political and social workers from the Taluka came forward and formed the 'Lift-Irrigation Federation of Haveli Taluka' and persuaded the farmers to come together under the Federation for proper planning and execution of the schemes. This idea was accepted by a large number of the farmers and 42 plans of such lift schemes in different villages of the Taluka were prepared under the supervision of the Federation. Joint loans were sanctioned and disbursed to each of the schemes by the

Continued..

(1) It was decided to select the schemes which have been completed and had started releasing water to the farms, at least for a period of two years at the time of our field survey.

(2) The source of irrigation water should be perennial.

(3) The schemes, as far as possible, should be of varying command areas and varying number of beneficiaries.

The preliminary information collected showed that out of the 42 schemes sponsored by the Lift Irrigation Federation of Haveli Taluka, only 23 schemes had been completed by 1972-73. Out of these 23 schemes, 15 schemes had been installed on rivers having perennial water supply. Three schemes of the above 15 did not satisfy the first condition, the schemes having been completed in the later part of 1971 and thus not having two full years of irrigation facility to the beneficiary-farmers. Thus, only 12 schemes were to be considered for final selection. Out of the 12 schemes, it was decided to select only four schemes of different sizes in respect of their command areas and number of beneficiaries. Such a selection would provide us a well distributed sample of beneficiaries and at the same time would facilitate comparative study of schemes with differing command areas.

State Government in 1965. Out of these 42 lift irrigation schemes, 23 schemes were completed by 1972-73. It was, therefore, decided to select a few of the schemes from the Haveli Taluka Lift Irrigation Federation for the study.

While selecting the schemes due consideration was given to the working of the schemes for the previous two-three years.

Apart from these four schemes, one more scheme was purposively selected from Khandala Taluka of Satara District.* The reasons for this were many: (1) Unlike in the case of other four projects, in this particular case, water was to be pumped from the reservoir behind a dam, and therefore as per rules of the Irrigation Department, there are certain restrictions on the quantity of water that can be lifted during a given year, the crops that can be grown under irrigation, etc. The Irrigation Department has granted permission to the project to lift water for only 250 acres, between 15th October and 28th February (i.e., the rabi season) every year. There is no restriction on the amount of water that can be lifted during the kharif season when the dam overflows. However, lifting of water is strictly prohibited during summer season. The conditions laid down largely restrict the crops to be grown in the command

* Nimbkar Seeds and Agricultural Development Company, Ltd.; one of the well-known seed producing companies in Maharashtra State, made available the loan from one of the leading banks to the scheme located at the village Ehade, in Khandala Taluka of Satara District on its own guarantee of repayment of the loan to the bank. The company ultimately prepared the plan of the scheme and executed.

area. Irrespective of the season, irrigation facility is available for growing food grain crops only. There are no such conditions in the case of the other four lift irrigation schemes in Haveli Taluka, where water was to be lifted from the rivers. (2) This lift irrigation scheme is a moderately large one in the region (irrigable command area of the scheme is 817 acres). Irrigable land holdings of majority of the beneficiaries in the project area was below five acres. This is not very common. (3) Besides, construction of this lift scheme was completed in less than a year when, generally, the construction of such schemes has not taken less than 3 years to complete. In these circumstances, this lift irrigation scheme would give us an opportunity of comparative study, highlighting the problems and the drawbacks in the execution of such schemes.

Table 3.1 shows the selected lift irrigation schemes, their irrigable command areas, number of beneficiaries, years in which the construction was started and completed, number of years of irrigation benefits accrued to the farmers till 1972-73, source of irrigation water, and other particulars.

3.3 Selection of the Beneficiaries

In the four selected lift irrigation schemes in Haveli Taluka, it was decided to cover all the beneficiaries

Table 3.1. Selected lift irrigation schemes, their irrigable command areas, number of beneficiaries, year of construction and other particulars.

Sr. No.	Lift irrigation scheme	Irrigable command area (acres)	No. of beneficiaries	Year of construction started	Year of construction completed	No. of years irrigation benefits accrued till 1972-73	Sources of irrigation water	Taluka
1.	Koregaon-Kul	272	48	1966	1970	3	River	Haveli
2.	Naigaon	127	27	1966	1970	3	River	Haveli
3.	Khangson-Tek	265	48	1966	1970	3	River	Haveli
4.	Pimpore-Waghare	61	21	1966	1970	3	River	Haveli
5.	Bhade	817	208	1971	1972	1	Reservoir	Khandala

in the survey, excepting the few (10 farmers) who had not taken water for irrigation at the time the survey began.

In the case of the scheme located at Bhade village (Khandala Taluka, Satara District), the number of beneficiaries being very large, it was decided to draw samples after dividing the cultivators into two distinct groups, one operating upto ten acres within the command area, and the other operating more than ten acres. All the cultivators from the second group were covered by our enquiry, and only 25 per cent of the beneficiaries from the first group were chosen at random. The objective for such a sample was twofold: (i) to have a reasonably manageable size of sample; and (ii) to cover the maximum irrigable command area of the project in the study.

In all, a sample of 196 beneficiary-farmers from the five lift irrigation schemes was selected. Ten of the farmers listed in fact turned out to belong to five families, and hence the sample size was reduced to 191 cultivators. Out of these 191 farm families, 179 were covered under the survey. Reasons for leaving 12 cultivators uncovered were that: (i) three small cultivators had migrated to other villages and could not be contacted (ii) five cultivators were staying in other villages of adjoining taluka and had more land there, (iii) three

were wrongly reported as irrigators in the list; and (iv) in one case, the land belonged to the temple, and therefore we could not collect the data since the land was jointly cultivated by the villagers.

Table 3.2 gives the number of beneficiaries selected and covered under the study according to the schemes.

Table 3.2. Number of beneficiaries selected and covered under the study according to the schemes

Sr. No.	Lift irrigation scheme	No. of beneficiaries selected under the study	No. of beneficiaries covered under the study
1.	Koregaon-Kul	41	37
2.	Naigaon	27	24
3.	Khangaon-Tek	47	44
4.	Pimpore-Waghare	19	19
5.	Bhade	57	55
	Total	191	179

3.4 Collection of the Farm Data

Data required for estimating the benefits and costs of an irrigation project are for two situations, i.e., the way the farms would develop 'with' and 'without' irrigation. For this purpose, detailed information from the farm families was collected by canvassing the

schedules among the selected farmers. Some of the farmers had land, both irrigated and unirrigated, outside the command area. Therefore, information was collected separately on the crop husbandry on the lands within and outside the command area, and further for irrigated and unirrigated lands for two periods - one before irrigation and another after the partial development of irrigation in 1972-73. The data collected for the period before irrigation did not relate to a specific year but the average of good, bad and indifferent agricultural years in the command areas on the basis of information gathered from the farmers in the villages for the earlier years. The average yield rates under unirrigated condition are considered as the yield rates during the normal situation in the command areas.

The Haveli Taluka Lift Irrigation Federation and the Nimbkar Seeds and Agricultural Development Company, Ltd. had collected some bench mark data of the farms in the year just before completion of their respective projects. These data were very useful and served as a check while interviewing the cultivators. All these various types of information were useful in building up the futures of the situations without irrigation, as well as with irrigation.

CHAPTER IV

ECONOMIC CONDITIONS OF THE SAMPLE FARMS

An attempt is made in this chapter to present important aspects of the economy of the sample farms as revealed by the survey of the selected lift irrigation schemes. Broadly, the aspects include classification of area operated on the farms, sourcewise distribution of the area under irrigation on the farms, soil types in the irrigable command areas of the projects, land utilisation and crop patterns in the command areas of the projects as well as on the total holdings of the farms including their non-project lands. All these data relate to the year 1972-73, i.e., after partial development of irrigation. Besides, land utilisation and crop patterns without irrigation in the irrigable command areas of the projects are also presented in this chapter. These data would be used to make estimates of benefits and costs of the lift irrigation schemes.

Perhaps the most important structural aspect of agriculture in a region is the way land is held and operated. These data on the total holdings of the sample farms in the lift irrigation schemes are presented in Table 4.1. It is seen from the table that in the Pimpore-Waghare and the Ehade lift irrigation schemes, the bulk of the

Table 4.1. Classification of the total area operated by the sample farms in the lift irrigation schemes during 1972-73.

(area in acres)

Sl.No.	Size of the cultivated holdings	No. of farms	Area owned	Leased out	Leased in	Total cultivated area Cols (4+5+6)	Land revenue (Rs.)	Average area cultivated per farm Cols. (7 + 3)	Average land revenue per cultivated acre (Rs.) Cols. (8 + 7)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1.	<u>Koregaon-Mul Lift Irrigation Scheme</u>								
	Less than 10.00	15 (40.54)	109.46 (14.65)	13.47	3.12	99.11 (13.91)	106.66	6.61	1.08
	10.00 to 19.99	11 (29.73)	189.85 (25.40)	24.24	2.65	168.26 (23.62)	169.37	15.30	1.01
	20.00 and above	11 (29.73)	448.07 (59.95)	3.05	-	445.02 (62.47)	315.88	40.46	0.71
	Total	37 (100.00)	747.38 (100.00)	40.76	5.77	712.39 (100.00)	591.91	19.25	0.83
2.	<u>Nalgaoon Lift Irrigation Scheme</u>								
	Less than 5.00	7 (29.17)	21.36 (9.09)	-	-	21.36 (8.72)	19.08	3.05	0.89
	5.00 to 9.99	7 (29.17)	61.17 (26.05)	-	-	61.17 (24.96)	53.62	6.74	0.88
	10.00 and above	10 (41.67)	152.36 (64.86)	-	10.15	162.51 (66.32)	145.12	16.25	0.89
	Total	24 (100.00)	234.89 (100.00)	-	10.15	245.04 (100.00)	218.02	10.21	0.89
3.	<u>Khamgaon-Tek Lift Irrigation Scheme</u>								
	Less than 5.00	13 (29.55)	35.44 (6.56)	-	-	35.44 (6.56)	50.75	2.73	1.43
	5.00 to 9.99	9 (20.45)	74.94 (13.67)	-	-	74.94 (13.67)	96.01	8.33	1.28
	10.00 to 14.99	11 (25.00)	134.92 (24.96)	-	-	134.92 (24.96)	186.70	12.27	1.38
	15.00 and above	11 (25.00)	295.13 (54.61)	-	-	295.13 (54.61)	274.37	26.83	0.93
	Total	44 (100.00)	540.43 (100.00)	-	-	540.43 (100.00)	607.83	12.28	1.12
4.	<u>Pinnare-Waghare Lift Irrigation Scheme</u>								
	Less than 5.00	14 (73.68)	34.11 (37.83)	-	-	34.11 (37.83)	91.42	2.44	2.68
	5.00 and above	5 (26.32)	56.06 (62.17)	-	-	56.06 (62.17)	69.07	13.61	1.23
	Total	19 (100.00)	90.17 (100.00)	-	-	90.17 (100.00)	160.49	8.45	1.78
5.	<u>Bhade Lift Irrigation Scheme</u>								
	Less than 2.50	14 (25.45)	27.55 (5.64)	4.97	-	22.58 (4.53)	28.74	1.61	1.27
	2.50 to 4.99	14 (25.45)	56.87 (16.40)	8.85	-	48.02 (9.63)	49.83	3.43	1.64
	5.00 to 9.99	12 (21.82)	91.76 (16.78)	15.00	4.15	80.91 (16.23)	135.30	6.74	1.67
	10.00 and above (less than 50% irriga- ble area)	8 (14.55)	189.11 (34.57)	13.00	1.00	177.11 (35.53)	151.07	22.14	0.85
	10.00 and above (more than 50% irriga- ble area)	7 (12.73)	181.68 (33.21)	11.75	-	169.93 (34.08)	157.15	24.28	0.92
	Total	55 (100.00)	546.97 (100.00)	53.57	5.15	498.55 (100.00)	522.09	9.06	1.05

(Figures in brackets indicate percentages)

farmers had land holdings below five acres. As against this, in the rest of the schemes the farmers mostly had land holdings above five acres. However, the bulk of the total land was with the farmers holding more than 5 acres in all the five schemes. Leasing of land was not very common among farmers in the selected schemes. In two of the schemes there was no leasing out or in of land by the sample farmers. In two other schemes, leasing out or in of land accounted for 5 per cent or less of the total owned land. Only in the case of farmers under the lift irrigation scheme in Bhade was leasing out significant, about 10 per cent of the total owned land. As stated earlier in Chapter III, this was due to an agreement with the Nimbkar Seeds and Agricultural Development Company, Ltd., which had guaranteed the repayment of loan to the bank on behalf of the beneficiaries of the scheme on the condition that the Company was to be given on least 25 per cent of the irrigable land of the farmers who obtained loan from the bank^{*} until the loan was fully repayed. The average area cultivated by the farm families varied between the minimum of 6.45 acres in the Pimpore-Waghare scheme and maximum of 19.25 acres in the Koregaon-Mul scheme.

* This excluded the farmers who did not take loan from the bank for availing the benefits of irrigation from the scheme. There were about 35 such farmers who paid the full investment cost of the project equivalent to their area under the scheme, in cash.

The proportion of the area under irrigation in the total cultivated holding of the sample farms in the schemes is presented in Table 4.2. The percentage of the total area under irrigation to the total cultivated area of the farms was more than 60 in the Naigaon, Pimpare-Waghera and Bhade lift irrigation schemes, and was about 50 per cent in the remaining two schemes. Very little irrigation facility over and above that from the lift irrigation scheme was available to the member-farmers in all but two schemes: Naigaon and Koregaon where 11-12 per cent of the total holdings had irrigation facility outside the scheme. It is also seen from the table that the entire cultivated area of the small farmers, in the first group of land holdings, in Naigaon village (below 5 acres) as well as in Bhade village (below 2.5 acres) had come under the lift irrigation scheme. In spite of this, the larger benefits of the lift irrigation were to accrue to the larger farmers since their share in the total irrigable area under the project was much larger than that of the small farmers.

One of the most important factors that go to determine the quality of land in the area is the type of soil. Data pertaining to soil types, etc., in the irrigable command areas of the schemes are presented in Table 4.3. The land has been classified into three soil types, namely, heavy soil, medium soil and light soil. This classification

Table A.2. Sourcewise distribution of the total area under irrigation on the sample farms in the lift irrigation schemes during 1972-73

(area in acres)

S.No.	Size of the cultivated holdings	No. of farms	Total cultivated area	Area under irrigation by different sources			Land outside the lift irrigation scheme Colg. (4-5)
				Lift irrigation scheme	Wells and canals	Total Cols. (5+6)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	<u>Koregaon-Mul Lift Irrigation Scheme</u>						
	Less than 10.00	15	99.11 (100.00)	44.67 (45.07)	6.50 (6.56)	51.17 (51.63)	54.44 (54.93)
	10.00 to 19.99	11	168.26 (100.00)	73.59 (43.74)	26.75 (15.89)	100.34 (59.63)	94.67 (56.26)
	20.00 and above	11	445.02 (100.00)	134.98 (30.33)	48.20 (10.83)	183.18 (41.16)	310.04 (69.67)
	Total	37	712.39 (100.00)	253.24 (35.55)	81.45 (11.43)	334.69 (46.98)	459.15 (64.45)
2	<u>Naigaon Lift Irrigation Scheme</u>						
	Less than 5.00	7	21.36 (100.00)	21.36 (100.00)	- (-)	21.36 (100.00)	- (-)
	5.00 to 9.99	7	61.17 (100.00)	17.44 (28.51)	11.41 (18.65)	28.85 (47.16)	43.73 (71.49)
	10.00 and above	10	162.51 (100.00)	83.06 (51.11)	19.10 (11.75)	102.16 (62.86)	79.45 (48.89)
	Total	24	245.04 (100.00)	121.86 (49.73)	30.51 (12.45)	152.37 (62.18)	123.18 (50.27)
3	<u>Khangaon-Tek Lift Irrigation Scheme</u>						
	Less than 5.00	13	35.44 (100.00)	29.15 (82.25)	- (-)	29.15 (82.25)	6.29 (17.75)
	5.00 to 9.99	9	74.94 (100.00)	40.66 (54.26)	3.00 (4.00)	43.66 (58.26)	34.28 (45.74)
	10.00 to 14.99	11	134.92 (100.00)	96.71 (71.68)	7.75 (5.74)	104.46 (77.42)	38.21 (28.32)
	15.00 and above	11	295.13 (100.00)	72.79 (24.67)	20.37 (6.90)	93.16 (31.57)	222.34 (75.33)
Total	44	540.43 (100.00)	239.31 (44.28)	31.12 (5.76)	270.43 (50.04)	301.12 (55.72)	
4	<u>Pimpri-Waghare Lift Irrigation Scheme</u>						
	Less than 5.00	14	34.11 (100.00)	27.68 (81.15)	-	27.68 (81.15)	6.43 (18.85)
	5.00 and above	5	56.06 (100.00)	30.49 (54.39)	-	30.49 (54.39)	25.57 (45.61)
Total	19	90.17 (100.00)	58.17 (64.51)	-	58.17 (64.51)	32.00 (35.49)	
5	<u>Bhade Lift Irrigation Scheme</u>						
	Less than 2.50	14	22.58 (100.00)	22.58 (100.00)	- (-)	22.58 (100.00)	- (-)
	2.50 to 4.99	14	48.02 (100.00)	39.35 (81.94)	- (-)	39.35 (81.94)	8.67 (18.06)
	5.00 to 9.99	12	80.91 (100.00)	63.61 (78.62)	0.50 (0.62)	64.11 (79.24)	17.30 (21.38)
	10.00 and above (Less than 50% irrigable area)	8	177.11 (100.00)	50.15 (28.32)	9.50 (5.36)	59.65 (33.64)	126.96 (71.64)
	10.00 and above (More than 50% irrigable area)	7	169.93 (100.00)	130.87 (77.01)	- (-)	130.87 (77.01)	39.06 (22.99)
Total	55	498.55 (100.00)	306.56 (61.49)	10.00 (2.01)	316.56 (63.50)	191.99 (38.51)	

(Figures in brackets indicate percentages)

Table 4.3. Soil types and number of fragments in the irrigable command areas of the sample farms in the lift irrigation schemes during 1972-73.

(area in acres)

Sr. No.	Size of the cultivated holdings	No. of farms	Irrigable command area	Area under different types of soil			Total No. of fragments in the area (8)	Average area per farm Cols. (4 + 3) (9)	Average area per fragment Cols. (4 + 8) (10)
				Heavy	Medium	Light			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	<u>Koregaon-Kul Lift Irrigation Scheme</u>								
	Less than 10.00	15	44.67 (100.00)	24.57 (55.00)	11.00 (24.63)	9.10 (20.37)	17	2.98	2.63
	10.00 to 19.99	11	73.59 (100.00)	33.80 (45.93)	18.87 (25.64)	20.92 (28.43)	18	6.69	5.09
	20.00 and above	11	134.98 (100.00)	37.90 (28.09)	43.80 (32.45)	53.26 (39.46)	22	12.27	6.14
	Total	37	253.24 (100.00)	96.29 (38.02)	73.67 (29.09)	83.28 (32.89)	57	6.84	4.44
2	<u>Naigaon Lift Irrigation Scheme</u>								
	Less than 5.00	7	21.36 (100.00)	7.49 (35.07)	9.55 (44.71)	4.32 (20.22)	11	3.06	1.94
	5.00 to 9.99	7	17.44 (100.00)	4.78 (27.41)	1.00 (5.73)	11.66 (66.86)	7	2.49	2.49
	10.00 and above	10	83.06 (100.00)	32.20 (38.77)	35.46 (42.69)	15.40 (18.54)	19	8.31	4.37
	Total	24	121.86 (100.00)	44.47 (36.49)	46.01 (37.76)	31.38 (25.75)	37	5.08	3.29
3	<u>Khamgaon-Tek Lift Irrigation Scheme</u>								
	Less than 5.00	13	29.15 (100.00)	22.91 (78.59)	4.74 (16.26)	1.50 (5.15)	13	2.24	2.24
	5.00 to 9.99	9	40.66 (100.00)	28.86 (70.98)	9.68 (23.81)	2.12 (5.21)	9	4.52	4.52
	10.00 to 14.99	11	96.71 (100.00)	48.32 (49.96)	37.14 (38.40)	11.25 (11.64)	15	8.79	6.45
	15.00 and above	11	72.79 (100.00)	37.17 (51.06)	28.57 (39.25)	7.05 (9.69)	13	6.62	5.60
Total	44	239.31 (100.00)	137.26 (57.36)	80.13 (33.48)	21.92 (9.16)	50	5.44	4.79	
4	<u>Pimpore-Washere Lift Irrigation Scheme</u>								
	Less than 5.00	14	27.68 (100.00)	20.00 (72.25)	6.93 (25.04)	0.75 (2.71)	25	1.98	1.11
	5.00 and above	5	30.49 (100.00)	18.50 (60.67)	8.42 (27.62)	3.57 (11.71)	14	6.10	2.18
Total	19	58.17 (100.00)	38.50 (66.18)	15.35 (26.39)	4.32 (7.43)	39	3.06	1.49	
5	<u>Bhade Lift Irrigation Scheme</u>								
	Less than 2.50	14	22.58 (100.00)	11.45 (50.71)	10.13 (44.86)	1.00 (4.43)	35	1.61	0.65
	2.50 to 4.99	14	39.35 (100.00)	16.92 (43.00)	15.28 (38.83)	7.15 (18.17)	49	2.81	0.80
	5.00 to 9.99	12	63.61 (100.00)	23.35 (36.71)	30.61 (48.12)	9.65 (15.17)	55	5.30	1.16
	10.00 and above (Less than 50% irrigable area)	8	50.15 (100.00)	18.85 (37.59)	26.85 (53.54)	4.45 (8.87)	28	6.27	1.79
	10.00 and above (More than 50% irrigable area)	7	130.87 (100.00)	47.90 (36.60)	47.10 (35.99)	35.87 (27.41)	45	18.70	2.91
Total	55	306.56 (100.00)	118.47 (38.64)	129.97 (42.40)	58.12 (18.96)	212	5.57	1.45	

(Figures in brackets indicate percentages)

is based on the experiences of the farmers about relationships between the quality and productivity of the land. According to the classification, the heavy soil is the best land of the area. This land has black to brown colour, is deep, has fine structure and texture, and better water holding capacity. The light soil is of an inferior type, sometimes rocky and liable to erosion. Fields are not levelled and in most cases have very thin top soil. The colour varies from reddish to brown. This land is also called Kal land. It is comparatively less productive. The medium soil is in between the heavy and light soils. It has brown colour, medium depth and has moderate water holding capacity. It is seen from the table that the irrigable command areas of all the projects were largely composed of better quality (medium to heavy) of soil. More than 90 per cent of the irrigable command area was reported to be of better quality soil in the Khamgaon-Tek and Pimpare-Waghera projects. The average per farm irrigable command area in the different projects was 6.84 acres in Koregaon-Mul, 5.08 acres in Naigaon, 5.44 acres in Khamgaon-Tek, 3.06 acres in Pimpare-Waghera, and 5.57 acres in Bhade.

Land utilisation and crop patterns without irrigation in the irrigable command areas of the projects are presented in Table 4.4. It is to be noted that as mentioned in Chapter II, these data are an average of the cropping

Table 4.4. Land utilisation and crop patterns without irrigation in the irrigable command areas of the sample farms in the lift irrigation schemes. (area in acres)

Sr. No.	Size of the cultivated holdings	Irrigable command area	Fallow	Net cultivated area Cols. (3-4)	Unirrigated crops					
					Jowar	Bajra	Total cereals	Groundnut	Pulses	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1.	<u>Koregaon-Mul Lift Irrigation Scheme</u>									
	Less than 10.00	44.67	6.06	38.61	24.84	11.42	36.26	2.35	-	38.61
	10.00 to 19.99	73.59	7.09	66.50	40.80	14.75	55.55	1.53	9.40	65.50
	20.00 and above	134.98	38.03	96.95	59.68	23.47	83.15	4.10	9.70	96.95
	Total	253.24 (100.00)	51.18 (20.21)	202.06 (79.79)	125.32 (62.02)	49.64 (24.57)	174.98 (86.59)	8.00 (3.96)	19.10 (9.45)	202.06 (100.00)
2.	<u>Nainaon Lift Irrigation Scheme</u>									
	Less than 5.00	21.36	1.25	20.11	20.11	-	20.11	-	-	20.11
	5.00 to 9.99	17.44	2.00	15.44	11.97	-	11.97	-	3.47	15.44
	10.00 and above	83.06	12.80	70.26	34.82	21.22	56.04	-	14.22	70.26
	Total	121.86 (100.00)	16.05 (13.17)	105.81 (86.83)	66.90 (63.23)	21.22 (20.05)	88.12 (83.28)	- (-)	17.69 (16.72)	105.81 (100.00)
3.	<u>Khamgaon-Tek Lift Irrigation Scheme</u>									
	Less than 5.00	29.15	0.63	28.52	22.00	6.52	28.52	-	-	28.52
	5.00 to 9.99	40.66	0.60	40.06	20.64	19.42	40.06	-	-	40.06
	10.00 to 14.99	96.71	10.90	85.81	35.17	30.64	65.81	-	20.00	85.81
	15.00 and above	72.79	8.23	64.56	21.17	23.39	44.56	-	20.00	64.56
Total	239.31 (100.00)	20.36 (8.51)	218.95 (91.49)	98.98 (45.21)	79.97 (36.52)	178.95 (81.73)	-	40.00 (18.27)	218.95 (100.00)	
4.	<u>Pimsoare-Waghera Lift Irrigation Scheme</u>									
	Less than 5.00	27.68	5.79	21.89	-	-	-	12.70	9.19	21.89
	5.00 and above	30.49	10.32	20.17	3.57	2.50	6.07	6.10	8.00	20.17
Total	58.17 (100.00)	16.11 (27.69)	42.06 (72.31)	3.57 (8.49)	2.50 (5.94)	6.07 (14.43)	18.80 (44.70)	17.19 (40.67)	42.06 (100.00)	

Continued..

Table 4.4: contd.

Sr. No.	Size of the cultivated holdings	Irrigable command area	Fallow	Net cultivated area Cols. (3-4) (5)	Area cropped more than once (6)	Irrigated crops					
						Wheat (7)	Jowar (8)	Local bajra (9)	Hybrid bajra (10)	Gram (11)	Kharif onion (12)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
5	<u>Bhade Lift Irrigation Scheme</u>										
	Less than 2.50	26.05	1.50	24.55	4.30	0.25	4.80	3.50	2.50	-	0.66
	2.50 to 4.99	45.95	1.00	44.95	7.65	1.48	8.40	5.18	3.28	-	0.62
	5.00 to 9.99	78.61	1.87	76.74	10.02	2.50	7.07	6.37	3.60	-	2.00
	10.00 and above (Less than 50% irrigable area)	60.15	-	60.15	10.35	3.00	6.35	4.27	2.16	2.50	1.80
	10.00 and above (More than 50% irrigable area)	142.62	6.27	136.35	21.80	10.30	14.15	7.75	5.12	2.57	3.20
Total	353.38 (100.00)	10.64 (3.01)	342.74 (96.99)	54.12 (15.79)*	17.53 (4.42)	40.77 (10.27)	27.07 (6.81)	16.66 (4.20)	5.07 (1.28)	8.28 (2.09)	

Sr. No.	Size of the cultivated holdings	Irrigated crops				Unirrigated crops			Total (20)
		Habi Onion (13)	Cotton (14)	Sugarcane (15)	Others (16)	Jowar (17)	Bajra (18)	Pulses (19)	
5	<u>Bhade Lift Irrigation Scheme</u>								
	Less than 2.50	0.78	-	-	0.75	10.25	5.36	-	28.85
	2.50 to 4.99	0.90	-	0.75	1.25	19.55	10.00	1.19	52.60
	5.00 to 9.99	3.00	2.10	3.10	1.40	30.97	17.37	7.28	86.76
	10.00 and above (Less than 50% irrigable area)	2.70	2.25	2.75	1.20	17.80	10.50	13.22	70.50
	10.00 and above (More than 50% irrigable area)	4.80	7.75	6.25	2.00	36.86	36.04	21.36	158.15
Total	12.18 (3.07)	12.10 (3.05)	12.85 (3.24)	6.60 (1.66)	115.43 (29.09)	79.27 (19.97)	43.05 (10.85)	396.86 (100.00)	

(Figures in brackets indicate percentages) * Percentage to the net cultivated area.

patterns in good, bad and indifferent agricultural years in the recent past in the region and do not refer to a particular year. It is seen from the table that only 3 per cent of the irrigable command area under the Bhade lift irrigation scheme^{*} was under permanent fallow (i.e., cultivable land but not cultivated for a long period plus cultivable waste which can be brought under irrigation) before irrigation. This was 20 per cent, 13 per cent, 9 per cent and 28 per cent in Koregaon-Mul, Naigaon, Khangaon-Tek and Pimpare-Waghare Lift irrigation schemes respectively. Land under current fallow (i.e., land not cultivated for one year) was not reported in any of the command areas before construction of the projects.

As for crop pattern, it is seen from the table that only dry crops were grown in the areas of the four lift irrigation schemes in Haveli Taluka. It means, these areas were completely unirrigated before introduction of the lift irrigation schemes. The common features of land use in the project areas were typical of the scarcity areas of Western Maharashtra. Crops were grown, depending upon the whims of monsoon, either in the kharif or in the rabi season. Double cropping was a very rare phenomenon.

* Before lift irrigation scheme in Bhade village, the land of the project was not leased out to the Nimbkar Company. Therefore, irrigable command area of the project shown in the table is inclusive of the land leased out to the Company during 1972-73.

Cereals were predominantly grown in the areas. Among cereals, jowar was dominant. A difference in the crops grown in the command area of the Pimpare-Waghare project is observed from the table. Unlike other command areas, cereals did not dominate the crop pattern in the area under this project, but groundnut and pulses before irrigation. The reasons for this will be discussed subsequently.

Situation in the project area in Bhade village was different in respect of irrigation facility before the lift irrigation scheme. It is reported that before construction of the scheme, 243 acres were seasonally irrigated from 61 existing wells in the project area. Out of this, 125 acres (more than 51 per cent) were cropped more than once. Various crops like wheat, jowar, hybrid and local bajra, onion, cotton, sugarcane, etc., were grown under well irrigation. Crop pattern in the unirrigated command area of the Bhade lift irrigation scheme was not different from that of crop patterns in the other project areas in Haveli Taluka.

Table 4.5 shows the land utilisation patterns in the irrigable command areas of the lift irrigation schemes during 1972-73 by which time irrigation water from the lift schemes had become available. It is seen from the table that in all the irrigable command areas of the projects, land under permanent fallow had significantly declined; it almost nil in the Pimpare-Waghare Project, during 1972-73.

Table 4.5. Land utilisation patterns in the irrigable command areas of the sample farms in the lift irrigation schemes during 1972-73.

(area in acres)

Sr. No.	Size of the cultivated holdings	No. of farms	Irrigable command area	Permanent fallow	Current fallow	Net cultivated area			Area cropped more than once	Gross cropped area	
						Irrigated	Unirrigated	Total		Irrigated	Unirrigated
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Koregaon-Mul Lift Irrigation Scheme										
	Less than 10.00	15	44.67 (100.00)	0.50 (1.12)	1.55 (3.47)	31.29 (70.05)	11.33 (25.36)	42.62 (95.41)	6.67	37.96	11.33
	10.00 to 19.99	11	73.59 (100.00)	5.30 (7.20)	6.83 (9.28)	49.93 (67.85)	11.53 (15.67)	61.46 (83.52)	11.83	61.76	11.53
	20.00 and above	11	134.98 (100.00)	24.75 (18.33)	26.09 (19.33)	56.00 (41.49)	28.14 (20.85)	84.14 (62.34)	22.93	78.93	28.14
	Total	37	253.24 (100.00)	30.55 (12.06)	34.47 (13.61)	137.22 (54.19)	51.00 (20.14)	188.22 (74.33)	41.43	178.65	51.00
2	Naigaon Lift Irrigation Scheme										
	Less than 5.00	7	21.36 (100.00)	- (-)	1.72 (8.07)	14.79 (69.24)	4.85 (22.71)	19.64 (91.95)	5.48	20.27	4.85
	5.00 to 9.99	7	17.44 (100.00)	1.00 (5.73)	2.00 (11.47)	11.27 (64.62)	3.17 (18.18)	14.44 (82.80)	5.26	16.53	3.17
	10.00 and above	10	83.06 (100.00)	8.53 (10.27)	11.27 (13.57)	39.52 (47.58)	23.74 (28.58)	63.26 (76.16)	23.77	63.29	23.74
	Total	24	121.86 (100.00)	9.53 (7.82)	14.99 (12.30)	65.58 (53.82)	31.76 (26.06)	97.34 (79.88)	34.51	100.09	31.76
3	Khangaon-Tek Lift Irrigation Scheme										
	Less than 5.00	13	29.15 (100.00)	0.78 (2.68)	1.27 (4.35)	22.63 (77.63)	4.47 (15.34)	27.10 (92.97)	2.68	25.31	4.47
	5.00 to 9.99	9	40.66 (100.00)	0.60 (1.48)	2.67 (6.57)	30.87 (75.92)	6.52 (16.03)	37.39 (91.95)	3.32	34.19	6.52
	10.00 to 14.99	11	96.71 (100.00)	5.65 (5.84)	12.88 (13.32)	51.68 (53.44)	26.81 (27.40)	78.48 (80.84)	18.37	70.05	26.50
	15.00 and above	11	72.79 (100.00)	3.23 (4.44)	5.20 (7.14)	55.75 (76.59)	8.61 (11.83)	64.36 (88.42)	11.43	67.18	8.61
	Total	44	239.31 (100.00)	10.26 (4.29)	22.02 (9.20)	160.93 (67.25)	46.10 (19.26)	207.03 (86.51)	35.80	196.73	46.10
4	Pimpore-Waghare Lift Irrigation Scheme										
	Less than 5.00	14	27.68 (100.00)	- (-)	0.52 (1.88)	17.68 (63.87)	9.48 (34.25)	27.16 (98.12)	10.06	27.74	9.48
	5.00 and above	5	30.49 (100.00)	0.23 (0.75)	0.22 (0.73)	12.84 (42.11)	17.20 (56.41)	30.04 (98.52)	0.42	13.26	17.20
	Total	19	58.17 (100.00)	0.23 (0.40)	0.74 (1.27)	30.52 (52.47)	26.68 (45.86)	57.20 (98.33)	10.48	41.00	26.68
5	Bhade Lift Irrigation Scheme										
	Less than 2.50	14	22.58 (100.00)	1.50 (6.64)	1.00 (4.43)	14.95 (66.21)	5.13 (22.72)	20.08 (88.93)	-	14.95	5.13
	2.50 to 4.99	14	39.35 (100.00)	1.00 (2.54)	0.72 (1.83)	19.66 (49.96)	17.97 (45.67)	37.63 (95.63)	-	19.66	17.97
	5.00 to 9.99	12	63.61 (100.00)	1.87 (2.94)	5.50 (8.65)	35.06 (55.12)	21.18 (33.29)	56.24 (88.41)	-	35.06	21.18
	10.00 and above (Less than 50% irrigable area)	8	50.15 (100.00)	- (-)	8.60 (17.15)	32.40 (64.60)	9.15 (18.25)	41.55 (82.85)	-	32.40	9.15
	10.00 and above (More than 50% irrigable area)	7	130.87 (100.00)	6.27 (4.79)	24.10 (18.42)	73.30 (56.01)	27.20 (20.58)	100.50 (76.79)	-	73.30	27.20
	Total	55	306.56 (100.00)	10.64 (3.47)	39.92 (13.02)	175.37 (57.21)	80.63 (26.30)	256.00 (83.51)	-	175.37	80.63

(Figures in brackets indicate percentages)

However, substantial land in all the project areas, except Pimpare-Waghare, was kept under current fallow during the year. This change in land utilisation indicates the process of development of irrigation in the project areas. The farmers reported that all the permanent fallow land would come under irrigation after levelling and making it suitable for irrigated farming. They also reported that the land kept fallow in the current year had been deliberately so kept to enable land ^{levelling} operations in preparation for irrigation.

It is observed from the table that more than 50 per cent of the total irrigable command area in all the schemes was brought under irrigation during 1972-73, leaving a potential balance of another 50 per cent to be developed in future. Nevertheless, development of irrigation in the Bhade lift irrigation scheme was remarkable as compared to the four projects in Haveli Taluka. Since the construction of all the lift projects in Haveli Taluka was completed by 1970, this means that these projects had taken about 3 years to achieve irrigation development of 50 per cent by 1972-73. In the Bhade lift irrigation scheme, the same performance took place in the first year after completion of the project. It appears from the land use data that the unirrigated land was sown only once, while some of the irrigated land was sown more than once in the project areas in Haveli Taluka. No area had been sown more than

once in the command area of the Bhade lift irrigation in 1972-73, the year during which the scheme was completed, since the year was a famine year and any cropping in kharif season was almost impossible. The lift irrigation scheme started working in September 1972 and therefore only rabi crops could be grown.

Table 4.6 gives the land utilisation patterns on the total cultivated areas of the sample farms in the lift irrigation schemes. The land outside the lift irrigation schemes was both irrigated and unirrigated. The increase in the total cropped area was, therefore, accounted for by the irrigated and dry lands outside the command areas.

Details of irrigated and unirrigated crop patterns in the irrigable command areas of the projects are given in Table 4.7. Cereals accounted for about 53 per cent, 46 per cent, 44 per cent and 73 per cent of the total irrigated area in the command areas of Koregaon, Naigaon, Khaugaon, and Bhade lift irrigation schemes respectively. Cereals were not grown under irrigation in the command area of the Pimpri-Waghare scheme for the following reasons:

(1) This lift irrigation scheme is located adjacent to the industrial area of Pune City. The small command area is situated within the Gaonhan (i.e., the village residential area proper) of the village, there being no other agricultural land in the vicinity. Consequently, all farmers reported that cultivation of jowar and bajra on this land

Table 4.6. Land utilisation patterns on the total cultivated areas of the sample farms in the lift irrigation schemes during 1972-73

(Area in acres)

Sr. No.	Size of the cultivated holdings	No. of farms	Total cultivated area	Permanent fallow	Current fallow	Net cultivated area			Area cropped more than once	Gross cropped area	
						Irrigated	Unirrigated	Total		Irrigated	Unirrigated
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Koregaon-Mul Lift Irrigation Scheme										
	Less than 10.00	15	99.11 (100.00)	4.15 (4.19)	5.53 (5.58)	37.29 (37.62)	52.14 (52.61)	89.43 (90.23)	8.67	45.96	52.14
	10.00 to 19.99	11	168.26 (100.00)	15.53 (9.23)	11.90 (7.07)	72.68 (43.20)	68.15 (40.50)	140.83 (83.70)	13.83	86.51	68.15
	20.00 and above	11	445.02 (100.00)	85.08 (19.12)	97.81 (21.98)	91.00 (20.45)	171.13 (38.45)	262.13 (58.90)	24.93	115.93	171.13
	Total	37	712.39 (100.00)	104.76 (14.71)	115.24 (16.18)	200.97 (28.21)	291.42 (40.90)	492.39 (69.11)	47.43	248.40	291.42
2	Naigaon Lift Irrigation Scheme										
	Less than 5.00	7	21.36 (100.00)	(-)	1.72 (8.07)	14.79 (69.24)	4.85 (22.71)	19.64 (91.95)	5.48	20.27	4.85
	5.00 to 9.99	7	61.17 (100.00)	2.26 (3.69)	2.40 (3.93)	22.69 (37.09)	33.82 (55.29)	56.51 (92.38)	6.51	29.20	33.82
	10.00 and above	10	162.51 (100.00)	25.43 (15.65)	18.27 (11.24)	58.62 (36.07)	60.19 (37.04)	118.81 (73.11)	23.77	82.39	60.19
	Total	24	245.04 (100.00)	27.69 (11.30)	22.39 (9.14)	96.10 (39.22)	98.86 (40.34)	194.96 (79.56)	35.76	131.86	98.86
3	Khangaon-Tek Lift Irrigation Scheme										
	Less than 5.00	13	35.44 (100.00)	0.90 (2.54)	1.27 (3.58)	22.63 (63.85)	10.64 (30.03)	33.27 (93.88)	2.68	25.31	10.64
	5.00 to 9.99	9	74.94 (100.00)	3.65 (4.87)	2.67 (3.56)	33.87 (45.20)	34.75 (46.37)	68.62 (91.57)	3.32	37.19	34.75
	10.00 to 14.99	11	134.92 (100.00)	17.77 (13.17)	12.88 (9.55)	59.43 (44.05)	44.84 (33.23)	104.27 (77.28)	18.37	77.80	44.84
	15.00 and above	11	295.13 (100.00)	69.58 (23.58)	5.20 (1.76)	76.12 (25.79)	144.23 (48.87)	220.35 (74.65)	13.55	89.67	144.23
Total	44	540.43 (100.00)	91.90 (17.00)	22.02 (4.07)	192.05 (35.54)	234.46 (43.38)	426.51 (78.92)	37.92	229.97	234.46	
4	Pimpore-Jaghare Lift Irrigation Scheme										
	Less than 5.00	14	34.11 (100.00)	(-)	0.52 (1.52)	17.68 (51.84)	15.91 (46.64)	33.59 (98.48)	10.06	27.74	15.91
	5.00 and above	5	58.56 (100.00)	10.68 (18.24)	0.22 (0.37)	12.84 (21.93)	34.82 (59.46)	47.66 (81.39)	0.42	13.26	34.82
	Total	19	92.67 (100.00)	10.68 (11.52)	0.74 (0.80)	30.52 (32.93)	50.73 (54.74)	81.25 (87.67)	10.48	41.00	50.73
5	Bhade Lift Irrigation Scheme										
	Less than 2.50	14	22.58 (100.00)	1.50 (6.64)	1.00 (4.43)	14.95 (66.21)	5.13 (22.72)	20.08 (88.93)	-	14.95	5.13
	2.50 to 4.99	14	48.02 (100.00)	2.45 (5.10)	3.09 (6.44)	19.66 (40.94)	22.82 (47.52)	42.48 (88.46)	-	19.66	22.82
	5.00 to 9.99	12	80.91 (100.00)	5.87 (7.25)	5.50 (6.80)	35.56 (43.95)	33.98 (42.00)	69.54 (85.95)	-	35.56	33.98
	10.00 and above (Less than 50% irrigable area)	8	177.11 (100.00)	61.67 (34.82)	8.60 (4.86)	41.90 (23.65)	64.94 (36.67)	106.84 (60.32)	-	41.90	64.94
	10.00 and above (More than 50% irrigable area)	7	169.93 (100.00)	20.94 (12.32)	24.10 (14.18)	73.30 (43.14)	51.59 (30.36)	124.89 (73.50)	-	73.30	51.59
Total	55	498.55 (100.00)	92.43 (18.54)	42.29 (8.48)	185.37 (37.18)	178.46 (35.80)	363.83 (72.98)	-	185.37	178.46	

(Figures in brackets indicate percentages)

Table 4.7. Contd...

Irrigated crops							Unirrigated crops				
Vegetables	Sugarcane	Groundnut	Gram	Cotton	Others	Total	Local Jowar	Local bajra	Groundnut	Pulses	Total
4.25	2.19	-	-	-	3.34	37.96	11.33	-	-	-	11.33
4.85	1.32	-	-	-	5.31	61.76	8.95	-	4.58	-	11.53
6.77	4.55	-	-	-	16.27	78.93	28.14	-	-	-	28.14
15.87	8.06	-	-	-	24.92	178.65	46.42	-	4.58	-	51.00
(8.88)	(4.51)	(-)	(-)	(-)	(13.55)	(100.00)	(91.02)	(-)	(3.98)	(-)	(100.00)
3.23	1.00	-	-	-	2.98	20.27	4.85	-	-	-	4.85
3.77	0.45	-	-	-	0.32	16.53	3.17	-	-	-	3.17
7.65	2.07	-	-	-	3.49	63.29	23.74	-	-	-	23.74
14.65	3.52	-	-	-	6.79	100.09	31.76	-	-	-	31.76
(14.64)	(3.52)	(-)	(-)	(-)	(6.78)	(100.00)	(100.0)	(-)	(-)	(-)	(100.00)
1.13	-	-	-	-	0.97	25.31	4.47	-	-	-	4.47
3.02	4.78	0.47	-	-	1.42	34.19	6.52	-	-	-	6.52
9.07	2.15	4.42	-	-	2.42	70.05	26.50	-	-	-	26.50
10.58	12.59	3.38	-	-	2.72	67.16	8.61	-	-	-	8.61
23.80	19.52	8.27	-	-	7.53	196.73	46.10	-	-	-	46.10
(12.10)	(9.92)	(4.20)	(-)	(-)	(3.83)	(100.00)	(100.0)	(-)	(-)	(-)	(100.00)
3.87	-	4.04	-	-	2.30	27.74	1.52	1.65	5.33	0.98	9.48
0.72	-	0.95	-	-	1.37	13.26	2.00	3.10	6.10	6.00	17.20
4.59	-	4.99	-	-	3.67	41.00	3.52	4.75	11.43	6.98	26.68
(11.20)	(-)	(12.17)	(-)	(-)	(8.95)	(100.00)	(13.19)	(17.80)	(42.84)	(26.17)	(100.00)
-	-	-	-	1.00	-	14.95	5.13	-	-	-	5.13
-	-	-	0.08	-	-	19.66	17.97	-	-	-	17.97
-	0.50	-	1.70	2.50	1.45	35.06	21.18	-	-	-	21.18
-	3.00	-	0.90	3.00	0.50	32.40	9.15	-	-	-	9.15
-	4.00	-	2.45	3.00	6.40	73.30	27.20	-	-	-	27.20
(-)	7.50	(-)	5.13	9.50	8.35	175.37	80.63	(-)	(-)	(-)	80.63
(-)	(4.28)	(-)	(2.92)	(5.42)	(4.76)	(100.00)	(100.0)	(-)	(-)	(-)	(100.00)

Table 4.7. Irrigated and unirrigated crop patterns in the irrigable command areas of the sample farms in the lift irrigation schemes during 1972-73

(area in acres)

Sr. No.	Size of the cultivated holdings	Irrigated crops								
		Paddy	Wheat	Local Jowar	Hybrid jowar	Local bajra	Hybrid bajra	Total cereals	Kharif onion	Rabi onion
1	Koregaon-Mul Lift Irrigation Scheme									
	Less than 10.00	3.42	3.62	6.90	-	2.84	-	16.78	9.91	1.49
	10.00 to 19.99	3.19	5.67	10.13	-	1.72	-	40.71	6.46	3.11
	20.00 and above	7.32	10.95	14.47	-	4.26	-	37.00	11.11	5.23
	Total	13.93 (7.80)	20.24 (11.33)	31.50 (28.83)	(-)	8.82 (4.94)	(-)	94.49 (52.90)	27.48 (15.98)	7.83 (4.38)
2	Nairgaon Lift Irrigation Scheme									
	Less than 5.00	-	4.29	1.70	-	0.55	1.62	8.36	2.70	2.00
	5.00 to 9.99	-	0.57	0.77	-	1.40	3.20	5.94	0.05	6.00
	10.00 and above	-	9.44	9.62	-	9.18	3.77	32.01	8.08	9.99
	Total	(-)	14.30 (14.29)	12.09 (12.08)	(-)	11.13 (11.12)	8.79 (8.78)	46.31 (46.27)	10.83 (10.82)	17.99 (17.97)
3	Khangaon-Tek Lift Irrigation Scheme									
	Less than 5.00	0.31	5.75	6.44	-	0.62	-	13.12	3.35	6.74
	5.00 to 9.99	0.55	3.02	11.00	-	2.79	-	17.36	2.90	4.24
	10.00 to 14.99	3.60	7.99	14.69	-	4.97	-	31.25	8.03	12.71
	15.00 and above	1.91	3.47	14.54	-	4.87	-	24.79	4.18	8.94
Total	6.37 (3.24)	20.23 (10.28)	46.67 (23.72)	(-)	13.25 (5.74)	(-)	86.52 (43.98)	18.46 (9.38)	32.63 (16.59)	
4	Pimpere-Naghere Lift Irrigation Scheme									
	Less than 5.00	-	-	-	-	-	-	-	-	17.53
	5.00 and above	-	-	-	-	-	-	-	-	10.22
Total	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	27.75 (67.68)
5	Rhate Lift Irrigation Scheme									
	Less than 2.50	-	3.03	4.57	4.604	-	-	12.20	-	1.75
	2.50 to 4.99	-	4.50	4.95	8.53	-	-	17.98	-	1.60
	5.00 to 9.99	-	6.22	7.90	8.00	-	-	22.12	-	6.79
	10.00 and above (Less than 50% irrigable area)	-	4.30	13.45	4.25	-	-	22.00	-	3.00
	10.00 and above (More than 50% irrigable area)	-	13.00	15.20	24.75	-	-	52.95	-	4.50
Total	(-)	31.05 (17.70)	46.07 (26.27)	50.13 (28.59)	(-)	(-)	127.25 (72.56)	(-)	17.64 (10.06)	

(Figures in brackets indicate percentages)

Continued.....

was just impossible as these crops suffer great loss due to heavy attack of the birds.*

(2) Moreover, majority of the farm families were not totally dependent on the agriculture for their livelihood because of easy availability of non-agricultural wage labour on regular basis in the factories.

(3) All the beneficiaries were small land holders and only a part of their holdings lay within the command area of the scheme. This situation made it possible for them to go in for cash crops in the command area. This very peculiar location of the command area will have to be taken into account while estimating the benefits of the project in future.

Unlike the situation in the Pimpare-Waghare project, cereals accounted for about three-fourths of the total irrigated command area in the Bhade lift irrigation scheme in 1972-73. Since most of the cropping in this particular year was possible only during the rabi season and that too because of the availability of irrigation from the lift, it was but natural to expect the farmers to comply with

* Apart from this, the location of the command area raised the problem of protection of the standing crops from village cattle, cultivation of the crops in this command area, for example, became possible only when permanent fence was put around the area by the farmers.

the restrictions placed by the Government on use of water from the reservoir for growing only food grains. Among cereals, maximum land was reported under hybrid jowar in the Bhade lift irrigation scheme. However, hybrid jowar was not grown in any of the four command areas in Haveli taluka. The reasons for this are discussed in the next chapter.

The most important cash crop in all the command areas was onion that accounted for 20 per cent of the total irrigated area in Koregaon, 33 per cent in Naigaon, 26 per cent in Khaugaon, 68 per cent in Pimpare-Waghare and 10 per cent in Bhade. Onion was grown in the kharif as well as in the rabi season in the first three lift irrigation schemes and only in rabi in the remaining schemes. The high percentage of area under onion in the Pimpare-Waghare lift irrigation scheme is justified from the earlier discussion. Vegetable(s) (other than onion) was the next important cash crop. Sugarcane was also grown in the command areas but only in small patches, because, as reported by the farmers, the land had not yet been properly developed. They also reported that after proper development of the land, sugarcane would get the first priority as a cash crop in the crop pattern in future. The unirrigated crop pattern in the command areas shows that most of the land was put under rabi jowar.² The comparison of land use in irrigated and

² In 1972-73, there was widespread failure of rains in large parts of Maharashtra State till the end of August.

unirrigated lands in the command areas, gives a clear indication of the change in land use following the introduction of irrigation. With irrigation, the farmers seem to display a propensity to gradually change from cereal farming to cultivation of cash crops like onion, vegetables and sugarcane.

Irrigated and unirrigated crop patterns on the total cultivated areas of the sample farms are presented in Table 4.6. It is seen from the table that the irrigated land outside the projects was mainly used for growing sugarcane and jowar. Like in the command areas, jowar was predominantly grown on the dry land outside the projects.

These various types of data are used in estimating the financial profitability and the social benefit-cost of the proposed lift irrigation schemes in the next chapters.

Therefore, unirrigated kharif crops could not be sown. During the year rains started around the middle of September. This made it possible to grow rabi jowar only. But unfortunately, a dry spell prevailed after sowing of the crop. As a result, yield of jowar was very low. This caused widespread famine in the State.

Table 4.8. Contd...

Irrigated crops							Unirrigated crops				
Vege- tables	Sugar- cane	Ground- nut	Gram	Cotton	Others	Total	Local jowar	Local bajra	Ground- nut	Pulses	Total
4.25	2.19	-	-	-	-	-	-	-	-	-	-
4.85	6.07	-	-	-	3.24	45.96	52.14	-	-	-	52.14
6.77	17.05	-	-	-	5.81	86.51	63.57	-	-	-	63.57
15.87	25.31	-	-	-	16.27	115.93	171.13	-	4.58	-	171.13
(6.39)	(10.19)	(-)	(-)	(-)	25.42	248.40	286.86	-	4.58	-	291.42
					(10.23)	(100.00)	(98.43)	(-)	(1.57)	(-)	(100.00)
3.23	1.00	-	-	-	2.98	20.27	4.85	-	-	-	4.85
5.02	1.95	-	-	-	0.32	29.20	33.82	-	-	-	33.82
7.65	7.07	-	-	-	3.49	82.39	60.19	-	-	-	60.19
15.90	10.02	-	-	-	6.79	131.86	98.86	-	-	-	98.86
(12.06)	(7.60)	(-)	(-)	(-)	(5.15)	(100.00)	(100.00)	(-)	(-)	(-)	(100.00)
1.13	-	-	-	-	0.97	25.31	10.64	-	-	-	10.64
3.02	5.28	0.47	-	-	1.42	37.19	34.75	-	-	-	34.75
9.07	4.15	6.17	-	-	2.42	77.80	44.84	-	-	-	44.84
10.58	23.84	3.38	-	-	2.72	89.67	144.23	-	-	-	144.23
23.60	33.27	10.02	-	-	7.53	229.97	234.46	-	-	-	234.46
(10.35)	(14.47)	(4.36)	(-)	(-)	(3.26)	(100.00)	(100.00)	(-)	(-)	(-)	(100.00)
3.87	-	4.04	-	-	2.30	27.74	1.52	1.65	11.76	0.98	15.91
0.72	-	0.95	-	-	1.37	13.26	11.57	3.10	8.60	11.55	34.82
4.59	-	4.99	-	-	3.67	41.00	13.09	4.75	20.36	12.53	50.73
(11.20)	(-)	(12.17)	(-)	(-)	8.95)	(100.00)	(25.60)	(9.36)	(40.14)	(24.70)	(100.00)
-	-	-	-	1.00	-	14.95	5.13	-	-	-	5.13
-	-	-	0.08	-	-	19.66	22.82	-	-	-	22.82
-	0.50	-	1.70	2.50	1.45	35.56	33.98	-	-	-	33.98
-	4.00	-	0.90	4.00	0.50	41.90	64.94	-	-	-	64.94
-	4.00	-	2.45	3.00	6.40	73.30	51.59	-	-	-	51.59
-	8.50	-	5.13	10.50	8.35	185.37	178.46	-	-	-	178.46
(-)	(4.59)	(-)	(2.77)	(5.66)	(4.51)	(100.00)	(100.00)	(-)	(-)	(-)	(100.00)

Table 4.6. Irrigated and unirrigated crop patterns on the total cultivated areas of the sample farms in the lift irrigation schemes during 1972-73
(area in acres)

Sr. No.	Size of the cultivated holding	Irrigated crops									
		Paddy	wheat	Local jowar	Hybrid jowar	Local bajra	Hybrid bajra	Total cereals	Kharif onion	Rabi onion	
1.	Koregaon-Mul Lift Irrigation Scheme										
	Less than 10.00	3.42	4.62	11.90	-	4.84	-	24.78	9.91	1.49	
	10.00 to 19.99	4.69	7.67	42.13	-	1.72	-	56.21	10.46	3.11	
	20.00 and above	7.32	10.95	33.97	-	6.26	-	58.50	14.11	3.23	
	Total	15.43 (6.21)	23.24 (9.36)	88.00 (35.43)	(-)	12.82 (5.16)	(-)	139.49 (56.16)	34.48 (13.88)	7.80 (3.15)	
2.	Naigaon Lift Irrigation Scheme										
	Less than 5.00	-	4.29	1.70	-	0.55	1.82	8.36	2.70	2.00	
	5.00 to 9.99	-	0.57	9.44	-	1.40	3.20	14.61	1.30	6.00	
	10.00 and above	-	9.44	23.72	-	9.18	3.77	46.11	8.08	9.99	
	Total	(-)	14.30 (10.84)	34.86 (26.44)	(-)	11.13 (8.44)	8.79 (6.67)	69.08 (52.39)	12.08 (9.16)	17.99 (13.64)	
3.	Khangaon-Tek Lift Irrigation Scheme										
	Less than 5.00	0.31	5.75	6.44	-	0.62	-	13.12	3.35	6.74	
	5.00 to 9.99	0.55	3.02	11.00	-	2.79	-	17.36	5.40	4.24	
	10.00 to 14.99	4.60	7.99	14.69	-	5.97	-	33.25	10.03	12.71	
	15.00 and above	4.03	5.59	20.04	-	4.87	-	34.53	5.68	8.94	
	Total	9.49 (4.12)	22.35 (9.72)	52.17 (22.69)	(-)	14.25 (6.20)	(-)	98.26 (42.73)	24.46 (10.64)	32.63 (14.19)	
4.	Pimpore-Waghare Lift Irrigation Scheme										
	Less than 5.00	-	-	-	-	-	-	-	-	17.53	
	5.00 and above	-	-	-	-	-	-	-	-	10.22	
	Total	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	27.75 (67.68)	
5.	Bhade Lift Irrigation Scheme										
	Less than 2.50	-	3.03	4.57	4.60	-	-	12.20	-	1.75	
	2.50 to 4.99	-	4.50	4.95	8.53	-	-	17.98	-	1.60	
	5.00 to 9.99	-	6.22	8.40	8.00	-	-	22.62	-	6.79	
	10.00 and above (Less than 50% irrigable area)	-	4.30	15.45	7.75	-	-	27.50	-	5.00	
	10.00 and above (More than 50% irrigable area)	-	13.00	15.20	24.75	-	-	52.95	-	4.50	
	Total	(-)	31.05 (16.75)	48.57 (26.20)	53.63 (28.93)	(-)	(-)	133.25 (71.88)	(-)	19.64 (10.59)	

(Figures in brackets indicate percentages)

Continued.....

CHAPTER V

FINANCIAL PROFITABILITY OF THE LIFT IRRIGATION SCHEMES

5.0 Introduction

In this chapter we assess all the lift irrigation schemes in respect of the financial profitability that will most probably result in future from each. The objective of the study is to ascertain if the expected returns from the lift irrigation scheme will be at least worth the costs incurred. Therefore, it is in the first place an exercise in forecasting into the future. Herein lie the problems and limitations of this approach.

In order to estimate the financial profitability of the scheme, we estimate the farm income from crop production in two situations, viz., without irrigation and with irrigation, and deduct the former from the latter to get the net increase in farm income because of irrigation. Then we estimate the project costs and finally calculate the net present worth as well as the internal rate of return of the project. For estimating the farm income without irrigation, crop pattern and input-output data of the crops estimated on the sample farms during the field investigation are used. For estimating the pattern of cropping after irrigation, we first discuss the crops

grown in the area, their yield rates and per acre net returns under irrigated condition and then estimate the economically efficient crop pattern by using the usual budgeting method. The same estimation is also attempted with the help of linear programming technique. Finally, we calculate the total net income under irrigated condition.

The costs of the project are already known. The only capital costs to be estimated are the costs of land development for irrigation, which will be estimated in this chapter.

We have already discussed in the preceding chapter the important structural features of the economy of the sample farms that had partly received the benefits of irrigation during 1972-73. This is an important part of the data on the basis of which we estimate the total income from the command areas of the specific schemes after irrigation. Out of the five lift irrigation schemes selected for the study, one scheme, viz., Koregaon-Mul lift irrigation scheme is taken up for estimation of the financial profitability of the project in detail. In the case of the rest of the schemes, we shall discuss only the distinguishing features in their estimates and avoid repetition of common procedures and problems.

5.1 Koregaon-Mul Lift Irrigation Scheme

Completion of this scheme would make irrigation available to 272 acres in Koregaon-Mul village. In order

to estimate the benefits resulting from the project, the first step is to estimate by how much the farm income will increase because of irrigation. There are quite a few problems involved in this and we shall begin by examining the problems involved in estimating the farm income in the area without irrigation.

5.1.1 Farm Income Without Irrigation

The irrigable command area of the scheme is 272 acres and its farm income from crop production in the absence of irrigation is to be estimated. Though the total irrigable area under the lift was estimated at 272 acres, the actually cropped area out of this before irrigation was only 217 acres. The rest of the land, i.e., 55 acres, was reported as permanent fallow. The estimate of farm income without irrigation, therefore, will be limited to 217 acres. The benefits after irrigation will be supplemental for 217 acres and reclamatory for 55 acres.

The next important thing is to know the distribution of the cultivated area under the various crops. The cropping pattern for the command area under unirrigated condition is based on the reported pattern on the lands of the 37 sample farmers who operated 253 of the 272 acres of the command area. The crop pattern without irrigation is given in Table 5.1. The yield rates for the different crops under unirrigated condition refer not

Table 5.1. Crop pattern without irrigation in the Koregaon-Mul lift irrigation scheme

S.No.	Crops	Area (acres)
1	Jowar	134.61
2	Bajra	53.31
	Total cereals	187.92
3	Groundnut	8.59
4	Pulses	20.52
	Total cropped area	217.03
	Area cropped more than once	-
	Net cropped area	217.03
	Fallow	54.97
	Total irrigable command area	272.00

to the actual yield rate in the year of survey, but to an average of the yield rates in good, poor and indifferent years as obtained from the cultivators. This point has been discussed in Chapter II. For valuation of inputs and outputs, input prices of 1972-73 are used, and for outputs relative price structure already discussed in Chapter II is calculated and used (Relative price structure of inputs is not calculated and used for the reason mentioned there). It is to be noted that in estimating the financial profitability of the schemes, all inputs

and outputs are valued at these estimated market prices.

Estimates of the income without irrigation are presented in Tables 5.2 and 5.3. Table 5.2 gives the average per acre net income from the different crops and Table 5.3 gives the total net income from crop production without irrigation. The value of gross produce includes the value of main produce plus the value of by-product (i.e., fodder). The associated costs include seed, manure, bullock labour, human labour (hired and family), payments to artisans and others, land revenue and other cesses, depreciation of implements, machinery and bullocks and interest on working capital. The total value of crop production in the area before irrigation came to Rs. 57,890. If from this gross value of production total associated costs (i.e., Rs. 30,387) are subtracted then we get the net income from the command area without irrigation, which came to Rs. 27,503. This net income will be gradually foregone in the process of development of irrigation.

It was estimated, on the basis of the data available from the office of the Haveli Taluka Lift Irrigation Federation as well as from the information provided by the farmers that the cultivated command area (i.e. 217 acres) would completely come under irrigation by the fourth year after release of water for irrigation. Water for irrigation was released in 1970-71. This means that

Table 5.2. Average per acre net income from the different crops without irrigation in the Koregaon-Kul lift irrigation scheme.

S.No.	Crops	Season	Main produce in quintals (per acre)	Price per quintal (Rs.)	Value of main produce Cols. (4 x 5) (Rs.)	By-product	Price (Rs.)	Value of by-product Cols. (7 x 8) (Rs.)	Value of gross produce Cols. (6+9) (Rs.)	Associated costs (Rs.)	Net income Cols. (10-11) (Rs.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Jowar	Rabi	1.45	145	210	2.25*	40	90	300	137	163
2	Bajra	Kharif	1.09	125	136	2.00*	20	40	176	132	44
3	Groundnut	Kharif	2.07	184	381	3.20**	10	32	413	225	188
4	Pulses	Kharif	1.33	155	206	1.75**	10	17	223	145	78

* In bundles of hundred stalks

** Cart loads

➤ Values rounded up

Table 5.3. Total net income from the crop production without irrigation in the Koregaon-Kul lift irrigation scheme

Crops (1)	Area (acres) (2)	Value of gross produce Rs. (3)	Associated costs Rs. (4)	Net income Cols. (3-4) Rs. (5)
Jowar	134.61	40383	18442	21941
Bajra	53.31	9383	7037	2346
Groundnut	8.59	3548	1933	1615
Pulses	20.52	4576	2975	1601
Total	217.03	57890	30387	27503

the cultivated area would come completely under irrigation in 1973-74. Therefore, as area under irrigation gradually increases from 1970-71, the unirrigated command area would decline. Consequently, the net income under unirrigated conditions would decline from year to year from 1970-71 to 1973-74. The estimated net incomes foregone under unirrigated condition in each of these years are given in Table 5.4.

Table 5.4. Net income foregone under the progressive irrigation in the Koregaon-Mul lift irrigation scheme

Years (1)	Gross irrigated area (acres) (2)	Value of gross produce from area in col. (2) under dry condition (Rs.) (3)	Associated costs (Rs.) (4)	Net Income Cols. (3-4) (Rs.) (5)
1970-71	130	29864	15675	14189
1971-72	149	34228	17966	16262
1972-73	187	42958	22548	20410
1973-74	252	57890	30387	27503

5.1.2 Farm Income With Irrigation

The next important step is to determine the future crop pattern and then to work out the future farm income under irrigation. We shall examine these in turn.

The technique of estimating the economically efficient crop pattern, i.e., the crop pattern that will maximise income on the farm under irrigation, is governed by a large number of factors like soil types, climatic conditions, discharge of water from the canals and water requirements of the crops, time of sowing and duration of the crops, crop rotations, fodder and food grain consumption needs on the farms, availability of farm labour, etc. We shall examine all these factors in detail along with the net returns from the crops in arriving at the possible crop pattern in future. However, one should not expect that the estimated crop pattern would appear on the farms immediately after water is made available, because, when irrigation is introduced into the area, the whole system of cropping would require some time to adjust itself to it.

We accordingly first estimate the crop pattern and farm income in the area after full development of the project. We then estimate the number of years it may take to come into this full form and the changes in the net income in the process of development of irrigation, that is, from the first year of release of water for irrigation to the estimated date for full development of the project.

5.1.2.1 Crop Pattern With Irrigation

For determining the crop patterns in all the command

areas of the projects we have the following data with us:

(1) Soil types within the irrigable command area and their suitability for the crops.

(2) Water discharge capacity of the pump and water requirements of each crop grown in the area.

(3) Actual pattern of irrigated crops within and outside the command area during 1972-73.

(4) Expectations of farmers regarding the future crop pattern in the area.

(5) Normal yield rates of the different crops grown in the area under irrigation, and

(6) other technical information like time of sowing and harvesting of the crops, crop rotation practices, etc.

The first thing in estimating the economically feasible crop pattern is to make the best judgement, on the basis of the available data, of the possible yield rates of the crops likely to be grown in the area after full development of the project and then estimate the net income of the crops after adjusting for their costs of cultivation. Thereafter, we shall decide on the most feasible future crop pattern in the area.

As mentioned earlier, water for irrigation from the projects in Haveli Taluka was released during 1970-71 and in 1972-73 from the project in Bhade village, while the survey of all the projects was conducted in 1972-73. It means, we have data relating to irrigated farming in the

third year of irrigation of the former projects and in the first year of irrigation of the latter project after their completion. These data would therefore provide a fair basis for estimating yields and costs of various irrigated crops in the region. If certain crops which were not very prominently grown in a particular command area under irrigation in 1972-73 were estimated to become important after full development of irrigation, then the relevant data relating to yields and costs were collected from the other irrigated areas in the neighbourhood and used by making suitable adjustments. Besides, data regarding the irrigated crops grown on the land outside the schemes and the information given by the farmers about the irrigation in the area are also used for the purpose. These data furnished us yields as well as costs of cultivation of the crops grown in the area. We have set down, in each case, the data on which we have based ourselves in respect of each crop.

5.1.2.1.1 Irrigated Crops and their Estimates of Yields

The average per acre yields of the irrigated crops within and outside the command areas during 1972-73, and farmers' estimates of the crop yields after full development of irrigation in all the projects are presented in Appendix 5-1. It is observed from these data that the estimates of the possible yield rates of the crops after

full development of irrigation would be more or less the same in all the command areas of the projects as these projects are located in the same agro-climatic conditions. The different crops grown in the area under irrigation and their expected average per acre yields after full development of the land are discussed below. In the following we have discussed only the main products of the crops. However, the by-products of the crops will also be taken into account while estimating the gross income from crop production. The estimates of the by-products will be made subsequently.

(1) P a d d y

Paddy is grown on the heavy and medium soils. This crop requires heavy and frequent waterings. The average per acre yield of paddy in the command area of Koregaon lift irrigation scheme came to 4.95 quintals in our farm business surveys. The farmers reported that the yield was rather low because the crop was grown on land which had not been levelled and had been newly brought under irrigation. Paddy was also reported in the neighbouring irrigated area of Khamgaon village where it was grown on the levelled land. The average per acre yield of this crop was 6.44 quintals, in the irrigated area of Khamgaon project. A slightly higher yield than this was reported on lands outside the project. Improved varieties of paddy like Jaya, Padma, Krishna Sal, Varangal, etc., were reported in

the area. Jaya and Padma are the recently introduced new varieties and the other two, Varangal and Krishna Sal, had been in use for quite some time in the area. The informed cultivators estimated that under careful cultivation and adequate irrigation, Jaya and Padma varieties could give a yield of 7 to 7.5 quintals per acre, while Krishna Sal and Varangal varieties could give a yield of 6 to 7 quintals per acre. On an average, therefore, it would be safe to assume a yield of 6.5 quintals per acre of paddy in the area under irrigated condition.

(2) W h e a t

This crop requires medium to heavy soil. The average yield of wheat in the command area of Koregaon lift irrigation scheme was 4.68 quintals per acre. This yield was low because land was not well-developed. The yield was 5.87 quintals on the land outside the scheme under well irrigation. The land under well irrigation was properly developed but received inadequate irrigations from the wells. The average per acre yield of this crop grown on levelled land and receiving adequate irrigation was 6.36 quintals under the Bhade lift irrigation scheme. The cultivators of all the projects reported that under careful cultivation one could get 6 to 7 quintals of wheat per acre. High yielding varieties of wheat like Kalyan Sona, Sonalika, Sarbati Sona, Niphad-146, etc., are grown in the area. Kalyan Sona, Sonalika and Sarbati Sona are

dwarf varieties of wheat and give a yield of 7 to 7.5 quintals per acre. The other varieties also give more or less the same yield but are of longer duration. It would, therefore, be proper to expect an average yield rate of 6.5 quintals per acre of this crop after full development of the area.

(3) J o w a r

This is an important rabi crop under both irrigated and unirrigated farming in the region. The most popular and commonly accepted variety of Jowar is K-35 (Baldandi) in the area. The survey showed that the average yield of irrigated jowar in the command area of the Koregaon lift irrigation scheme was 3.84 quintals per acre. It was reported that the yield was very low as the land had not been properly developed under irrigation. This crop was also grown on the land outside the scheme, but received hardly two waterings from the Government canal. The average yield of jowar on this land was 4.75 quintals per acre. It was more than 5 quintals under the Khamgaon and Bhade lift irrigation schemes. Informed farmers reported that with three to four timely irrigations and careful cultivation, one could harvest a yield of 5 to 7 quintals of jowar per acre. This crop can be successfully grown even on the light soil, and hence growing jowar on the light soil is a general practice under irrigated farming in this area. The lands with medium to heavy soil are used for other

cash crops. In view of this, it would be reasonable to expect a per acre yield of 5 to 6 quintals of rabi jowar under fully developed irrigation in the scheme.

It is to be noted that despite the enthusiastic talk and propaganda about the hybrid varieties of jowar in the State, the sample farmers in Haveli Taluka were very reluctant to go in for these varieties. Our survey of the project area and neighbourhood showed that not a single acre of irrigated land had been put under hybrid jowar. Two reasons were reported for this. Firstly, these varieties are very susceptible to the pests and diseases, and therefore are risky ventures. Secondly, the yield of stalks, the by-product of hybrid jowar, which is the main fodder for cattle is very low. Moreover, as fodder it is of poor quality. The second reason appears more relevant in irrigated farming areas where there is a much greater scope for cultivation of several cash crops with higher profit margins, but most of these with little or no by-product fit as cattle fodder. It is, therefore, best to ignore hybrid jowar from the estimates of the crop patterns in all the command areas of the projects in Haveli Taluka. But this picture is quite different in the Bhade lift irrigation scheme where a large acreage under hybrid jowar was reported during 1972-73. We shall discuss the reason for this while estimating the crop pattern in the Bhade lift irrigation project.

(4) Bajra

This crop is next in importance to jowar in the region. However, the area under irrigated bajra was very low in all the command areas during 1972-73. The reported reason for this was that under the circumstances of delayed rains in that year and the prejudice of farmers about irrigation, only a few farmers put their land under bajra. There is a great prejudice among the cultivators that if germination of some cereal crops, especially jowar and bajra, takes place after application of irrigation (artificial supply of water) instead of moisture supply from natural precipitation, both germination and subsequent growth of the plants are hampered. However, there is an altogether different method of growing the crops under irrigation if rains are delayed, which the local farmers do not know presently. The method is to water the land first and then sow the seeds, instead of the reverse. We expect that in future the farmers will learn this technique to make the best use of irrigation, as all farmers do in irrigated areas.

Like jowar, this crop can be grown even on the inferior land. In fact, it is the common practice in the region to grow bajra on inferior land. In the command area of the Koregaon lift irrigation project the average yield of irrigated bajra, was reported to be 3.81 quintals. It was 4.72 quintals in the area outside this scheme. In all

the command areas, reported yield of bajra was more or less the same. It would not be improper, therefore, to expect an average per acre yield of 4.5 quintals of local varieties of bajra in the area after full development of irrigation.

Unlike hybrid jowar, hybrid bajra had become very popular among the farmers for its assured and greater yield than the local varieties. However, in 1972-73, hybrid bajra was not grown in most of the command areas because under the circumstances of delayed rains and the lack of irrigation techniques the farmers were not ready to spend on costly items of input, especially seed and fertilisers, for hybrid bajra than local bajra. The farmers reported that during the first two years prior to 1972-73, they had grown hybrid bajra in the area under irrigation and harvested a yield of 6 to 7 quintals per acre. This crop was reported on the farms with irrigation facility in the Naigaon lift irrigation scheme; and they had harvested a yield of 6.54 quintals per acre. In the case of a few farms in Khaugaon village, the average yield of hybrid bajra was 8.15 quintals per acre; but of course, this was under exceptional conditions that are rarely reported by all the farmers. Taking all this into account we safely expect the average yield of hybrid bajra of 6.5 quintals per acre. It may be important to note that hybrid bajra is a shorter duration crop than the local bajra, and

therefore, the farmers may find it more convenient to sow jowar as a second crop after hybrid bajra.

(5) SUGARCANE

Sugarcane is one of the most important cash crops in the region. But in 1972-73, it was grown in small patches in all the command areas of the projects. However, this crop was reported on a larger area outside the projects, which receive perennial supply of irrigation water from the Government canals. Sugarcane requires heavy and deep soil, and a large amount of water throughout the year. This is an annual crop (Suru) in the area and is planted in January-February. The average per acre yield of sugarcane in the command area of the Koregaon project was 42 tonnes. It was 46 tonnes per acre in the area outside the scheme. It was more than 50 tonnes per acre in the Bhade lift irrigation scheme. In the rest of the areas, the yield was about 45 to 50 tonnes. It was noted that sugarcane was grown on the well-levelled and most fertile land. Experienced farmers in the cultivation of sugarcane reported a yield of between 50 and 60 tonnes per acre. The per acre yield of this crop was reported between 40 and 45 tonnes in the Annual Reports of the Yashwant Sugar Factory (1970 to 1974) located in Haveli Taluka. All the informed farmers expect to harvest a yield of 45 to 50 tonnes per acre of the cane. Taking everything into consideration, an average yield of 45 tonnes would not be unfair to expect

from an acre in the project area.

(6) O n i o n

Among cash crops grown in the command areas of all the five projects during 1972-73, onion tops the list in terms of acreage. This is an irrigated crop and is grown in both kharif and rabi seasons. Heavy soil is best for the crop. All the sample farmers reported that in 1972-73, onion was very carefully cultivated and yielded a very good harvest of more than 75 quintals per acre in kharif and 85 quintals per acre in rabi in the command area of the Koregaon project. The average per acre yield of onion in the rest of the command areas was about 70 quintals in kharif and 80 quintals in rabi. The difference in the yields between kharif onion and rabi onion is due to dissimilarities in cultivation practices and lay-outs of the land under the crop in both the seasons. In order to protect the crop from excess rain in kharif, lay-out of the land is prepared in ridges and furrows and transplanting of the seedlings is done only on the ridges of the beds at a distance of about 6" x 4" between two plants. Flat beds are prepared for transplanting the seedlings in rabi season, and therefore land is not wasted in ridges and furrows. Besides this, planting is done at a distance of about 4" x 3" between two plants. Considering all such factors, the present average per acre yield of onion of 70 quintals in kharif and 80 quintals in rabi appears

reliable for future estimates.

(7) G r o u n d n u t

A small fraction of the command area was reported under this crop in Koregaon village. However, the farmers were in favour of growing groundnut as it is an important cash crop in the region. This crop is grown on the heavy soil. Groundnut can be a kharif or a summer crop, under irrigation. This crop was reported on a large number of the farms in two project areas, viz., Khangaon and Pimpare-Waghare. The average per acre yield of groundnut came to 7.99 quintals in the Khangaon project area. It was 6.18 quintals in the Pimpare-Waghare project area. The reported reason for the low yield in this project area was that groundnut was grown on the unlevelled land. Two sample farmers had grown this crop on the land outside the Khangaon lift irrigation scheme. They harvested the average yield of 10 quintals per acre. The farmers reported that the high yield was possible because of intensive cultivation. Two varieties of groundnut, spreading and erect, are commonly grown in the kharif season. The erect variety is more common in hot weather, though it gives lower yield than the spreading variety. This is because the land becomes very hard due to heavy and a large number of irrigations required for this crop in summer, and the erect variety is easier to harvest in such condition. According to the informed cultivators, a good crop of the spreading

variety gives about 7 to 8 quintals of groundnut per acre in kharif, while the erect variety gives about 6 to 7 quintals per acre in summer. Taking everything into account, it would not be wrong to expect an average per acre yield of 7.5 quintals of groundnut in kharif and 6.5 quintals in summer. Of course, we assume that the present practice of growing erect variety in summer and spreading variety of groundnut in kharif will continue in future.

(8) Cotton

Though this is an important cash crop in the region under irrigation, the farmers in Haveli Taluka had neither reported even a fraction of an acre under cotton nor shown any interest in growing this crop in future. However, the informed farmers in Bhade village reported that cotton was a very important cash crop and its importance would increase in the command area under irrigation. It was learnt on the second visit to Bhade village during 1974 that a substantial area was put under cotton in the year. This was, of course, only under the existing wells within the command area because of the restrictions, as mentioned in Chapter III, on the use of water from the lift scheme. It would be interesting to find out the reasons behind the two contrasting situations, though the farmers in both the areas expect more or less the same yield. To examine this question, we will have to assess the profitability of cotton in relation to other crops in both the areas, and

this will be discussed in the subsequent analysis.

Cotton is a two seasonal crop, i.e., summer and kharif, and is grown on the medium to heavy soil in the region under irrigation. This crop was reported on the few farms under intensive cultivation in the Bhade project during 1972-73. The average per acre yield of cotton was reported to be 7.25 quintals in the command area. It was 6.25 quintals on the land outside the scheme. However, all the farmers accepted that under normal conditions one can produce a yield of 6 to 7 quintals of cotton from an acre of land. Three varieties of cotton are well known in the village. Those are, hybrid cotton (H-4), Nimbkar, and Laxmi. The experienced farmers stated that the hybrid cotton could give a yield of 6 to 7 quintals per acre provided it is very carefully cultivated, for it runs a great risk of attack by pests and diseases. Two other varieties, Nimbkar and Laxmi can give a yield of 6.5 to 7 quintals and 6 to 6.5 quintals per acre respectively. Hybrid cotton fetches a high price in the market, and therefore money value of produce from an acre of this crop will not be less than for the other varieties even if H-4 may give a somewhat lower yield, because of the risks mentioned. Taking all these factors into account, it might be safe and reasonable to assume an average per acre yield of cotton of 6.5 quintals in the Bhade project. The agro-climatic conditions in Haveli Taluka are more or less the same as in Bhade

village. Under similar conditions, therefore, it would not be unfair to expect the same yield of cotton of 6.5 quintals in Haveli Taluka.

(9) Vegetables

These crops can be grown in kharif or rabi or summer in the region. These are irrigated crops and are grown on the medium to heavy soil. Pune City is located at the centre of Haveli Taluka. It serves as the best market for the vegetables which fetch high prices, and therefore a large acreage under the crops is seen in the Taluka. However, the farmers reported that some times great risk was involved in growing vegetables on a larger area for two reasons: (1) Vegetables are very susceptible to pests and diseases; and (2) price fluctuations in the vegetable market. It was very difficult for the farmers to report the physical yield of the crop. They reported the yield in money terms at prices current in 1972-73. The average per acre value of the produce came to Rs. 1010 in the Koregaon scheme. The reported values were Rs. 1336, Rs. 1380 and ^{Rs.} 1350 in Naigaon, Khangaon and Pimpare-Waghare projects respectively. This crop was not reported in the Bhade project. It is seen from the above figures that the gross values of the vegetables were more or less the same in all the projects, except in the Koregaon project. The reported reason for this was that the crop in Koregaon was affected by pests and diseases towards the end of the

season. The informed farmers, however, reported that under careful cultivation per acre yield of the crop would increase and its money value would be Rs. 200 to 300 more than the reported gross value. Taking all these things into account, it is safe to assume the present average value of the produce in all the schemes to be expected except in the Koregaon scheme. In the Koregaon project, we expect an increase in the value of produce to be at par with the other projects.

(10) Pulses

In the region, most of the pulses are kharif crops under dry farming and are grown on the light soil which is of poor quality. The yield is low. Among the pulses, kulthi, gram, mung, tur and matki are common crops in the area. Of these crops, gram and mung are grown under irrigation. Mung is of short duration, grown in kharif, and therefore it requires hardly one irrigation. As it is a delicate crop, even slightly unfavourable weather condition or pests might completely damage it. Gram is a rabi crop and mostly grown under irrigation. According to the informed farmers, a good crop of mung yields about 2 to 3 quintals per acre, while gram yields about 4 to 4.5 quintals per acre. These crops were reported on the few farms under irrigation. The reported yields were 1.5 to 2 quintals of mung and 3 to 4 quintals of gram per acre. All these considerations lead us to believe that with

irrigated farming the average per acre yield of mung will be 2 quintals and that of gram, 3.5 quintals.

5.1.2.1.2 Per Acre Net Income of the Crops

We can now work out the average per acre net income of the different crops under irrigation in the project area from the estimates of yields made above and the associated costs. These calculations are presented in Table 5.5. The associated costs are based on the data of the farm business surveys and include seeds, manure and fertilizers, insecticides and pesticides, bullock labour, human labour (hired as well as family), payments to village artisans and others, land revenue and other cesses, depreciation of implements, machinery and bullocks, interest on working capital and energy charges (i.e., electricity consumption charges). The cost of electric power is included in the associated costs for estimating the profitability of the different crops discussed in the subsequent analysis. The expenses on materials used in the production include the value of actual inputs (purchased as well as home produced). The fodder cost (bullock labour) is taken into account after deducting the value of home produced manure and income from hiring out of bullock labour. Human labour includes wages paid in cash and kinds to the attached and casual hired labour, while the family human labour is valued at the prevailing market wage rates of the hired labour in the village. Depreciation is

Table 5.5. Average per acre net income from the different crops with irrigation in the Koregaon-Mul lift irrigation scheme.

S. No.	Crops	Season	Main produce in quintals (per acre)	Price per quintal	Value of main produce* Cols. (4 x 5)	By-product	Price	Value of by-product Cols. (7 x 8)	Value of gross produce Cols. (6+9)	Associated costs	Net income Cols. (10-11)
(1)	(2)	(3)	(4)	Rs. (5)	Rs. (6)	Rs. (7)	Rs. (8)	Rs. (9)	Rs. (10)	Rs. (11)	Rs. (12)
1	Paddy	Kharif	6.50	185	1202	5.00**	10	50	1252	703	549
2	Wheat	Rabi	6.50	161	1046	5.00**	10	50	1096	487	609
3	Local Jowar	Rabi	5.25	145	761	3.50*	40	140	901	365	536
4	Local bajra	Kharif	4.50	125	562	4.00*	20	80	642	354	288
5	Hybrid bajra	Kharif	6.50	125	812	5.00*	20	100	912	544	368
6	Sugarcane	Annual	450.00	14	6300	-	-	-	6300	2758	3542
7	Onion	Kharif	70.00	35	2450	-	-	-	2450	1386	1064
8	Onion	Rabi	80.00	35	2800	-	-	-	2800	1603	1197
9	Groundnut	Kharif	7.50	184	1380	5.00**	10	50	1430	627	803
10	Groundnut	Summer	6.50	184	1196	4.00**	10	40	1236	704	532
11	Cotton	Summer and Kharif	6.50	331	2151	5.00**	10	50	2201	1148	1053
12	Vegetables	Kharif	-	-	1336	-	-	-	1336	629	707
13	Vegetables	Rabi	-	-	1336	-	-	-	1336	694	642
14	Vegetables	Summer	-	-	1336	-	-	-	1336	713	623
15	Gram	Rabi	3.50	155	542	3.00**	10	30	572	317	255
16	Mung	Kharif	2.00	155	310	3.00**	10	30	340	261	79

* In bundles of hundred stalks.

** Cart loads.

* Values rounded up.

calculated on the basis of expected life period of the implements, machinery and bullocks. Energy charges are calculated on the basis of water requirements of the crops and consumption of electric power (see Appendix 5.2). Interest on working capital is calculated at 9.5 per cent. These costs are related to the yield rates of the crops estimated after full development of the project. The estimates of by-products based on the farm business surveys are also given in the table.

5.1.2.1.3 Selection of the Crops and their Acreage in the Crop Pattern

We shall now examine all the crops in the light of technical factors mentioned earlier, and select the feasible crops to be grown in the irrigable command area. Thereafter, we shall decide the acreage under each of the selected crops to arrive at a future crop pattern under irrigation.

Table 5.5 reveals that sugarcane is the most profitable among all the crops. But sugarcane is an annual crop and therefore two, or even three, seasonal crops can be grown in the area instead of this single crop in a year. Therefore, it is necessary to compare the net income from sugarcane with the total net income from the 2 or 3 seasonal crops that can be grown on the same land during the year. We shall examine this.

A few important points relating to the possible com-

binations of the seasonal crops, i.e., crops that are grown one after another in the different seasons on the same piece of land in a year, may be noted. (1) First of all, it is to be noted that growing three seasonal crops on a given plot in a year would appear somewhat over-ambitious in the case of many of the crop combinations. For, in any given year, after setting aside the period necessary for preliminary tillage and land preparation for the crops, the time left for all operations appears too short for anything other than a very tight schedule for raising three successive crops. It was learnt during the farm surveys that harvesting of the third crop, the one grown in summer, may sometimes spill over to the kharif season of the subsequent year. If harvesting gets delayed, there is every likelihood that the farmer may have to keep the land fallow in the subsequent kharif season much against his wishes. If three crops in a given year are to be taken, the necessary condition will be that in the following year not more than two crops in two seasons may be grown, meaning thereby that in any two years not more than five crops can be grown. Even this involves meticulous attention to preliminary operations and harvesting of each crop, which, only a farmer who commands all the necessary resources may be able to manage. However, three seasonal crops in some of the crop combinations where gram and jowar are taken in the rabi season are possible. This is because

harvesting of these two crops is completed a little earlier than of any other rabi crop. As a result, there is a greater chance of minimising the risk of spill-over of the summer crop to kharif season of the subsequent year. The combinations with these two rabi crops are the only possibilities of three seasonal crops to occur in the possible crop combinations. (2) Cotton is a two seasonal crop, i.e., summer and kharif, and therefore only a rabi crop is possible with cotton. (3) Rabi jowar can be taken only after bajra and mung. It is not possible to grow jowar after any other kharif crops except these two, as the other irrigated kharif crops are not ready for harvest and require some more waterings by the time rabi jowar needs to be sown. (4) Vegetables as well as onion in kharif followed by the same crops in rabi is not at all a feasible practice since these crops are highly susceptible to pests and diseases; a little infection carried from kharif vegetables to rabi vegetables or onions may damage the whole rabi crop.

Now, we can examine the total net return from the possible combinations of the seasonal crops against the single crop, i.e., sugarcane. The possible combinations of the seasonal crops and their net income from an acre of land are presented in Table 5.6. It is seen from the table that for an individual farmer any combination of two or even three seasonal crops is not as profitable as grow-

Table 5.6. Possible crop combinations and per acre net income from these in the Koregaon-Mul lift irrigation scheme

Sr. No.	Kharif crops	Rabi crops	Summer crops	Net income (per acre) (Rs.)
(1)	(2)	(3)	(4)	(5)
1	Paddy	wheat	-	1153
2	Paddy	Onion	-	1746
3	Paddy	Vegetables	-	1191
4	Paddy	Gram	Groundnut/ Vegetables	1336/ 1427
5	Hybrid bajra	wheat	-	977
6	Hybrid bajra	Local jowar	Groundnut/ Vegetables	1436/ 1527
7	Hybrid bajra	Onion	-	1565
8	Hybrid bajra	Vegetables	-	1010
9	Hybrid bajra	Gram	Groundnut/ Vegetables	1155/ 1246
10	Onion	wheat	-	1673
11	Onion	Gram	Groundnut/ Vegetables	1851/ 1942
12	Groundnut	wheat	-	1412
13	Groundnut	Onion	-	2000

Contd.

Table 5.6: contd.

(1)	(2)	(3)	(4)	(5)
14	Groundnut	Vegetables	-	1445
15	Groundnut	Gram	Groundnut/ Vegetables	1590/ 1661
16	Vegetables	wheat	-	1316
17	Vegetables	Gram	Groundnut/ Vegetables	1494/ 1585
18	Kung	wheat	-	688
19	Kung	Local Jowar	Groundnut/ Vegetables	1147/1236
20	Kung	Onion	-	1279
21	Kung	Vegetables	-	721
22	Kung	Gram	Groundnut/ Vegetables	866/957
23	Cotton*	wheat	Cotton	1662
24	Cotton	Onion	Cotton	2250
25	Cotton	Vegetables	Cotton	1695
26	Cotton	Gram	Cotton	1308
27	Sugarcane**	Sugarcane	Sugarcane	3542

* Cotton is a two seasonal crop

** Sugarcane is an annual crop

ing an acre of sugarcane.

However, it can more appropriately be argued that if the pump is freed from watering an area under sugarcane in a season, then it can be used to irrigate more area under a seasonal crop. Therefore, the proper alternative to growing sugarcane with the help of the pump is not the same area under seasonal crop as under sugarcane, in each season, but the area of any seasonal crop the pump can irrigate in a season in place of 'cane, subject of course to the availability of the necessary water at the source. We now turn to this exercise.

To estimate the total area under any particular crop that can be irrigated during a season, given the capacity of the pump, it is necessary to know the requirement of total irrigation water by every crop in the season and the interval of time in which this has to be provided. The Irrigation Development Corporation of Maharashtra has estimated the average irrigation water requirement of the various crops in the region in which our sample projects are located, and the frequencies with which this total water is to be provided. We have modified this, wherever necessary, to suit local rainfall and soil condition, with the help of information provided by the local farmers. From these data we worked out the irrigable area under each crop with a pumping capacity of one cusec discharge. This irrigable area, in irrigation engineering, is known as

'duty' of a crop. Duty of a crop is calculated as area of a crop irrigated per day (a day of 16 hours)* by one cusec discharge of water multiplied by the average interval between two waterings of the crop. All these calculations are presented in Appendix 5.2. Difference in the irrigable areas (duties) of the crops arises due to the different water requirements of the crops in respect of depth of water per irrigation and the interval between waterings.

Duties of the crops are given in Table 5.7 (Col. 2). If we work out the duties of all the crops in relation to an acre of sugarcane, as shown in the table, and multiply them by their respective per acre net income, then we get the maximum area under any other crop that can be irrigated in any season as an alternative to one acre of irrigated sugarcane and the respective net incomes generated. These calculations are also presented in Table 5.7. It is seen from the table that given the capacity of the pump to discharge water, no combination of two or three seasonal crops (see the crop combinations in Table 5.6) is as profitable as sugarcane. Thus, given the discharge capacity of the pump, it becomes clear that sugarcane is the

* Duties of the crops are calculated at 16 hours working of a lift irrigation scheme in a day for the following reasons:

- (1) Rest can be given to the pumping units only by working the project for less than 24 hours a day;
- (2) Time allowance for breakdown of the project is essential.
- (3) Irrigators are generally averse to working for longer hours and particularly at night.

Table 5.7. Duties and profitability of the different crops in relation to sugarcane in the Koregaon-Mul lift irrigation scheme

Crops	Duties of the crops at one cusec discharge of water (acres)	Duties of the crops in relation to an acre of sugarcane (acres)	Per acre net income from the crops (Rs.)	Profitability of the crops in relation to an acre of sugarcane Cols. (3 x 4) (Rs.) (5)
(1)	(2)	(3)	(4)	(5)
<u>Kharif crops</u>				
Paddy	40	0.62	519	340
Local bajra	125	1.92	288	553
Hybrid bajra	125	1.92	368	707
Onion	95	1.46	1084	1553
Groundnut	80	1.23	803	988
Vegetables	95	1.46	707	1032
Kung	95	1.46	79	115
Cotton*	105	1.62	1053	1707
Sugarcane**	65	1.00	3542	3542
<u>Rabi crops</u>				
Wheat	80	1.45	609	883
Local jowar	105	1.91	536	1026
Onion	75	1.36	1197	1628
Vegetables	75	1.36	642	873
Gram	105	1.91	255	487
Sugarcane	55	1.00	-	-
<u>Summer crops</u>				
Groundnut	55	1.57	532	835
Vegetables	55	1.57	623	978
Cotton	65	1.66	-	-
Sugarcane	35	1.00	-	-

* Cotton is a two seasonal crop
 ** Sugarcane is an annual crop

most profitable among all the crops that can be grown by the farmers. This being the case, sugarcane should get the first priority in the crop pattern under the lift irrigation scheme.

Before proceeding further in working out the expected crop pattern under irrigation, it is necessary to note one important aspect in the calculation of the most economical use of irrigation water. The estimation so far has been made on the basis of a given pumping capacity and the duty of every crop under irrigation. It, however, does not necessarily tell us what is the most economical use of a given quantity of water that may be available for irrigation. Given the pumping capacity, it is quite clear that taking the three seasons together, sugarcane will use much more water for irrigation than any alternative individual crop or combination of crops (see Appendix 5.2). Thus, in order to know the most economical alternative to the use of the total quantity of water used to irrigate sugarcane, a different approach is necessary. If the given pumping capacity cannot pump that quantity of water for any seasonal crop, because of the intervals in which water is required for that crop, then the pumping capacity would have to be increased. Moreover, the total water given to sugarcane over three seasons can as well be given to seasonal crops over two seasons, kharif and rabi, if the irrigation water is supplied from a reservoir which is filled by the end of

the South-west monsoon (i.e., kharif) season. This would require even greater pumping capacity and more area under command of the irrigation system, and longer distributory channels. Thus, while the alternative returns to the given quantity of water may be greater than calculated in this chapter for the given pumping capacity, the costs may also be greater, and the net profitability of this alternate use of water has to be accordingly estimated. We propose to turn to this question in Chapter VIII. In the present chapter we take the pumping capacity to be given, and therefore proceed on the basis of our earlier finding that sugarcane is the most profitable crop that the farmer can grow under the circumstance.

Given that sugarcane is the most profitable crop under the existing lift scheme, what would be the acreage under 'cane in the command area? The lift irrigation scheme at 2.5 cusec discharge of water can irrigate 162 acres under sugarcane in kharif, 137 acres in rabi and 87 acres in summer. Herein lies the first restriction on the area under sugarcane. Maximum area under sugarcane is fixed by its irrigable area in the summer season. It is 87 acres. But it was learnt from the office of the Haveli Taluka Lift Irrigation Federation as well as the Maharashtra State Electricity Board (M.S.E.B.) that in summer, due to shortage of power, the pumps can operate only half the time, i.e., out of every 10 days in summer, only for 5 days water

would be available for irrigation.* This is the second restriction on the area under this crop. It means, the scheme can irrigate half of the irrigable area under sugarcane in summer. That is, about 45 acres. It implies that none of the other crops except sugarcane will be grown in summer.

Since only 45 acres can be put under sugarcane during the year, it leaves surplus pumping capacity in the kharif and rabi seasons which can be used for growing seasonal crops. Out of a total pumping capacity of 2.5 cusecs, the 45 acres of sugarcane will need only 0.69 cusec. in kharif and 0.82 cusec in rabi, leaving the remainder in each season for seasonal crops.

The irrigable command area of the project can be classified into heavy, medium and light soils. Of the 272 acres of the irrigable land, 103 acres are of heavy soil, 79 acres are of medium soil and 90 acres are of light soil. Out of 103 acres of heavy soil, 45 acres can be put under sugarcane as this crop is grown on heavy soil.

* Shortage of electric power in summer is a common feature in the region. It compels the M.S.E.B. to impose power cut on the lift irrigation schemes in the Taluka. It is learnt from the past experience (1970 to 1975) that the power cut was imposed between April and June of every year and it was about 5 days in 10 day period. It means, out of 10 days, the electric pumps can be operated only for five days. It is possible that the supply situation will improve in future. But we assume, conservatively the situation to continue for the life of the basic investments.

Table 5.7 shows that cotton is the most profitable irrigated crop next to sugarcane. However, this crop can not be selected in the crop pattern as it requires irrigation in summer as well as in kharif. This seems to be the reason for the lack of interest on the part of the farmers in Haveli Taluka, mentioned earlier. In Bhade this was not the situation because during summer, water in the existing wells within the command area of the project would be in surplus for raising cotton after growing feasible acreage under sugarcane.

The next profitable crop is onion in both kharif and rabi seasons. This crop is grown on heavy soil; and it can be grown only once in a year on the same piece of land, as noted earlier. Therefore, scope of this crop in the crop pattern is only on 58 acres of heavy soil, left after growing sugarcane, in one of the two seasons or in the two seasons taken together. It may be seen from the above table that the profit margin of this crop is more or less the same in both the seasons. Therefore, it may be grown on 58 acres of heavy soil in either season. We, however, consider it more likely that the area under onion will be divided equally between the kharif and rabi seasons. For, onion is a labour intensive crop, and therefore such division may serve as a precautionary measure against possible seasonal shortage of labour. This reason was supported by all the farmers who had grown onion in both

the seasons during 1972-73.* Taking all this into account, we may safely divide this area into 30 acres under kharif onion and 28 acres under rabi onion.

Now, what crops will be grown in kharif and rabi in the area which has already been allocated to onion? Table 5.7 reveals that vegetables are a little more profitable than groundnut in kharif season. But growing vegetables in kharif to be followed by onion during rabi on the same land is not a feasible crop sequence for the reason mentioned earlier. Groundnut requires heavy soil, and therefore this crop will be grown on 28 acres of the land in kharif to be followed by onion in rabi season. It is seen from the above table that next to onion, jowar is profitable in the rabi season. However, it is not possible to grow jowar on the land that was previously put under onion in kharif because kharif onion is not ready for harvest by the time rabi jowar needs to be sown. Indeed, this is a common problem with all the kharif crops except bajra and mung, if jowar is to follow any of them in rabi season. There are only two other crops, wheat and gram, that can be grown in rabi season on the land

* Moreover, an attempt was made to examine the labour force available in the village for growing different crops. It was seen from the results that area under kharif vegetables and rabi onion cannot exceed 31 acres and 28 acres respectively, in the irrigable command area of the project, without running into difficulties with availability of labour.

which had onion in the kharif season. However, wheat and gram are comparatively less profitable crops than irrigated rabi jowar which is sure to be an important crop in the rabi season for other reasons as well. The question of how much of the land under kharif onion can be put under wheat/gram in rabi season will depend on the availability of pumping capacity in that season after meeting the requirements of rabi jowar. So we now turn to the area under rabi jowar and the corresponding kharif crops. The use of land under kharif onion in rabi season will be taken up after that.

At this point it is to be noted that of the 2.5 cusec discharge of water available for irrigation during a day, 1.36 cusec discharge is used in irrigating 45 acres of sugarcane, 30 acres of onion and 28 acres of groundnut during kharif leaving a balance of 1.14 cusecs to be used for growing a few more crops like bajra, etc. in the season. Similarly, out of the 2.5 cusec discharge of water available for irrigation during rabi, 1.19 cusec discharge is utilised in growing 45 acres of sugarcane (same crop as in kharif) and 28 acres of onion; this means, still 1.31 cusecs are left over to be utilised for raising some additional crops like jowar, etc. in the season.

As mentioned above, jowar as a second crop during rabi can follow only when kharif crop is bajra or mung. Mung is not at all a profitable crop under irrigation. To

estimate the area under rabi jowar, therefore, it is necessary to decide the area under bajra. But, we cannot decide the area under bajra unless due consideration is given to kharif vegetables as these crops are more profitable than bajra. On the basis of the irrigated crop pattern in 1972-73 and after considering all the technical factors, especially the risk involved in growing vegetables on a larger area because of their high susceptibility to pests and diseases, price fluctuations in the market, labour requirements and availability of labour force in the village during kharif season, as mentioned earlier, we can expect at the most, 31 acres under kharif vegetables. There is another reason to expect about 31 acres under kharif vegetables and this will become clear in the following discussion.

Next to vegetables, jowar and bajra are the most profitable crops in rabi and kharif seasons respectively. Besides, these two cereals are the most important food-grain crops in the region and their by-products constitute the main source of fodder for cattle. To meet the annual foodgrain consumption needs of the farm families and fodder requirements for cattle on the farm we have to include these cereals in the crop pattern. To meet these requirements on the farm, as per our estimates, the farmers would have to grow jowar on 55 acres and bajra on 75 acres. Jowar can be sown in rabi only after bajra in kharif for

the reason discussed earlier. It means, whatever area is put under irrigated kharif bajra (plus the unirrigated land, if any, due to shortage of irrigation in kharif), only that much would be available for growing rabi jowar. Similarly, whatever discharge of water is used for growing bajra in kharif, only that much would be available for growing jowar in rabi because when rabi jowar is sown all other irrigated kharif crops would still be standing in the field and needing some more irrigation. This possibility does not exist in the case of kharif bajra which is harvested in time to release the pump for watering rabi jowar. To irrigate 85 acres of jowar 0.81 cusec discharge of water is required. It implies that 0.81 cusec discharge of water should be used for growing kharif bajra so that the same discharge would be available for growing 85 acres under rabi jowar. We can irrigate 101 acres under bajra with 0.81 cusec discharge of water. After raising bajra and the other crops that have already been decided in kharif, 0.33 cusec discharge of water is left that can irrigate only 31 acres under kharif vegetables. Kharif vegetables will be grown on medium soil and can be followed by wheat or gram in rabi season.

Hybrid bajra is more profitable and is a shorter duration crop than local bajra. As a result, sufficient time will be available for harvesting of hybrid bajra and further, for preparing and sowing of the same land under

jowar in the next season. Now, only 48 acres of medium soil and all 90 acres of light soil are left to be utilised in kharif season. Therefore, we assume that all the 48 acres of medium soil and only 53 acres of the 90 acres of light soil, making the total of 101 acres, would be put under hybrid bajra in kharif. It means, 37 acres of light soil would remain unirrigated due to shortage of irrigation in kharif season. This area would be readily available for growing rabi jowar. After harvesting of hybrid bajra, therefore, only 48 acres of medium soil would be recropped under rabi jowar so as to make the total of 85 acres under this crop.

Still 0.5 cusec discharge of water is left over to be utilised in rabi season. It can be used for growing wheat or gram or vegetables in the season. Gram is not a profitable crop under irrigation. Table 5.7 shows that profitability of wheat and vegetables is more or less the same. However, this discharge would be used for growing wheat since the land under kharif vegetables and kharif onion, as mentioned above, would be available for this crop in rabi and as it is vegetables after vegetables including onion, it is not a feasible crop combination. With the available residual discharge of water in rabi, therefore we can put 40 acres under wheat.

Estimated crop pattern in the area and utilisation of the water discharge according to the crops are shown

in Table 5.8. We can see from the table that the pumping capacity of 2.5 cusecs of the project is fully utilised in irrigating 235 acres in kharif and 198 acres in rabi under the different crops. This implies that out of 272 acres of the irrigable command area available for raising crops in both the seasons, 37 acres in kharif and 74 acres in rabi would remain without irrigation as no water discharge is left over for further irrigation. Nevertheless, it may be seen from the above discussion that each acre in the irrigable command area would receive irrigation in at least one season in the year meaning thereby that all the potential beneficiaries would avail of the irrigation facility.

The same estimation of crop pattern under irrigation is also attempted with the help of linear programming technique by using the Simplex method. The algebraic model and the results of the linear programming problem are presented in Appendix 5.3. It is seen from the results that the optimal crop pattern obtained in the programming exercise tallies with our estimated economically efficient crop pattern. In fact, the procedure followed above in estimating the economically efficient crop pattern under irrigation; namely, first to select the most profitable crop from the amongst crops grown in the region and then decide the acreage under it in the light of various factors like soil types, climatic conditions, discharge of

Table 5.8. Crop pattern with irrigation and utilisation of the water discharge according to the crops in the Koregson-Mul lift irrigation scheme

Kharif			
Crops (1)	Area (acres) (2)	Duties (acres) (3)	Water discharge Cols. (2 + 3) (cusecs) (4)
Sugarcane	45	65	0.69
Groundnut	28	80	0.35
Vegetables	31	95	0.33
Onion	30	95	0.32
Hybrid bajra	101	125	0.81
Total	235	-	2.50
Rabi			
Crops (1)	Area (acres) (2)	Duties (acres) (3)	Water discharge Cols. (2 + 3) (cusecs) (4)
Sugarcane	45	55	0.82
Onion	28	75	0.37
Wheat	40	80	0.50
Local Jowar	85	105	0.81
Total	198	-	2.50
Summer			
Crops (1)	Area (acres) (2)	Duties (acres) (3)	Water discharge Cols. (2 + 3) (cusecs) (4)
Sugarcane	45	35	1.29
Total	45	-	1.29

water from the pumps and water requirements of the crops, crop combinations, fodder and foodgrain consumption needs on the farms, availability of farm labour, etc., is the same as ^{is} done in framing the algebraic model of linear programming.

5.1.2.2 Total Net Income With Irrigation

From the crop pattern estimated above, we can calculate the total net income from the crop production after full development of irrigation. These calculations are presented in Table 5.9. Total value of the crop production comes to Rs. 7,29,393, while the total associated costs of the crop production works out to Rs. 3,53,078. If from the gross value of crop production the total associated costs are deducted, we get the total net income with irrigation. It comes to Rs. 3,76,315. However, this total income will not accrue to the farms immediately. It will accrue only partly in the initial years and steadily increase in the process until ^{the} fully developed form of irrigated crop pattern is reached after some interval of time. Therefore, it is necessary to estimate the year to year changes in the income generated in this interval between the beginning of irrigation and the attainment of full maturity of the system.

5.1.2.3 Changes in the Net Income in the Process of Full Development of Irrigation

The estimates of changes in the net income in the

Table 5.9. Total net income from the crop production with irrigation in the Koregaon-Mul lift irrigation scheme

Crops	Season	Area (acres)	Value of gross produce		Associated costs		Net income	
			per acre (Rs.) (4)	Total (Rs.) (5)	per acre (Rs.) (6)	Total (Rs.) (7)	per acre (Rs.) (8)	Total (Rs.) (9)
(1)	(2)	(3)						
Wheat	Rabi	40	1095	43840	487	19480	609	24360
Local jowar	Rabi	85	901	76585	365	31025	536	45560
Hybrid bajra	Kharif	101	912	92112	544	54944	368	37168
Groundnut	Kharif	28	1430	40040	627	17556	803	22484
Onion	Kharif	30	2450	73500	1386	41580	1064	31920
Onion	Rabi	28	2800	78400	1603	44884	1197	33516
Vegetables	Kharif	31	1336	41416	629	19499	707	21917
Sugarcane	Annual	45	6300	283500	2758	124110	3542	159390
Total		388		729393		353078		376315

process of full development of irrigation are presented in Table 5.10. The data of gross irrigated area presented in the table, were available upto 1974-75 from the office of the lift irrigation scheme. In 1974-75, 300 acres (all figures refer to gross acres) were brought under irrigation, while our estimated crop pattern shows that 388 acres would come under irrigation in future. That means, a potential balance of 88 acres was left in 1974-75 to be brought under irrigation. It is seen from the table that the annual increase in the irrigated area was between 19 and 65 acres. On this basis, therefore, we estimate that the potential balance of 88 acres will be achieved in the next two years (44 acres in each year), that is, by the end of 1976-77.

However, the estimated full net income will not accrue in 1976-77 for two reasons. Firstly, the additional land that will come under irrigation every year, will take some period to adjust to irrigation, and therefore, the estimated crop pattern and yields of the crops will not occur immediately. They will come about slowly and accumulate steadily till the stage of maturity is reached. Secondly, it is seen from the data that the levelling of the irrigable command area would be completed in 1976-77. It means that the levelled land which will come under irrigation for the first time in 1976-77 will take some time to reach the stage of maturity. According to the informed

Table 5.10. Changes in the net income in the process of full development of irrigation in the Koregaon-Nul lift irrigation scheme

Years	Gross irrigated area (acres)	Increase in gross irrigated area (acres)	Matured irrigated area (acres)	Immatured irrigated area (acres)	Net income on the matured area (col. 4)		
					Value of gross produce (Rs.) (6)	Associated costs (Rs.) (7)	Net income (Rs.) (8)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1970-71	130	-	-	130	-	-	-
1971-72	149	19	-	149	-	-	-
1972-73	187	38	-	187	-	-	-
1973-74	252	65	130	122	2,44,384	1,18,299	1,26,085
1974-75	300	48	149	151	2,80,102	1,35,589	1,44,513
1975-76	344	44	187	157	3,51,538	1,70,168	1,81,370
1976-77	388	44	252	136	4,73,730	2,29,317	2,44,413
1977-78	388	-	300	88	5,63,964	2,72,997	2,90,967
1978-79	388	-	344	44	6,46,679	3,13,037	3,33,642
1979-80	388	-	388	-	7,29,393	3,53,078	3,76,315

Continued.

Table 5.10: contd.

Years	Net income on the immatured area (Col. 5)			Total		
	Value of gross production (Rs.) (9)	Associated costs (Rs.) (10)	Net income (Rs.) (11)	Value of gross produce (Rs.) (12)	Associated costs (Rs.) (13)	Net income (Rs.) (14)
1970-71	1,71,669	95,524	76,145	1,71,669	95,524	76,145
1971-72	1,96,759	1,09,485	87,274	1,96,759	1,09,485	87,274
1972-73	2,46,940	1,37,407	1,09,533	2,46,940	1,37,407	1,09,533
1973-74	1,61,105	89,646	71,459	4,05,489	2,07,945	1,97,544
1974-75	1,99,400	1,10,955	88,445	4,79,502	2,46,544	2,32,958
1975-76	2,07,323	1,15,364	91,959	5,58,861	2,85,532	2,73,329
1976-77	1,79,592	99,933	79,659	6,53,322	3,29,250	3,24,072
1977-78	1,16,207	64,662	51,545	6,80,171	3,37,659	3,42,512
1978-79	53,103	32,331	25,772	7,04,782	3,45,368	3,59,414
1979-80	-	-	-	7,29,393	3,53,078	3,76,315

farmers and on the basis of the farm data available to us during 1972-73 we estimate that the irrigable area will reach full maturity after receiving irrigation for three consecutive years. That means, the estimated full annual net return from the project will start accruing from 1979-80. The calculations of annual net incomes from the land at the stage of full development and in the premature stage are given in the table. The net income from the matured area is worked out on the basis of full development of irrigation that would occur in 1979-80, while the net income from the land in the premature stage is calculated on the basis of net income during 1972-73.

5.1.3 Farm Income: With and Without Irrigation

In the foregoing discussion, we have estimated the farm income of the area to be affected by the lift irrigation scheme in both the situations: with and without irrigation. However, the benefits of the project consist of the net increase in farm income because of irrigation. For this purpose, we have to further net the 'net income' by deducting the net income without irrigation from the net income with irrigation. These calculations are presented in Table 5.11.

5.1.4 Project Costs

Project costs include capital, maintenance and operation costs of the project. Estimates of these costs

Table 5.11. Net increase in the farm income because of irrigation in the Koregaon-Kul lift irrigation scheme

(In Rupees)

Year (1)	Farm income with irrigation			Farm income without irrigation			Net increase in farm income		
	Value of gross produce (2)	Associated costs (3)	Net income (4)	Value of gross produce (5)	Associated costs (6)	Net income (7)	Value of gross produce (8)	Associated costs (9)	Net income (4)-(7) (10)
1970-71	171669	95524	76145	29884	15675	14189	141805	79849	61956
1971-72	196759	109485	87274	34228	17966	16262	162531	91519	71012
1972-73	246940	137407	109533	42958	22548	20410	203982	114859	89123
1973-74	405489	207945	197544	57890	30387	27503	347599	177558	170041
1974-75	479502	246544	232958	57890	30387	27503	421612	216157	205455
1975-76	558861	285532	273329	57890	30387	27503	500971	255145	245826
1976-77	653322	329250	324072	57890	30387	27503	595432	298863	295569
1977-78	680171	337659	342512	57890	30387	27503	622281	307272	315009
1978-79	704782	345368	359414	57890	30387	27503	646892	314981	331911
1979-80	729393	353078	376315	57890	30387	27503	671503	322691	348612

are discussed below.

5.1.4.1 Capital Costs

The capital work of the lift irrigation scheme was started in 1966 and completed by 1970. It means, capital was locked up over this construction period. Interest on this capital, therefore, should be calculated. Capital investment in the project was made through borrowed funds from two sources. At the beginning of the construction work on 26th February 1966, the Revenue and Forest Department of Maharashtra State had issued a loan of Rs. 69,750 to the project at the simple interest rate of 5.5 per cent. However, the construction could not be completed as the amount of loan was inadequate for the plan of investment. The Government was not in a position to give an additional loan for the completion of the work. In this situation, the farmers approached a leading commercial bank to step in. The bank issued a loan of Rs. 1,49,522 at the interest rate of 9.5 per cent, to the project on 9th October 1969 against the guarantee of repayment given by the State Government. At the same time, the Government loan was repaid through the bank loan. The construction work was completed in early 1970. The interest on the funds locked up during the period, is first calculated on the Government loan at 5.5 per cent from 26th February 1966 to 9th October 1969 and then on the bank loan at 9.5 per cent from 9th October 1969 to

1st May 1970. The total interest over the period came to Rs. 21,968. In the case of project's capital costs, the absolute costs are revalued at the prices of 1972-73 as discussed in Chapter II, and are presented in Table 5.12. The cost of mechanical and electrical portion of the project is Rs. 29,951. This is a replacement cost and these equipments have to be replaced once in 10 years over the life of the project, while the civil works are expected to last 30 years which is the life period of the lift irrigation scheme.

Table 5.12. Capital cost of the Koregaon-Mul lift irrigation scheme

	<u>Rs.</u>
(A) <u>Civil portion</u>	
(1) Intake chamber	3,790.
(2) Dry well	14,115.
(3) Pump house	8,020.
(4) Rising main	60,000.
(5) Delivery Chamber	1,070.
(6) Distribution system	26,140.
Total	1,13,135.
(B) Mechanical and electrical portion	29,951.
(C) Agency charges (including cost of initial survey and others).	8,585.
(D) Interest on the capital (loan) locked up over the period of construction	21,968.
Grand Total	1,73,639.

5.1.4.2 Operation and Maintenance Costs

These are annual costs which include consumption of electric power, salaries of the staff, maintenance, repairs and others. The annual estimates of these costs are given in Table 5.13. The total annual cost of electric power to be required for irrigating the estimated crop pattern worked out to Rs. 32,200. This cost is already included in the associated costs for estimating the profitability of the different crops as discussed earlier and hence we should not again take this cost into account in calculating the project costs.

Table 5.13. Annual operation and maintenance costs of the Koregaon-Mul lift irrigation scheme

<u>Items</u>	<u>Rs.</u>
(1) Electric power consumption	32,200.*
(2) Salaries of the agricultural officer, water distributors and pump drivers	9,120.
(3) Maintenance, repairs and others	2,920.
Total	44,240.

* Calculated at the rate of Rs. 0.19 per unit (KWh) of electric power consumption.

Annual estimated salaries (including allowances) of the water distributors and pump drivers worked out to Rs. 6,120. An agricultural officer was appointed for extension services in two lift irrigation schemes. His

annual salary was Rs. 6,000 during 1972-73. Therefore, we considered half of this payment, i.e., Rs. 3,000, as his annual salary towards this lift scheme. The annual maintenance, repairs and other costs are estimated to be Rs. 2,920.

5.1.4.3 Cost of Land Levelling

Total cost of the land levelling is estimated to be Rs. 54,350 in the project area at 1972-73 prices. Interest on this cost at 9.5 per cent is considered as an annual cost of land levelling. It came to Rs. 5,163. It is estimated that the land levelling would be completed in 1976-77. Therefore, changes in this cost in the initial period are obvious and are calculated on the basis of the irrigated area.

5.1.5 Financial Profitability

So far, we have estimated the financial returns and costs of the lift irrigation scheme. We shall now calculate the net present worth and the internal rate of return of the project. The basic idea of the net present worth or the internal rate of return is to ascertain if the costs incurred in the project are fully covered by the expected returns, by less or by more than the returns. To attempt this, we have taken the excess of all costs - project and associated costs with irrigation over the associated costs without irrigation and then deducted this

from the net increase in the value of gross produce with irrigation over the value of gross produce without irrigation to get net benefits of the project as shown in Table 5.14. Calculations of the profitability are made over the life of the project, considered to be 30 years. Water for irrigation from the project was released in 1970-71. It means that the stream of irrigation benefits will start flowing from 1970-71 onward till the end of 1999-2000. Capital costs of the project are already compounded to the year of beginning of the project for comparison with the income stream discounted to that year. The replacement cost of electrical equipments, to be replaced once in 10 years, is incurred during 1980-81 and 1990-91. The cost of land levelling is presented separately in the table to distinguish it from the installation costs (capital costs) of the project. The net benefit stream is discounted to 1970-71 at the bank rate of 9.5 per cent for calculating the net present worth of the project. That came to Rs. 20.79 lakhs. The internal rate of return that would make the net present worth of the project equal to zero, worked out to 82 per cent.

However, it is not necessary to emphasise that the reliability of the rate of return, or of the net present worth depends largely on the propriety of the projected costs and incomes. It would be useful to see how sensitive the internal rate of return or the net present worth are

Table 5.14. Financial profitability of the Koregaon-Mul lift irrigation scheme
(in Rupees)

Period	Capital costs	Operation and maintenance costs	Cost of land leveling	Net increase in the associated costs	Gross costs Cols. (2+3+4+5)	Net increase in the crop production	Net benefits Cols. (7-6)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1970-71	1,73,639	12,040	1,730	79,849	2,67,258	1,41,805	-1,25,453
1971-72	-	12,040	1,983	91,519	1,05,542	1,62,531	56,989
1972-73	-	12,040	2,489	1,14,859	1,29,388	2,03,982	74,594
1973-74	-	12,040	3,354	1,77,558	1,92,952	3,47,599	1,54,647
1974-75	-	12,040	3,993	2,16,157	2,32,190	4,21,612	1,89,422
1975-76	-	12,040	4,579	2,55,145	2,71,764	5,00,971	2,29,207
1976-77	-	12,040	5,163	2,98,863	3,16,066	5,95,432	2,79,366
1977-78	-	12,040	5,163	3,07,272	3,24,475	6,22,281	2,97,806
1978-79	-	12,040	5,163	3,14,981	3,32,184	6,46,892	3,14,708
1979-80	-	12,040	5,163	3,22,691	3,39,894	6,71,503	3,31,609
1980-81	29,951*	12,040	5,163	3,22,691	3,69,845	6,71,503	3,01,658
1981-82 to 1989-90**	-	12,040	5,163	3,22,691	3,39,894	6,71,503	3,31,609
1990-91	29,951*	12,040	5,163	3,22,691	3,69,845	6,71,503	3,01,658
1991-92 to 1999-2000**	-	12,040	5,163	3,22,691	3,39,894	6,71,503	3,31,609
Total	2,33,541	3,51,200	1,42,040	86,32,714	93,69,495	1,77,44,668	83,75,173

* Replacement cost.

** For these periods only yearly figures which remain constant over the years are presented.

W.P.V. at 9.5% discount rate = Rs. 20,79,486

I.R.R. = 82%

At 10% reduction in the net increase in crop production

W.P.V. at 9.5% discount rate = Rs. 17,38,779

I.R.R. = 64%

to alternative estimates of costs and returns. If we assume that the net crop production (Col. 7 in Table 5.14) with irrigation will be 10 per cent lower than what has been estimated by us, then the internal rate of return will be 64 per cent, and the net present worth will be Rs. 17.39 lakhs. We assumed ten per cent reduction in the value of net crop production after irrigation on the ground that while attempting the relative price structure of the outputs as discussed in Chapter II, around 10 per cent fluctuations were observed in the yearly prices of outputs during the period of 15 years. The alternative calculations no doubt reduce the worthwhile-ness of the project somewhat, but it still proves to be a profitable proposition.

In the foregoing, out of the five lift irrigation projects selected for the study, we have estimated the financial profitability of the Koregaon-Mul lift irrigation scheme in detail. In the case of the rest of the projects, therefore, as mentioned in the beginning of this chapter, we shall discuss only the distinguishing features in the estimates and avoid repetition of common procedures and problems.

5.2 Naigaon Lift Irrigation Scheme

Estimates of the financial profitability of the scheme are presented in Tables 5.15 to 5.26.

The irrigable command area of the project is 127 acres. The net income from the crop production without irrigation comes to Rs. 11,184. Under irrigation, once again we observe that given the pumping capacity of the lift irrigation scheme, sugarcane turns out to be the most profitable crop compared to any single or combination of crops. Accordingly, we estimated the crop pattern under irrigation. It is observed from the crop pattern with irrigation that the pumping capacity of 1.25 cusecs of the project is fully utilized in irrigating 120 acres in kharif and 101 acres in rabi under the different crops. It implies that out of 127 acres of the irrigable command area available for irrigation, 7 acres in kharif and 26 acres in rabi would remain unirrigated as no pumping capacity is left over for further irrigation. The net income from the crop production without irrigation comes to Rs. 1,74,371. This net income will accrue after full development of irrigation. The irrigation potential of the project will be fully utilized in the course of 8 years from the beginning.

The capital work of the lift irrigation scheme was started in 1966 and completed by 1970. Like in the Koregaon project, interest on the capital locked up over the period of construction is first calculated on the Government loan of Rs. 46,500 at the rate of 5.5 per cent and then on the bank loan of Rs. 76,498 at the rate of

9.5 per cent. Total cost of land levelling is estimated to be Rs. 55,164.

The net present value of the project, at 9.5 per cent discount rate, comes to Rs. 9.1 lakhs, while the internal rate of return comes to 51 per cent. If we assume a 10 per cent lower value of net crop production after irrigation, the net present worth and the internal rate of return of the project worked out to Rs. 6.53 lakhs and 39 per cent respectively. It means that the Naigaon lift irrigation scheme is financially a profitable proposition.

5.3 Khangaon-Tek Lift Irrigation Scheme

Initial plan of this lift irrigation scheme was to make irrigation available to 405 acres that would have benefitted to 65 farm families in the village. However, at the time of completion of the project, 18 potential beneficiaries refused to participate in the project activity as they constructed their independent lift irrigation scheme in the command area. As a result, the irrigable command area as well as the number of potential beneficiaries of the project substantially reduced to 265 acres and 47 beneficiaries respectively. It means that the project constructed for irrigating 405 acres would make irrigation available to only 265 acres in the village. From this it appears that some of the total

pumping capacity of the project may remain idle in both the seasons. Calculations of the financial profitability of the project are presented in Tables 5.27 to 5.38.

Before irrigation, the estimated area under bajra and its average per acre yield in this project are comparatively more than that of in the other projects. The reported reason for this is that before construction of the project, some of the land in the command area was receiving one irrigation in the kharif season from the Government canal. In spite of the uncertainty, both of availability and adequate supply of irrigation water, the farmers used to allot more land under bajra. The net income from the crop production without irrigation comes to Rs. 28,674. Under irrigation, the estimated per acre yield of jowar and hybrid bajra is half-a-quintal more in this project than in the earlier projects. The difference in the yield is estimated on the ground that comparatively superior land would come under these two crops as more than 90 per cent of the irrigable command area is either medium or heavy soil. Sugarcane is the most profitable crop under the project. It is observed from the crop pattern under irrigation that all the area would come under irrigation in kharif as well as in rabi seasons. However, out of the total pumping capacity of the project (i.e. 5.25 cusecs) available for irrigation

in both the seasons, 3.11 cusecs and 3.64 cusecs would be only used in kharif and rabi seasons respectively. The rest of the pumping capacity would remain idle in both the seasons for the reason mentioned earlier. The net income from the crop production with irrigation worked out to Rs. 5,50,936. Like in the Koregaon project, the irrigation potential of this scheme will be fully utilised in 1979-80, that is, in course of 10 years after completion of the project.

Interest on the capital locked up over the period of construction is calculated on the Government loan of Rs. 68,700 at the rate of 5.5 per cent and on the bank loan of ^{Rs.} 1,80,365 at the rate of 9.5 per cent. The cost of land levelling is estimated to be Rs. 61,636.

The net present value of the project at 9.5 per cent discount rate worked out to Rs. 30.40 lakhs, while the internal rate of return of the project came to 65 per cent. In the sensitivity analysis (at 10 per cent lower value of net crop production after irrigation) the net present worth of the project worked out to Rs. 23.04 lakhs and the rate of internal return came to 51 per cent. It implies that the Khamgaon-Tek lift irrigation scheme is financially a feasible assertion.

5.4 Pimpore-Waghare Lift Irrigation Scheme

The beneficiaries of the scheme reported that during

the construction of the project half of the irrigable command area was not under cultivation. They further reported that whatever crop was grown in the area was heavily damaged by village cattle. As mentioned in Chapter IV, crops were possible only after putting a permanent fence around the command area. For all practical purposes, therefore, this was some thing of a permanent fallow land. As a result, the introduction of irrigation was more or less reclamatory in nature and hence question of crop production previous to irrigation does not arise. The returns from the irrigated farming, therefore, would be wholly the result of the facility.

It means, if irrigation had not been introduced, the farmers would have been continued the practice of keeping the land fallow, or, what would be more likely, they might have sold their land for non-agricultural purposes. As in fact happened, as per the initial plan, the project was to make irrigation available to 76 acres in the village. But before completion of the scheme, a piece of 15 acres of the irrigable command area was sold for non-agricultural purposes. Under these circumstances, therefore, we do not estimate the farm income without irrigation.

Irrigable command area of the scheme is 61 acres. It is to be irrigated from the project having one cusec pumping capacity. In estimating the economically efficient crop pattern under irrigation, we will have to take

into account the problems raised in the previous chapter about the unusual features of the command area.

The lift irrigation scheme is located adjacent to the industrial area of Pune City. The small command area is situated within the Gaothan of the village there being no other agricultural land in the vicinity. This peculiar location of the command area along with the small size of land holdings of the beneficiaries and also comparatively easy availability of non-agricultural wage labour employment on regular basis to the village folk raise some problems especially when we try to visualise the expected crop pattern in the area under irrigation.

(1) The location of the command area does not favour cultivation of jowar and bajra as per the contention of the beneficiaries. The command area being located within the Gaothan the standing crop suffers heavy losses as a result of attack of the birds, thereby reducing the yield of the crops. (2) This problem stated by the beneficiaries could be true but the more important reasons, for non-cultivation of the food grain crops, could be the small size of the land holdings of the beneficiaries along with availability of factory labour employment.

All the beneficiaries are small land holders and only a part of this holding lies within the command area of the scheme. The size of the holdings is such that it by and large fails to meet the food grain needs of the

farm families to any significant extent. The farm families are almost wholly dependent on the supplies available in the market to meet their food grain requirements. Under the circumstances, it would be quite natural for the beneficiaries to go in for cash crops like sugarcane, onion, vegetables, groundnut, etc., in the command area. This is more conducive to larger net income from irrigated farming.

All the beneficiaries being small land holders, they have to depend on wage labour employment, for their livelihood, for most of the period in a year. The possibilities of wage labour employment in agriculture are limited. However, factory labour employment is easily available. As it is, most of the families of the village seek employment as factory labour and in fact almost all the families have some member or the other working as factory labour. If the employment opportunities are considered along with the dependence on the market for food grains, it is quite rational for the beneficiaries to go in for cash crops and earn a larger income. In effect if one may say so, the farm families are essentially those of factory labourers having some subsidiary agricultural activity. It means that these beneficiaries are only part time agriculturists.

Two things are very clear from the above discussions. Firstly, jawar and bajra do not have any place in the

future crop pattern; and secondly, the beneficiaries would try to maximise their income by allotting more land under cash crops. Besides the cash crops, the farmers did not deny the possibility of raising wheat in the area. This is because the birds cannot damage the crop as wheat grains on the plants are completely covered by spikes. Moreover, the stalks of the crop are very thin and delicate; hence the birds cannot rest on them and eat the grains.

Unlike in the other projects, onion was grown only in rabi season in the command area during 1972-73 for two reasons: (1) per acre net income from rabi onion is higher than kharif onion; and (2) like in the other projects, the problem of shortage of agricultural labour does not arise in the area because of small size of land holdings of the beneficiaries. Moreover, since there is no agricultural land in the vicinity of the command area, agricultural labour is in surplus that can be easily available for cultivation of land all the year round in the village. Under the circumstances, we assume that the beneficiaries would continue the present practice of growing onion in rabi season only. Estimates of the financial profitability of the scheme are presented in Tables 5.39 to 5.45.

It is seen from the crop pattern under irrigation that the entire irrigable command area of the project would come under irrigation in both: kharif and rabi

seasons. However, some part of the pumping capacity of the project would remain unutilised in both the seasons. The estimated net income from crop production under irrigation came to Rs. 1,30,828. The project will come to full maturity of irrigation in the course of 9 years from the beginning.

Interest on the capital locked up over the period of construction is first calculated on the Government loan of Rs. 28,500 at the rate of 5.5 per cent, and then on the bank loan of Rs. 70,000 at the rate of 9.5 per cent.

The net present worth of the project at 9.5 per cent discount rate comes to Rs. 7.55 lakhs and the rate of return on the investment comes to 42 per cent. In the sensitivity analysis, the net present worth and the internal rate of return came to Rs. 4.77 lakhs and 34 per cent respectively. This implies that the Pimpri-Waghare lift irrigation scheme is financially a worthwhile proposition.

5.5 Bhade Lift Irrigation Scheme

Before construction of the project, out of 817 acres of the irrigable command area, 243 acres were seasonally irrigated from 81 existing wells in the project area. Of this, 125 acres (more than 51 per cent) were cropped more than once. All the farmers and the promoters of the scheme reported that after construction of the project,

water level in all the existing wells in the area was substantially increased. Moreover, they reported that the present (increased) level of water in the wells was more than sufficient to bring all the 243 acres under perennial irrigation. This is a part of the direct benefit. To include this direct benefit in the benefit stream resulting from the project, as mentioned in Chapter II, we have included the command area of the existing wells in the project area and made comparison between with and without irrigation. Estimates of the financial profitability of the project are presented in Tables 5.45 to 5.57. Before construction of the project, the net income from the crop production came to Rs. 3,54,024.

As mentioned in Chapter III, the Irrigation Department has granted permission to the project to lift water for only 250 acres in the rabi season. There is no restriction on the amount of water that can be lifted during the kharif season. However, lifting of water is strictly prohibited in the summer season. Irrespective of the season, irrigation facility is available only for growing food grain crops. These conditions laid down by the Government largely restrict the crops to be grown in the command area. All this means that out of 817 acres of the irrigable command area, only 243 acres under well irrigation will be available for raising cash crops. The rest of the land, i.e., 574 acres will be used for growing

food grain crops only.

Under irrigation, vegetable is not selected in the crop pattern, because this crop is not raised in the area for lack of marketing facility in its vicinity. However, cotton and hybrid jowar are considered in the crop pattern under irrigation. Cotton is selected in the crop pattern because during summer, irrigation water in the wells would be in surplus after growing feasible acreage under sugarcane. In fact, it was learnt on the second visit to the project in 1974 that sugarcane and cotton were grown on about 100 acres and 50 acres respectively in the command area.

Hybrid jowar has become very popular in the command area after construction of the project. Reasons for this are many. (1) Average per acre net income from hybrid jowar is much higher than the other food grain crops. (2) Under the condition laid down by the Government on the use of the lift irrigation water, surplus land is available for growing hybrid jowar after allotting sufficient area under local jowar to meet fodder requirements on the farms. (3) Since lift irrigation water is available for only 250 acres in rabi season and as local jowar is a rabi crop, all the 250 acres will be put under this crop to meet fodder requirements of the livestock. Hybrid jowar is grown in both kharif and rabi seasons. However, because of restriction on the irrigation

facility, hybrid jowar will be grown in kharif only. This means that the land under hybrid jowar will be sown only once in a year, that is, in kharif. In the rest of the seasons, this land will remain fallow, and hence hybrid jowar will not be much affected by pests and diseases.

The average per acre yield of local jowar in the command area is estimated at par with the yield rate of the crop in the Khangaon lift irrigation scheme for the aforesaid reason. Average yield of hybrid jowar is estimated to be 11 quintals per acre in both the seasons on the basis of the farm data collected during 1972-73. Similarly, on the basis of the past and the present data, it will not be unfair to estimate an average per acre yield of 50 tonnes of sugarcane in the area. Total pumping capacity of the project is 7.5 cusecs. Out of this, only 2.38 cusecs will be utilised in rabi season. The rest of the capacity, i.e., 5.12 cusecs will remain under-utilised in rabi due to the restrictions on the use of irrigation water mentioned above. The net income from crop production under irrigation came to Rs. 10,01,313. Most of the irrigable command area of the project is already developed. Besides, all the farmers possess technical know-how of the crops under irrigated farming. Considering these factors we estimate that the irrigation potential will be fully utilised in course of 6 years from the beginning of the project. This period is much

shorter than the period estimated in case of the projects in Haveli Taluka.

Construction of the project started in 1971 and completed in 1972. The bank financed a loan of Rs. 4 lakhs to the project at 10.5 per cent rate of interest. In addition to this loan, the share capital worth Rs. 1.73 lakhs was incurred in the construction of the project. Accordingly, interest on the capital locked up over the period of construction is calculated. Total cost of land levelling is estimated to be Rs. 2,19,367.

The net present value of the project is calculated at the discount rate of 10.5 per cent. It came to Rs. 38.19 lakhs. The rate of return on the investment worked out to 74 per cent. In the sensitivity calculus, the net present worth and the internal rate of return of the project came to Rs. 27.38 lakhs and 55 per cent respectively. This justifies that the Bhade lift irrigation scheme is financially a profitable assertion.

Now, it is seen from the foregoing discussion that all the five lift irrigation schemes selected for the study are financially profitable propositions. However, as mentioned in Chapter II, the financial profitability of the projects estimated in this chapter may not alone settle the question between the financing agencies which have financed the projects and the beneficiaries, when the problem of actual repayment of loans of the projects

would arise. This is because, the financial profitability of the project estimated in this chapter only indicates that the present worth of the income stream is greater than the present worth of the cost stream and hence the beneficiaries can repay the full loan of the project. But when it comes to actual payment, the farmers may not be able to divert the net income towards the repayment of loans after meeting their minimum level of living and other essential needs. The problem would be further complicated by the fact that the financing agencies usually want to recover the loans in a shorter period than the life of the project considered in the above financial profitability calculus. Therefore, we propose to examine the repayment of loans from these points of view in the next chapter.

Table 5.15. Crop pattern without irrigation in the Naigaon lift irrigation scheme

Sr. No.	Crops	Area (acres)
1	Jowar	69.72
2	Bajra	22.12
	Total cereals	91.84
3	Pulses	18.44
	Total cropped area	110.28
	Area cropped more than once	-
	Wet cropped area	110.28
	Fallow	16.72
	Total irrigable command area	127.00

Table 5.15. Average per acre net income from the different crops without irrigation in the Waigaon lift irrigation scheme

Sr. No.	Crops	Season	Main produce in quintals (per acre)	Price per quintal (Rs.)	Value of main produce* cols. (4 x 5) (Rs.)	By-product	Price (Rs.)	Value of by-product cols. (7 x 8) (Rs.)	Value of gross produce cols. (6+9) (Rs.)	Associated costs (Rs.)	Net income Cols. (10-11) (Rs.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Jowar	Rabi	1.26	145	183	2.10*	40	84	267	145	121
2	Bajra	Kharif	1.17	125	146	1.80*	20	36	182	142	40
3	Pulses	Kharif	1.28	155	198	2.00**	10	20	218	117	101

* In bundles of hundred stalks

** Cart loads

* Values rounded up

Table 5.17. Total net income from the crop production without irrigation in the Naigaon lift irrigation scheme

Crops	Area (acres)	Value of gross produce (Rs.)	Associated costs (Rs.)	Net income cols. (3-4) (Rs.)
(1)	(2)	(3)	(4)	(5)
Jowar	69.72	18,615	10,179	8,436
Bajra	22.12	4,026	3,141	885
Pulses	18.44	4,020	2,157	1,863
Total	110.28	26,661	15,477	11,184

Table 5.18. Net income foregone under the progressive irrigation in the Naigaon lift irrigation scheme

Years	Gross irrigated (acres)	Value of gross produce from area in col. (2) under dry condition (Rs.)	Associated costs (Rs.)	Net income cols. (3-4) (Rs.)
(1)	(2)	(3)	(4)	(5)
1970-71	66	12,391	7,193	5,198
1971-72	82	15,395	8,937	6,458
1972-73	104	19,525	11,335	8,191
1973-74	142	26,661	15,477	11,184

Table 5.19. Average per acre net income from the different crops with irrigation in the Waigaon lift irrigation scheme

Sr. No.	Crops	Season	Main produce in quintals (per acre)	Price per quintal (Rs.)	Value of main produce* cols. (4 x 5) (Rs.)	By-product	Price (Rs.)	Value of by-product col. (7 x 8) (Rs.)	Value of gross produce cols. (6+9) (Rs.)	Associated costs (Rs.)	Net income cols. (10-11) (Rs.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Wheat	Rabi	6.50	161	1,046	5.00**	10	50	1,096	516	580
2	Local Jowar	Rabi	5.25	145	761	3.50*	40	140	901	422	479
3	Hybrid bajra	Kharif	6.50	125	812	5.00*	20	100	912	572	340
4	Onion	Kharif	70.00	35	2,450	-	-	-	2,450	1,426	1,024
5	Onion	Rabi	80.00	35	2,800	-	-	-	2,800	1,658	1,142
6	Vegetables	Kharif	-	-	1,336	-	-	-	1,336	718	620
7	Groundnut	Kharif	7.50	184	1,380	5.00**	10	50	1,430	659	771
8	Sugarcane	Annual	450.00	14	6,300	-	-	-	6,300	2,852	3,448

* In bundles of hundred stalks

** Cart loads

* Values rounded up

Table 5.20. Crop pattern with irrigation and utilisation of the water discharge according to the crops in the Naigaon lift irrigation scheme

Kharif			
Crops (1)	Area (acres) (2)	Duties (acres) (3)	Water discharge cols. (2 ÷ 3) (cusecs) (4)
Sugarcane	22	65	0.34
Groundnut	12	80	0.15
Onion	12	95	0.13
Vegetables	15	95	0.16
Hybrid bajra	59	125	0.47
Total	120	-	1.25

Rabi			
Crops (1)	Area (acres) (2)	Duties (acres) (3)	Water discharge cols. (2 ÷ 3) (Cusecs) (4)
Sugarcane	22	55	0.40
Onion	12	75	0.16
Wheat	18	80	0.22
Local jowar	49	105	0.47
Total	101	-	1.25

Summer			
Crops (1)	Area (acres) (2)	Duties (acres) (3)	Water discharge cols. (2 ÷ 3) (Cusecs) (4)
Sugarcane	22	35	0.63
Total	22	-	0.63

Table 5.21. Total net income from the crop production with irrigation in the Naigaon lift irrigation scheme

Crops	Season	Area (acres)	Value of gross produce		Associated costs		Net income	
			Per acre (Rs.)	Total (Rs.)	Per acre (Rs.)	Total (Rs.)	Per acre (Rs.)	Total (Rs.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Wheat	Rabi	18	1,096	19,728	516	9,288	580	10,440
Local jowar	Rabi	49	901	44,149	422	20,678	479	23,471
Hybrid bajra	Kharif	59	912	53,808	572	33,748	340	20,060
Onion	Kharif	12	2,450	29,400	1,426	17,112	1,024	12,288
Onion	Rabi	12	2,800	33,600	1,658	19,896	1,142	13,704
Vegetables	Kharif	15	1,335	20,040	716	10,740	620	9,300
Groundnut	Kharif	12	1,430	17,160	659	7,908	771	9,252
Sugarcane	Annual	22	6,300	1,38,600	2,852	62,744	3,448	75,856
Total		199		3,56,485		1,82,114		1,74,371

Table 5.22. Changes in the net income in the process of full development of irrigation in the Waigson lift irrigation scheme

Years	Gross irrigated area (acres)	Increase in gross irrigated area (acres)	Matured irrigated area (acres)	Immatured irrigated area (acres)	Net income on the matured area (col. 4)		
					Value of gross produce (Rs.) (6)	Associated costs (Rs.) (7)	Net income (Rs.) (8)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1970-71	66	-	-	66	-	-	-
1971-72	82	16	-	82	-	-	-
1972-73	104	22	-	104	-	-	-
1973-74	142	38	66	76	1,18,231	60,400	57,831
1974-75	199	57	82	117	1,46,893	75,042	71,851
1975-76	199	-	104	95	1,86,304	95,176	91,128
1976-77	199	-	142	57	2,54,376	1,29,951	1,24,425
1977-78	199	-	199	-	3,56,485	1,82,114	1,74,371

Continued..

Table 5.22: contd.

Years	Net income on the immatured area (col. 5)			Total		
	Value of gross pro- duce (Rs.) (9)	Associated costs (Rs.) (10)	Net income (Rs.) (11)	Value of gross pro- duce (Rs.) (12)	Associated costs (Rs.) (13)	Net income (Rs.) (14)
1970-71	1,01,086	58,546	42,540	1,01,086	58,546	42,540
1971-72	1,25,591	72,739	52,852	1,25,591	72,739	52,852
1972-73	1,59,286	92,254	67,032	1,59,286	92,254	67,032
1973-74	1,16,402	67,417	48,985	2,34,633	1,27,817	1,06,816
1974-75	1,79,197	1,03,786	75,411	3,26,090	1,78,828	1,47,262
1975-76	1,45,502	84,271	61,231	3,31,806	1,79,447	1,52,359
1976-77	87,301	50,562	36,739	3,41,677	1,80,513	1,61,164
1977-78	-	-	-	3,56,485	1,82,114	1,74,371

Table 5.23. Net increase in the farm income because of irrigation in the Waigaon lift irrigation scheme (in Rupees)

Years	Farm income with irrigation			Farm income without irrigation			Net increase in farm income		
	Value of gross produce	Associated costs	Net income	Value of gross produce	Associated costs	Net income	Value of gross produce	Associated costs	Net income
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1970-71	1,01,086	58,546	42,540	12,391	7,193	5,198	88,695	51,353	37,342
1971-72	1,25,591	72,739	52,852	15,395	8,937	6,458	1,10,198	63,802	46,396
1972-73	1,59,286	92,254	67,032	19,526	11,335	8,191	1,39,760	80,919	58,841
1973-74	2,34,633	1,27,817	1,06,816	26,661	15,477	11,184	2,07,972	1,12,340	95,632
1974-75	3,26,090	1,78,828	1,47,262	26,661	15,477	11,184	2,99,429	1,63,351	1,36,078
1975-76	3,31,806	1,79,447	1,52,359	26,661	15,477	11,184	3,05,145	1,63,970	1,41,175
1976-77	3,41,677	1,80,513	1,61,164	26,661	15,477	11,184	3,15,016	1,65,036	1,49,980
1977-78	3,56,485	1,82,114	1,74,371	26,661	15,477	11,184	3,29,824	1,66,637	1,63,187

Table 5.24. Capital cost of the Waigson lift irrigation scheme

<u>Items</u>	<u>Rs.</u>
(A) Civil portion	
(1) Intake chamber	4,070.
(2) Dry well	13,645.
(3) Pump house	7,530.
(4) Rising main	65,725.
(5) Delivery chamber	1,780.
(6) Distribution system	24,815.
Total	1,17,365.
(B) Mechanical and electrical portion	22,726.
(C) Agency charges (including cost of initial survey and others)	8,405.
(D) Interest on the capital (loan) locked up over the period of construction	13,061.
Grand total	1,61,557.

Table 5.25. Annual operation and maintenance costs of the Waigson lift irrigation scheme.

<u>Items</u>	<u>Rs.</u>
(1) Electric power consumption	22,818.*
(2) Salaries of the agricultural officer, water distributors and pump drivers	9,120.
(3) Maintenance, repairs and others	2,765.
Total	34,703.

* Calculated at the rate of Rs. 0.19 per unit (Kwh) of electric power consumption.

Table 5.25. Financial profitability of the Waigaon lift irrigation scheme

(in Rupees)

Period	Capital costs	Operation and maintenance costs	Cost of land leveling	Net increase in the associated costs	Gross costs Cols. (2+3+4 +5)	Net increase in the crop production	Net benefits Cols.(7-6)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1970-71	1,61,557	11,885	1,738	51,353	2,26,533	88,695	- 1,37,838
1971-72	-	11,885	2,160	63,802	77,847	1,10,198	32,349
1972-73	-	11,885	2,739	80,919	95,543	1,39,760	44,217
1973-74	-	11,885	3,740	1,12,340	1,27,985	2,07,972	80,007
1974-75	-	11,885	5,241	1,63,351	1,80,477	2,99,429	1,18,952
1975-76	-	11,885	5,241	1,63,970	1,81,096	3,05,145	1,24,049
1976-77	-	11,885	5,241	1,65,036	1,82,162	3,15,046	1,32,884
1977-78 to 1979-80**	-	11,885	5,241	1,66,637	1,83,763	3,29,824	1,46,061
1980-81	22,726*	11,885	5,241	1,66,637	2,06,489	3,29,824	1,23,335
1981-82 to 1989-90**	-	11,885	5,241	1,66,637	1,83,763	3,29,824	1,46,061
1990-91	22,726*	11,885	5,241	1,66,637	2,06,489	3,29,824	1,23,335
1991-92 to 1999-2000**	-	11,885	5,241	1,66,637	1,83,763	3,29,824	1,46,061
Total	2,07,009	3,56,550	1,45,643	46,33,422	53,43,624	90,52,165	37,08,541

* Replacement cost

** For these periods only yearly figures which remain constant over the years are presented.

W.P.W. at 9.5% discount rate = Rs. 9,10,201
I.R.R. = 51%

At 10% reduction in the net increase in crop production

W.P.W. at 9.5% discount rate = Rs. 6,53,247
I.R.R. = 39%

**Table 5.27. Crop pattern without irrigation in the
Khangson-Tek lift irrigation scheme**

Sr. No.	Crops	Area (acres)
1	Jowar	109.60
2	Bajra	88.55
	Total cereals	198.15
3	Pulses	44.30
	Total cropped area	242.45
	Area cropped more than once	-
	Net cropped area	242.45
	Fallow	22.55
	Total irrigable command area	265.00

Table 5.2^a. Average per acre net income from the different crops without irrigation in the Khangaon-Tek lift irrigation scheme

Sr. No.	Crops	Season	Main produce in quintals (per acre)	Price per quintal (Rs.)	Value of main produce \times cols. (4 x 5) (Rs.)	By-product	Price (Rs.)	Value of by-product cols. (7 x 8) (Rs.)	Value of gross produce cols. (6+9) (Rs.)	Associated costs (Rs.)	Net income Cols. (10-11) (Rs.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Jowar	Rabi	1.43	145	207	2.15*	40	86	293	153	140
2	Bajra	Kharif	1.71	125	214	3.00*	20	60	274	177	97
3	Pulses	Kharif	1.49	155	229	2.00**	10	20	249	142	107

* In bundles of hundred stalks.

** Cart loads

\times Values rounded up.

Table 5.29. Total net income from the crop production without irrigation in the Khangson-Tek lift irrigation scheme

Crops	Area (acres)	Value of gross produce (Rs.)	Associated costs (Rs.)	Net income Cols. (3-4) (Rs.)
(1)	(2)	(3)	(4)	(5)
Jowar	109.60	32,113	16,769	15,344
Bajra	88.55	24,263	15,673	8,590
Pulses	44.30	11,031	6,291	4,740
Total	242.45	67,407	38,733	28,674

Table 5.30. Net income foregone under the progressive irrigation in the Kham-Tek lift irrigation scheme

Years	Gross irrigated area (acres)	Value of gross produce from area in col. (2) under dry condition (Rs.)	Associated costs (Rs.)	Net income cols. (3-4) (Rs.)
1970-71	175	35,746	20,540	15,206
1971-72	201	41,057	23,592	17,465
1972-73	218	44,529	25,587	18,942
1973-74	264	53,926	30,986	22,940
1974-75	330	67,407	38,733	28,674

Table 5.31. Average per acre net income from the different crops with irrigation in the Khangson-Tek lift irrigation scheme

Sr. No.	Crops	Season	Main produce in quintals (per acre)	Price per quintal (Rs.)	Value of main produce * cols. (4 x 5)	By-product	Price (Rs.)	Value of by-product cols. (7 x 8)	Value of gross produce cols. (6+9)	Associated costs (Rs.)	Net income cols. (10-11)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Wheat	Rabi	6.50	161	1,046	5.00**	10	50	1,096	519	577
2	Local Jowar	Rabi	5.75	145	834	3.50*	40	140	974	370	604
3	Hybrid Bajra	Kharif	7.00	125	875	5.00*	20	100	975	559	416
4	Onion	Kharif	70.00	35	2,450	-	-	-	2,450	1,412	1,038
5	Onion	Rabi	80.00	35	2,800	-	-	-	2,800	1,649	1,151
6	Vegetables	Kharif	-	-	1,380	-	-	-	1,380	698	682
7	Groundnut	Kharif	7.50	184	1,380	5.00**	20	50	1,430	658	772
8	Sugarcane	Annual	450.00	14	6,300	-	-	-	6,300	2,822	3,478

* In bundles of hundred stalks

** Cart loads

* Values rounded up.

Table 5.32. Crop pattern with irrigation and utilisation of the water discharge according to the crops in the Khangaon-Tek lift irrigation scheme

Kharif			
Crops (1)	Area (acres) (2)	Duties (acres) (3)	Water discharge cols. (2 ÷ 3) (Cusecs) (4)
Sugarcane	92	65	1.42
Groundnut	30	80	0.37
Onion	30	95	0.32
Vegetables	40	95	0.42
Hybrid bajra	73	125	0.58
Total	265	-	3.11

Rabi			
Crops (1)	Area (acres) (2)	Duties (acres) (3)	Water discharge cols. (2 ÷ 3) (Cusecs) (4)
Sugarcane	92	55	1.67
Onion	30	75	0.40
Wheat	70	80	0.87
Local jowar	73	105	0.70
Total	265	-	3.64

Summer			
Crops (1)	Area (acres) (2)	Duties (acres) (3)	Water discharge cols. (2 ÷ 3) (Cusecs) (4)
Sugarcane	92	35	2.63
Total	92	-	2.63

Table 5.33. Total net income from the crop production with irrigation in the Khangaon-Tek lift irrigation scheme

Crops	Season	Area (acres)	Value of gross produce		Associated costs		Net income	
			Per acre (Rs.)	Total (Rs.)	Per acre (Rs.)	Total (Rs.)	Per acre (Rs.)	Total (Rs.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Wheat	Kharif	70	1,096	76,720	519	36,330	577	40,390
Local Jowar	Kharif	73	974	71,102	370	27,010	604	44,092
Hybrid bajra	Kharif	73	975	71,175	559	40,807	416	30,368
Onion	Kharif	30	2,450	73,500	1,412	42,360	1,038	31,140
Onion	Kharif	30	2,800	84,000	1,649	49,470	1,151	34,530
Vegetables	Kharif	40	1,350	54,000	698	27,920	652	27,280
Groundnut	Kharif	30	1,430	42,900	658	19,740	772	23,160
Sugarcane	Annual	92	6,300	5,79,600	2,822	2,59,624	3,478	3,19,976
Total		438		10,354,197		5,03,261		5,50,936

Table 5.34. Changes in the net income in the process of full development of irrigation in the Khangaon-Tek lift irrigation scheme

Years (1)	Gross irrigated area (acres) (2)	Increase in gross irrigated area (acres) (3)	Matured irrigated area (acres) (4)	Immatured irrigated area (acres) (5)	Net income on the matured area (col. 4)		
					Value of gross produce (Rs.) (6)	Associated costs (Rs.) (7)	Net income (Rs.) (8)
1970-71	175	-	-	175	-	-	-
1971-72	201	26	-	201	-	-	-
1972-73	218	17	-	218	-	-	-
1973-74	264	46	175	89	4,21,197	2,01,075	2,20,122
1974-75	330	66	201	129	4,83,775	2,30,949	2,52,826
1975-76	384	54	218	166	5,24,691	2,50,482	2,74,209
1976-77	438	54	264	174	6,35,406	3,03,336	3,32,070
1977-78	438	-	330	108	7,94,257	3,79,170	4,15,087
1978-79	438	-	384	54	9,24,227	4,41,216	4,83,011
1979-80	438	-	438	-	10,54,197	5,03,261	5,50,936

Contd..

Table 5.34: contd.

Years	Net income on the immature area (col. 5)			Total		
	Value of gross pro- duce (Rs.) (9)	Associa- ted costs (Rs.) (10)	Net income (Rs.) (11)	Value of gross pro- duce (Rs.) (12)	Associa- ted costs (Rs.) (13)	Net income (Rs.) (14)
1970-71	3,38,154	1,76,087	1,62,067	3,38,154	1,76,087	1,62,067
1971-72	3,88,394	2,02,248	1,86,146	3,88,394	2,02,248	1,86,146
1972-73	4,21,244	2,19,354	2,01,890	4,21,244	2,19,354	2,01,890
1973-74	1,71,976	89,553	82,423	5,93,173	2,90,628	3,02,545
1974-75	2,49,268	1,29,801	1,19,467	7,33,043	3,60,750	3,72,293
1975-76	3,20,763	1,67,031	1,53,732	8,45,454	4,17,513	4,27,941
1976-77	3,36,222	1,75,081	1,61,141	9,71,628	4,78,417	4,93,211
1977-78	2,08,689	1,08,671	1,00,018	10,02,946	4,87,841	5,15,105
1978-79	1,04,345	54,335	50,010	10,28,572	4,95,551	5,33,021
1979-80	-	-	-	10,54,197	5,03,261	5,50,936

Table 5.35. Net increase in farm income because of irrigation in the Khangson-Tek lift irrigation scheme

(in Rupees)

Years (1)	Farm income with irrigation			Farm income without irrigation			Net increase in farm income		
	Value of gross produce (2)	Associated costs (3)	Net income (4)	Value of gross produce (5)	Associated costs (6)	Net income (7)	Value of gross produce (8)	Associated costs (9)	Net income (10)
1970-71	3,38,154	1,76,087	1,62,067	35,746	20,540	15,206	3,02,408	1,55,547	1,46,861
1971-72	3,88,394	2,02,248	1,86,146	41,057	23,592	17,465	3,47,337	1,78,656	1,68,681
1972-73	4,21,244	2,19,354	2,01,890	44,529	25,587	18,942	3,76,715	1,93,767	1,82,948
1973-74	5,93,173	2,90,629	3,02,545	53,926	30,986	22,940	5,39,247	2,59,642	2,79,605
1974-75	7,33,043	3,60,750	3,72,293	67,407	38,733	28,674	6,65,636	3,22,017	3,43,619
1975-76	8,45,454	4,17,513	4,27,941	67,407	38,733	28,674	7,78,047	3,78,780	3,99,267
1976-77	9,71,628	4,78,417	4,93,211	67,407	38,733	28,674	9,04,221	4,39,684	4,64,537
1977-78	10,02,945	4,87,841	5,15,105	67,407	38,733	28,674	9,35,539	4,49,108	4,86,431
1978-79	10,28,572	4,95,551	5,33,021	67,407	38,733	28,674	9,61,165	4,56,818	5,04,347
1979-80	10,54,197	5,03,261	5,50,936	67,407	38,733	28,674	9,86,790	4,64,528	5,22,262

Table 5.36. Capital cost of the Khangson-Tek lift irrigation scheme

<u>Items</u>	<u>Rs.</u>
(A) Civil portion	
(1) Intake chamber No. 1	4,250.
(2) Intake chamber No. 2	9,210.
(3) Inlet trench	20,755.
(4) Jack and dry well	29,960.
(5) Pump house	11,785.
(6) Delivery chambers	12,265.
(7) Rising main and distribution system	1,19,135.
Total	2,06,360.
(B) Mechanical and electrical portion	1,91,251.
(C) Agency charges (including cost of initial survey and others)	23,857.
(D) Interest on the capital (loan) locked up over the period of construction	24,335.
Grand total	4,45,806.

Table 5.37. Annual operation and maintenance costs of the Khangson-Tek lift irrigation scheme

<u>Items</u>	<u>Rs.</u>
(1) Electric power consumption	53,126.*
(2) Salaries of the agricultural officer, water distributors and pump drivers	14,850.
(3) Maintenance, repairs and others	9,313.
Total	77,319.

* Calculated at the rate of Rs. 0.19 per unit (KWh) of electric power consumption.

Table 5.14. Financial profitability of the Khamgaon-Tek lift irrigation scheme

(in Rupees)

Period	Capital costs	Operation and maintenance costs	Cost of land leveling	Net increase in the associated costs	Gross costs Cols. (2+3)+4 +5)	Net increase in the crop production	Net benefits Cols.(7-6)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1970-71	4,45,806	24,193	2,340	1,55,547	6,27,886	3,02,408	-3,25,478
1971-72	-	24,193	2,687	1,78,656	2,05,536	3,47,337	1,41,801
1972-73	-	24,193	2,915	1,93,767	2,20,875	3,76,715	1,55,840
1973-74	-	24,193	3,530	2,59,642	2,87,385	5,39,247	2,51,862
1974-75	-	24,193	4,412	3,22,017	3,50,622	6,65,636	3,15,014
1975-76	-	24,193	5,134	3,78,780	4,08,107	7,78,047	3,69,940
1976-77	-	24,193	5,855	4,39,664	4,69,732	9,04,221	4,34,489
1977-78	-	24,193	5,855	4,49,108	4,79,156	9,35,539	4,56,383
1978-79	-	24,193	5,855	4,56,818	4,88,868	9,61,165	4,74,299
1979-80	-	24,193	5,855	4,64,528	4,94,576	9,86,790	4,92,214
1980-81	1,91,251*	24,193	5,855	4,64,528	6,85,827	9,86,790	3,00,963
1981-82 to 1989-90**	-	24,193	5,855	4,64,528	4,94,576	9,86,790	4,92,214
1990-91	1,91,251*	24,193	5,855	4,64,528	6,85,827	9,86,790	3,00,963
1991-92 to 1999-2000**	-	24,193	5,855	4,64,528	4,94,576	9,86,790	4,92,214
Total	8,28,308	7,25,790	1,61,538	1,25,89,107	1,43,04,743	2,65,32,905	1,22,28,162

* Replacement cost

** For these periods only yearly figures which remain constant over the years are presented.

W.P.W. at 9.5% discount rate = Rs. 30,40,470
 I.R.R. = 65%
 At 10% reduction in the net increase in crop production
 W.P.W. at 9.5% discount rate = Rs. 23,03,862
 I.R.R. = 51%

Table 5.39. Average per acre net income from the different crops with irrigation in the Pimpri-Vaghare lift irrigation scheme

Sr. No.	Crops	Season	Main produce in quintals (per acre) (4)	Price per quintal (Rs.) (5)	Value of main produce* cols. (4 x 5) (Rs.) (6)	By-product (7)	Price (Rs.) (8)	Value of by-product cols. (7 x 8) (Rs.) (9)	Value of gross produce cols. (6+9) (Rs.) (10)	Associated costs (Rs.) (11)	Net income cols. (10-11) (Rs.) (12)
1	Wheat	Rabi	6.50	151	1,016	5.00**	10	50	1,096	573	523
2	Onion	Rabi	80.00	35	2,800	-	-	-	2,800	1,747	1,053
3	Vegetables	Kharif	-	-	1,350	-	-	-	1,350	675	675
4	Groundnut	Kharif	7.50	184	1,380	5.00**	10	50	1,430	619	811
5	Sugarcane	Annual	450.00	14	6,300	-	-	-	6,300	2,606	3,694

** Cart loads.

* Values rounded up.

Table 5.10. Crop pattern with irrigation and utilisation of the water discharge according to the crops in the Pimpere-Waghare lift irrigation scheme

Kharif			
Crops (1)	Area (acres) (2)	Duties (acres) (3)	Water discharge cols. (2 ÷ 3) (Cusecs) (4)
Sugarcane	17	65	0.26
Groundnut	23	80	0.29
Vegetables	21	95	0.22
Total	61	-	0.77

Rabi			
Crops (1)	Area (acres) (2)	Duties (acres) (3)	Water discharge cols. (2 ÷ 3) (Cusecs) (4)
Sugarcane	17	55	0.31
Onion	23	75	0.31
Wheat	21	80	0.26
Total	61	-	0.88

Summer			
Crops (1)	Area (2)	Duties (3)	Water discharge cols. (2 ÷ 3) (Cusecs) (4)
Sugarcane	17	35	0.49
Total	17	-	0.49

Table 5.41. Total net income from the crop production with irrigation in the Pimpere-Waghare lift irrigation scheme

Crops	Season	Area (acres)	Value of gross produce		Associated costs		Net income	
			Per acre (Rs.)	Total (Rs.)	Per acre (Rs.)	Total (Rs.)	Per acre (Rs.)	Total (Rs.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Wheat	Rabi	21	1,096	23,016	573	12,033	523	10,983
Onion	Rabi	23	2,800	64,400	1,747	40,181	1,053	24,219
Vegetables	Kharif	21	1,350	28,350	675	14,175	675	14,175
Groundnut	Kharif	23	1,430	32,890	619	14,237	811	18,653
Sugarcane	Annual	17	6,300	1,07,100	2,606	44,302	3,694	62,798
Total		105		2,55,755		1,24,928		1,30,828

**Table 5.12. Changes in the net income in the process of full development of irrigation in the Pimpri-
Waghare lift irrigation scheme**

Years	Gross irrigated area (acres)	Increase in gross irrigated area (acres)	Matured irrigated area (acres)	Immatured irrigated area (acres)	Net income on the matured area (col. 4)		
					Value of gross produce (Rs.) (6)	Associated costs (Rs.) (7)	Net income (Rs.) (8)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1970-71	13	-	-	13	-	-	-
1971-72	28	15	-	28	-	-	-
1972-73	46	18	-	46	-	-	-
1973-74	66	20	13	53	31,665	15,467	16,198
1974-75	87	21	28	59	68,202	33,314	34,888
1975-76	105	18	46	59	1,12,045	54,730	57,315
1976-77	105	-	66	39	1,60,761	78,526	82,235
1977-78	105	-	87	18	2,11,912	1,03,512	1,08,400
1978-79	105	-	105	-	2,55,756	1,24,928	1,30,828

Continued..

Table 5.42: continued

Years	Net income on the immatured area (col. 5)			Total		
	Value of gross pro- duce (Rs.) (9)	Associated costs (Rs.) (10)	Net income (Rs.) (11)	Value of gross pro- duce (Rs.) (12)	Associated costs (Rs.) (13)	Net income (Rs.) (14)
1970-71	27,365	17,758	9,607	27,365	17,758	9,607
1971-72	58,940	38,248	20,692	58,940	38,248	20,692
1972-73	96,830	62,836	33,994	96,830	62,836	33,994
1973-74	1,11,565	72,398	39,167	1,43,230	87,865	55,365
1974-75	1,24,195	80,594	43,601	1,92,397	1,13,908	78,489
1975-76	1,24,195	80,594	43,601	2,36,240	1,35,324	1,00,916
1976-77	82,095	53,274	28,821	2,42,856	1,31,800	1,11,056
1977-78	37,890	24,588	13,302	2,49,802	1,28,100	1,21,702
1978-79	-	-	-	2,55,756	1,24,928	1,30,828

Table 5.43. Capital cost of the Pimpare-Waghare lift irrigation scheme

<u>Items</u>	<u>Rs.</u>
(A) Civil portion	
(1) Intake chamber	2,995.
(2) Dry well	10,552.
(3) Pump house	6,330.
(4) Rising main	37,983.
(5) Delivery chamber	1,512.
(6) Distribution system	5,255.
Total	64,627.
(B) Mechanical and electrical portion	11,239.
(C) Agency charges (including cost of initial survey and others)	4,552.
(D) Cost of fence around the command area	19,422.
(E) Interest on the capital (loan) locked up over the construction period	9,672.
Grand total	1,09,512.

Table 5.44. Annual operation and maintenance costs of the Pimpare-Waghare lift irrigation scheme

<u>Items</u>	<u>Rs.</u>
(1) Electric power consumption	5,498*
(2) Salaries of the agricultural officer, water distributors and pump drivers	8,040
(3) Maintenance, repairs and others	1,858.
Total	15,396

* Calculated at the rate of Rs. 0.19 per unit (Kwh) of electric power consumption.

Table 5.45. Financial profitability of the Pimpri-Waghare lift irrigation scheme

(In Rupees)

Period	Capital costs	Operation and maintenance costs	Cost of land leveling	Net increase in the associated costs	Gross costs Cols. (2+3+4+5)	Net increase in the crop production	Net benefits Cols. (7-6)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1970-71	1,09,512	9,898	67	17,758	1,37,235	27,365	- 1,09,870
1971-72	-	9,898	144	38,248	48,290	58,940	10,650
1972-73	-	9,898	236	62,836	72,970	96,830	23,860
1973-74	-	9,898	339	87,855	98,102	1,43,230	45,128
1974-75	-	9,898	447	1,13,908	1,24,253	1,92,397	68,144
1975-76	-	9,898	540	1,35,324	1,45,762	2,36,240	90,478
1976-77	-	9,898	540	1,31,800	1,42,238	2,42,856	1,00,618
1977-78	-	9,898	540	1,28,100	1,38,538	2,49,802	1,11,264
1978-79 to 1979-80**	-	9,898	540	1,24,928	1,35,366	2,55,756	1,20,390
1980-81	11,239*	9,898	540	1,24,928	1,46,605	2,55,756	1,09,151
1981-82 to 1989-90**	-	9,898	540	1,24,928	1,35,366	2,55,756	1,20,390
1990-91	11,239*	9,898	540	1,24,928	1,46,605	2,55,756	1,09,151
1991-92 to 1999-2000**	-	9,898	540	1,24,928	1,35,366	2,55,756	1,20,390
Total	1,31,990	2,96,940	14,733	34,64,255	39,07,918	68,74,292	29,66,374

* Replacement cost

** For these periods only yearly figures which remain constant over the years are presented

W.P.W. at 9.5% discount rate = Rs. 7,55,200

I.R.R. = 42%

At 10% reduction in the net increase in crop production

W.P.W. at 9.5% discount rate = Rs. 4,95,941

I.R.R. = 34%

Table 5.16. Crop pattern without irrigation in the Bhade lift irrigation scheme

Sr. No.	Crops	Area (acres)
	<u>Irrigated</u>	
1	Wheat	40.53
2	Jowar	94.25
3	Local bajra	62.59
4	Hybrid bajra	38.52
5	Gram	11.73
6	Onion (Kharif)	19.15
7	Onion (Rabi)	28.12
8	Cotton	27.96
9	Sugarcane	29.68
10	Others	15.25
	<u>Unirrigated</u>	
11	Jowar	266.85
12	Local bajra	183.28
13	Pulses	99.61
	Total cropped area	917.52
	Area cropped more than once	125.12
	Net cropped area	792.40
	Fallow	24.60
	Total irrigable command area	817.00

Table 5.17. Average per acre net income from the different crops without irrigation in the Bhade lift irrigation scheme.

Sr. No.	Crops	Season	Main produce in quintals (per acre)	Price per quintal (Rs.)	Value of main produce* cols. (4 x 5)	By-product	Price (Rs.)	Value of by-product cols. (7 x 8)	Value of gross produce cols. (6+9)	Associated costs (Rs.)	Net income cols. (10-11)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Irrigated										
1	Wheat	Rabi	6.59	161	1,061	5.00**	10	50	1,111	605	506
2	Jowar	Rabi	5.41	145	784	3.90*	40	155	940	473	467
3	Local Bajra	Kharif	4.39	125	549	4.80*	20	95	645	438	207
4	Hybrid Bajra	Kharif	6.57	125	821	5.25*	20	105	926	641	285
5	Gram	Rabi	3.79	155	587	3.00**	10	30	617	463	154
6	Onion	Kharif	66.25	35	2,319	-	-	-	2,319	1,510	809
7	Onion	Rabi	78.83	35	2,759	-	-	-	2,759	1,798	961
8	Cotton	Summer and Kharif	7.61	331	2,519	6.00**	10	60	2,579	1,254	1,315
9	Sugarcane	Annual	543.15	14	7,604	-	-	-	7,604	3,176	4,428
10	Others	-	-	-	2,283	-	-	-	2,283	1,497	786
	Unirrigated										
11	Jowar	Rabi	1.39	145	202	2.10*	40	84	286	179	107
12	Local Bajra	Kharif	1.20	125	150	1.90*	20	38	188	148	40
13	Pulses	Kharif	1.23	155	191	2.50**	10	25	216	164	52

* In bundles of hundred stalks. ** Cart loads. * Values rounded up.

Table 5.48. Total net income from the crop production without irrigation in the Bhade lift irrigation scheme

Crops (1)	Area (acres) (2)	Value of gross produce (Rs.) (3)	Associated costs (Rs.) (4)	Net income cols. (3-4) (Rs.) (5)
Irrigated				
Wheat	40.53	45,029	24,521	20,508
Jowar	94.25	88,595	44,580	44,015
Local bajra	62.59	40,371	27,414	12,957
Hybrid bajra	38.52	35,670	24,691	10,979
Gram	11.73	7,237	5,431	1,806
Onion (Kharif)	19.15	44,409	28,916	15,493
Onion (Rabi)	28.12	77,583	50,560	27,023
Cotton	27.98	72,109	35,341	36,768
Sugarcane	29.68	2,25,687	94,264	1,31,423
Others	15.25	34,826	22,829	11,987
Unirrigated				
Jowar	266.85	76,319	47,766	28,553
Local bajra	183.28	34,457	27,125	7,332
Pulses	99.61	21,516	16,336	5,180
Total	917.52	8,03,798	4,49,774	3,54,024

Table 5.49. Net income foregone under the progressive irrigation in the Bhade lift irrigation scheme

Years (1)	Gross irrigated area (acres) (2)	Value of gross produce from area in col. (2) under dry condition (Rs.) (3)	Associa- ted costs (Rs.) (4)	Net income Cols. (3-4) (Rs.) (5)
1972-73	400	2,65,720	1,48,684	1,17,036
1973-74	695	4,61,688	2,58,338	2,03,350
1974-75	1,210	8,03,798	4,49,774	3,54,024

Table 5.50. Average per acre net income from the different crops with irrigation in the Bhade lift irrigation scheme

Sr. No.	Crops	Season	Main produce in quintals (per acre)	Price per quintal (Rs.)	Value of main produce* cols. (4 x 5) (Rs.)	By-product	Price (Rs.)	Value of by-product cols. (7 x 8) (Rs.)	Value of gross produce cols. (6+9) (Rs.)	Associated costs (Rs.)	Net income cols. (10-11) (Rs.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Wheat	Rabi	6.50	161	1,046	5.00**	10	50	1,096	579	517
2	Local Jowar	Rabi	5.75	145	834	3.50*	40	140	974	456	518
3	Hybrid Jowar	Kharif	11.00	125	1,375	5.00*	20	100	1,475	795	680
4	Hybrid Bajra	Kharif	6.50	125	812	5.00*	20	100	912	623	289
5	Onion	Kharif	70.00	35	2,450	-	-	-	2,450	1,510	940
6	Onion	Rabi	80.00	35	2,800	-	-	-	2,800	1,798	1,002
7	Groundnut	Kharif	7.50	184	1,380	5.00**	10	50	1,430	758	672
8	Cotton	Summer and Kharif	6.50	331	2,151	5.00**	10	50	2,201	1,264	937
9	Sugarcane	Annual	500.00	14	7,000	-	-	-	7,000	3,176	3,824

* In bundles of hundred stalks. ** Cart loads. * Values rounded up.

Table 5.51. Crop pattern with irrigation and utilisation of the water discharge according to the crops in the Bhade lift irrigation scheme

Kharif			
Crops (1)	Area (acres) (2)	Duties (acres) (3)	Water discharge cols. (2 ÷ 3) (Cusecs) (4)
Sugarcane*	100	-	-
Cotton*	50	-	-
Onion*	50	-	-
Groundnut*	43	-	-
Hybrid bajra	324	125	2.59
Hybrid jowar	250	105	2.38
Total	817	-	4.97

Rabi			
Crops (1)	Area (acres) (2)	Duties (acres) (3)	Water discharge cols. (2 ÷ 3) (Cusecs) (4)
Sugarcane *	100	-	-
Wheat*	83	-	-
Onion*	60	-	-
Local jowar	250	105	2.38
Total	493	-	2.38

Summer			
Crops (1)	Area (acres) (2)	Duties (acres) (3)	Water discharge cols. (2 ÷ 3) (Cusecs) (4)
Sugarcane *	100	-	-
Cotton *	50	-	-
Total	150	-	-

* Crops under the existing wells within the command area.

Table 5.52. Total net income from the crop production with irrigation in the Bhade lift irrigation scheme

Crops	Season	Area (acres)	Value of gross produce		Associated costs		Net income	
			Per acre (Rs.)	Total (Rs.)	Per acre (Rs.)	Total (Rs.)	Per acre (Rs.)	Total (Rs.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Wheat	Rabi	83	1,095	90,968	579	48,057	517	42,911
Local jowar	Rabi	250	974	2,43,500	456	1,14,000	518	1,29,500
Hybrid jowar	Kharif	250	1,475	3,68,750	795	1,98,750	680	1,70,000
Hybrid bajra	Kharif	324	912	2,95,488	623	2,01,852	289	93,636
Onion	Kharif	50	2,450	1,22,500	1,510	75,500	940	47,000
Onion	Rabi	60	2,800	1,68,000	1,798	1,07,880	1,002	60,120
Groundnut	Kharif	43	1,430	61,490	758	32,594	672	28,896
Cotton	Summer and Kharif	50	2,201	1,10,050	1,264	63,200	937	46,850
Sugarcane	Annual	100	7,000	7,00,000	3,176	3,17,600	3,824	3,82,400
Total		1,210		21,60,746		11,59,433		10,01,313

Table 5.53. Changes in the net income in the process of full development of irrigation in the Bhade lift irrigation scheme

Years	Gross irrigated area (acres)	Increase in gross irrigated area (acres)	Matured irrigated area (acres)	Immatured irrigated area (acres)	Net income on the matured area (col. 4)		
					Value of gross produce (Rs.)	Associated costs (Rs.)	Net income (Rs.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1972-73	400	-	-	400	-	-	-
1973-74	695	295	-	695	-	-	-
1974-75	1,210	515	-	1,210	-	-	-
1975-76	1,210	-	400	810	7,14,296	3,83,284	3,31,012
1976-77	1,210	-	695	515	12,41,089	6,65,956	5,75,133
1977-78	1,210	-	1,210	-	21,60,746	11,59,433	10,01,313

Continued..

Table 5.53: contd.

Years	Net income on the immatured area (col. 5)			Total		
	Value of gross pro- duce (Rs.) (9)	Associated costs (Rs.) (10)	Net income (Rs.) (11)	Value of gross pro- duce (Rs.) (12)	Associated costs (Rs.) (13)	Net income (Rs.) (14)
1972-73	6,86,712	3,75,796	3,10,916	6,86,712	3,75,796	3,10,916
1973-74	11,93,162	6,52,946	5,40,216	11,93,162	6,52,946	5,40,216
1974-75	20,77,304	11,36,783	9,40,521	20,77,304	11,36,783	9,40,521
1975-76	13,90,592	7,60,987	6,29,605	21,04,888	11,44,271	9,60,617
1976-77	8,84,142	4,83,837	4,00,305	21,25,231	11,49,793	9,75,438
1977-78	-	-	-	21,60,746	11,59,433	10,01,313

Table 5.5a. Wet increase in farm income because of irrigation in the Bhade lift irrigation scheme

(in Rupees)

Years (1)	Farm income with irrigation			Farm income without irrigation			Wet increase in farm income		
	Value of gross produce (2)	Associated costs (3)	Net income (4)	Value of gross produce (5)	Associated costs (6)	Net income (7)	Value of gross produce (8)	Associated costs (9)	Net income (10)
1972-73	6,86,712	3,75,798	3,10,916	2,55,720	1,48,684	1,17,036	4,20,992	2,27,112	1,93,880
1973-74	11,93,162	6,52,946	5,40,216	4,61,688	2,58,338	2,03,350	7,31,474	3,94,608	3,36,866
1974-75	20,77,304	11,36,783	9,40,521	8,03,798	4,49,774	3,54,024	12,73,506	6,87,069	5,86,437
1975-76	21,04,888	11,44,271	9,60,617	8,03,798	4,49,774	3,54,024	13,01,090	6,94,497	6,06,593
1976-77	21,25,231	11,49,793	9,75,438	8,03,798	4,49,774	3,54,024	13,21,433	7,00,019	6,21,414
1977-78	21,60,746	11,59,433	10,01,313	8,03,798	4,49,774	3,54,024	13,56,948	7,09,659	6,47,289

Table 5.55. Capital cost of the Bhade lift irrigation scheme

<u>Items</u>	<u>Rs.</u>
(A) Civil portion	
(1) Intake chamber, jack well and pump house	76,396.
(2) Delivery chambers	28,113.
(3) Rising main, syphons and distribution system	3,23,884.
(4) Others	10,000.
Total	4,38,393.
(B) Mechanical and electrical portion	1,73,245.
(C) Agency charges (including cost of initial survey and others)	61,164.
(D) Interest on the capital locked up over the period of construction	56,511.
Grand total	7,29,313.

Table 5.56. Annual operation and maintenance costs of the Bhade lift irrigation scheme

<u>Items</u>	<u>Rs.</u>
(1) Electric power and fuel consumption	1,12,328*
(2) Salaries of the agricultural officer, water distributors, pump drivers electricians and office bearers	26,520.
(3) Maintenance, repairs and others	13,373.
Total	1,52,221.

* Calculated at the rate of Rs. 0.19 per unit (Kwh) of electric power consumption.

Table 5.57. Financial profitability of the Blade lift irrigation scheme

(in Rupees)

Period (1)	Capital costs (2)	Operation and maintenance costs (3)	Cost of land leveling (4)	Net increase in the associated costs (5)	Gross costs cols. (2+3+4+5) (6)	Net increase in the crop production (7)	Net benefits cols. (7-6) (8)
1972-73	7,29,313	39,893	7,616	2,27,112	10,03,934	4,20,992	- 5,82,942
1973-74	-	39,893	13,233	3,94,608	4,47,734	7,31,474	2,83,740
1974-75	-	39,893	23,034	6,87,009	7,49,936	12,73,506	5,23,570
1975-76	-	39,893	23,034	6,94,497	7,57,424	13,01,090	5,43,666
1976-77	-	39,893	23,034	7,00,019	7,62,946	13,21,433	5,58,487
1977-78 to 1981-82**	-	39,893	23,034	7,09,659	7,72,586	13,56,948	5,84,362
1982-83	1,73,245*	39,893	23,034	7,09,659	9,45,831	13,56,948	4,11,117
1983-84 to 1991-92**	-	39,893	23,034	7,09,659	7,72,586	13,56,948	5,84,362
1992-93	1,73,245*	39,893	23,034	7,09,659	9,45,831	13,56,948	4,11,117
1993-94 to 2001-02 **	-	39,893	23,034	7,09,659	7,72,586	13,56,948	5,84,362
Total	10,75,803	11,95,790	6,65,801	2,04,44,720	23,83,114	3,49,72,195	1,55,29,081

* Replacement cost
 ** For these periods only yearly figures which remain constant over the years are presented.

W.P.V. at 10.5% discount rate = Rs. 38,19,157
 I.R.R. = 74%

At 10% reduction in the net increase in crop production

W.P.V. at 10.5% discount rate = Rs. 27,37,566
 I.R.R. = 55%

Appendix 5.1. Average per acre yields of the irrigated crops within and outside the command areas during 1972-73, and farmers' estimates of the yields after full development of irrigation in the lift irrigation schemes. (in Quintals)

Crops	Koregaon-Mul			Kaigaon			Khanggaon-Tek		
	Within command area	Outside command area	Farmers' estimates	Within command area	Outside command area	Farmers' estimates	Within command area	Outside command area	Farmers' estimates
Paddy	4.95	3.63	7.12	-	-	7.25	6.44	6.92	6.75
Wheat	4.68	5.87	6.78	4.88	-	7.13	5.25	6.72	6.72
Local jowar	3.84	4.78	5.53	4.12	4.59	5.30	5.11	5.05	5.81
Hybrid jowar	-	-	-	-	-	-	-	-	-
Local bajra	3.81	4.72	4.79	3.39	-	4.94	4.41	-	4.68
Hybrid bajra	-	-	-	6.54	-	6.76	-	8.15	7.15
Onion	75.75	89.14	75.96	79.06	78.48	74.35	77.69	70.77	78.92
Groundnut	-	-	7.84	-	-	8.25	7.99	10.00	8.17
Vegetables (Rs.)	1,010	-	1,355	1,336	-	1,542	1,380	-	1,550
Cotton	-	-	-	-	-	-	-	-	-
Sugarcane (Tonnes)	42.56	45.46	50.20	37.86	47.52	48.42	41.43	45.40	45.79
Mung	1.76	-	2.20	-	-	2.25	-	-	2.60
Gram	3.28	-	4.25	-	-	4.00	-	-	4.35

Continued..

Appendix 5.1: contd.

Crops	Pimpri-Waghare			Shade		
	Within command area	Outside command area	Farmers' estimates	Within command area	Outside command area	Farmers' estimates
Paddy	-	-	6.82	-	-	6.95
Wheat	-	-	6.47	6.36	-	6.75
Local jowar	-	-	-	5.15	6.36	5.40
Hybrid jowar	-	-	-	9.95	9.21	11.36
Local bajra	-	-	-	-	-	4.69
Hybrid bajra	-	-	-	-	-	7.10
Onion	74.17	-	75.90	78.00	70.25	75.90
Groundnut	6.18	-	7.56	-	-	7.88
Vegetables (Es.)	1,350	-	1,565	-	-	-
Cotton	-	-	-	7.25	6.25	6.94
Sugarcane (Tonnes)	-	-	47.25	52.80	58.00	48.70
Mung	-	-	2.00	-	-	2.10
Grass	-	-	4.10	3.96	-	3.90

Appendix 5.2. Per acre irrigation water requirements of the crops, duties of the crops and other particulars.

Sr. No.	Crops	Season	Interval between irrigations (days)	Depth of water per irrigation (inches)	No. of irrigations required for the crops	Per acre irrigation water requirements of the crops cols.(5 x 6) (acre-inches)	Area irrigated in a day (16 hrs.) at one cusec discharge of water (i.e., 15.87 acre-inches ÷ col.5) (acres)	Duties of the crops at one cusec discharge of water cols. (4 x 8) (acres)	Total irrigation water requirements for the area in col. 9 cols. (7 x 9) (acre-inches)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	Paddy	Kharif	10	4.00	10	40.00	3.97	40	1,600
2	Wheat	Rabi	15	3.00	6	18.00	5.29	80	1,440
3	Local jowar	Rabi	20	3.00	4	12.00	5.29	105	1,260
4	Hybrid jowar	Kharif	20	3.00	3	9.00	5.29	105	945
5	Hybrid jowar	Rabi	15	3.00	5	15.00	5.29	80	1,200
6	Local bajra	Kharif	20	2.50	2	5.00	6.35	125	625
7	Hybrid bajra	Kharif	20	2.50	3	7.50	6.35	125	937
8	Onion	Kharif	15	2.50	5	12.50	6.35	95	1,147
9	Onion	Rabi	12	2.50	12	30.00	6.35	75	2,250
10	Groundnut	Kharif	15	3.00	4	12.00	5.29	80	960
11	Groundnut	Summer	10	3.00	12	36.00	5.29	55	1,980
12	Vegetables	Kharif	15	2.50	4	10.00	6.35	95	950
13	Vegetables	Rabi	12	2.50	12	30.00	6.35	75	2,250
14	Vegetables	Summer	10	3.00	12	36.00	5.29	55	1,980
15	Mung	Kharif	15	2.50	1	2.50	6.35	95	237
16	Gram	Rabi	20	3.00	3	9.00	5.29	105	945
17	Cotton*	Summer	12	3.00	5	15.00	5.29	65	975
	Cotton	Kharif	20	3.00	3	9.00	5.29	105	945
18	Sugarcane**	Kharif	12	3.00	6	18.00	5.29	65	1,170
	Sugarcane	Rabi	12	3.50	10	35.00	4.53	55	1,925
	Sugarcane	Summer	10	4.50	12	54.00	3.53	35	1,490

* Cotton is a two seasonal crop. ** Sugarcane is an annual crop.

H.P. of the electric motors: Koregaon-Mul 50, Naigaoan 40, Khamgaon-Tek 120, Pimpri-Naghere 10, and Bhade 167. We have considered 90% efficiency of the electric motors while calculating the cost of electric power consumption.

Appendix 5.3: Linear programming

In Chapter V, an attempt is made by using the budgeting method to estimate the optimum cropping pattern which will maximise net income under irrigation in the Koregson-Mul lift irrigation scheme. The estimation of optimum crop pattern under irrigation in the project is also attempted by linear programming. In this appendix, therefore, we discuss in brief the formulation of the linear programming problem and present the solution obtained by the Simplex method.

Our objective is to arrive at a cropping pattern which will give maximum net income in the project area. However, the objective of net income maximisation is governed by a large number of limitations like soil types, discharge of water available for irrigation and water requirements of the crops, crop combinations, fodder and food grain consumption needs on the farms, availability of farm labour, etc. We set an objective function where profit is expressed as a linear function of area under different crops with the per acre net income as the coefficients. This objective function is to be maximised subject to the constraints mentioned above.

First of all, area under each crop has to be identified for its seasons and also for the types of soil on which it is grown. We have used symbol 'X' for area under a crop in acres with upper and lower subscripts. The

upper subscript refers to seasons, viz., kharif, rabi, summer, annual and double season like summer and kharif. There are two lower subscripts. The first stands for the crops and the second for the soil types. For example, X_{Jh}^R stands for area under jowar in rabi season on heavy soil; X_{Pm}^K stands for area under paddy in kharif season on medium soil. The list of the symbols used for the subscripts is given below:

Upper subscript (seasons)

- K = Kharif
- R = Rabi
- S = Summer
- SK = Summer and Kharif
- A = Annual

Lower subscript (crops)

- | | |
|-------------------|----------------|
| P = Paddy | O = Onion |
| W = Wheat | D = Groundnut |
| J = Jowar | C = Cotton |
| BT = Local bajra | V = Vegetables |
| BY = Hybrid bajra | G = Gram |
| E = Sugarcane | N = Mung |

Lower subscript (Soil types)

- h = Heavy soil
- m = Medium soil
- l = Light soil

The objective function is formulated by using these

symbols and taking the per acre net income of the crops from Table 5.5. It may be noted here that for each crop we have only one estimate of per acre net income. As a matter of fact the per acre net income from any crop may be different on different types of soil. However, such data were not available. Therefore, we have used the same per acre net income for each type of soil on which a crop is grown. This limitation of the exercise is common in both the methods.

It may be mentioned that all crops cannot be grown in all the seasons and on all types of soil, and therefore only the possible crops appear in the objective function. The objective function is set as follows:

Maximise $W =$

$$\begin{aligned}
 & 549 x_{Ph}^K + 549 x_{Pm}^K + 609 x_{Wh}^R + 609 x_{Wm}^R + 536 x_{Jh}^R \\
 & + 536 x_{Jm}^R + 536 x_{Jl}^R + 288 x_{BTh}^K + 288 x_{BTm}^K \\
 & + 288 x_{BTl}^K + 368 x_{BYh}^K + 368 x_{BYm}^K + 368 x_{BYl}^K \\
 & + 3542 x_{Eh}^A + 1064 x_{Oh}^K + 1197 x_{Oh}^R + 803 x_{Dh}^K \\
 & + 532 x_{Dh}^S + 1053 x_{Ch}^{SK} + 1053 x_{Cm}^{SK} + 707 x_{Vh}^K + 707 x_{Vm}^K \\
 & + 642 x_{Vh}^R + 642 x_{Vm}^R + 623 x_{Vh}^S + 623 x_{Vm}^S \\
 & + 255 x_{Oh}^R + 255 x_{Gm}^R + 255 x_{Gl}^R + 79 x_{Nh}^K + 79 x_{Nm}^K \\
 & + 79 x_{Nl}^K
 \end{aligned}$$

This objective function is to be maximised subject to total 26 constraints constructed on the basis mentioned earlier. Now, we shall explain the constraints in brief.

The first set of constraints, 1 to 8, is because of limitation on the total area to be brought under irrigation. Total irrigable command area of the project is 272 acres divided into 103 acres of heavy soil, 79 acres of medium soil and 90 acres of light soil. Thus, the area under the various crops should be such that their total for any season on any particular type of soil should not exceed the total area of that soil type available in the project. For example, constraint 1 indicates that total area under kharif crops on heavy soil, namely, paddy, local and hybrid bajra, sugarcane, onion, groundnut, cotton, vegetables and mung should not exceed 103 acres. It may be mentioned that while writing the constraints for any season, we must also include annual as well as two seasonal crops, if any, along with the crops of that season.

The second set of constraints, 9 to 11, arises out of limitation on the discharge of water available for irrigation during each of the three seasons. The total discharge of water available for irrigation is 2.5 cusecs in both kharif and rabi seasons but only half of it (i.e., 1.25 cusecs) in summer season for the reason mentioned in Chapter V. Constraint 9 refers to the kharif season.

The per acre discharge of water required for each crop is the coefficient of area of that crop, and therefore, the total of the terms on the left hand side of the constraint gives the total discharge of water required during the kharif season. This should be, of course, less than or equal to 2.5 cusecs. Constraints 10 and 11 refer to rabi and summer seasons respectively, and are similarly constructed.

There is a certain difficulty in the case of rabi jowar. At the time of sowing of rabi jowar, all irrigated kharif crops except bajra and mung, are still standing in the fields and requiring some more waterings. Therefore, the amount of water discharge available at the time of sowing of rabi jowar is the residual discharge after using it for all standing kharif crops in the fields. Constraint 12 is designed to take care of this.

To meet the annual food grain consumption needs of the farm families and fodder for cattle on the farms, it is estimated on the basis of the farm survey data that the minimum necessary area under jowar and bajra should be 65 acres and 75 acres respectively. Constraints 13 and 14 ensure this.

Onion and vegetables are the labour intensive crops. It was seen by examining the labour force available in the village for growing different crops that area under rabi onion and kharif vegetables cannot exceed 24 acres

and 31 acres respectively, in the project area, without running into difficulties with availability of labour. Constraints 15 and 16 are formulated for this purpose.

The next set of constraints from 17 to 23 is based on the total area limitations as in the case of the first set of constraints but here the crop combination possibilities are taken into consideration. Double or treble cropping on the same piece of land is possible only if we follow certain crop combinations. For example, on the same piece of land we cannot grow onion in rabi season after growing vegetables or onion in kharif season. If we consider heavy soil and grow kharif onion, kharif vegetables and sugarcane then the total land used in kharif is:

$$x_{Oh}^K + x_{Vh}^K + x_{Eh}^A$$

Now, rabi onion can be taken on the piece of land other than that used for kharif onion, kharif vegetables and sugarcane. This means, the area under rabi onion, i.e., x_{Oh}^R should satisfy the following condition because we have only 103 acres of heavy soil.

$$x_{Oh}^R \leq 103 - x_{Oh}^K - x_{Vh}^K - x_{Eh}^A,$$

$$\text{i.e., } x_{Oh}^R + x_{Oh}^K + x_{Vh}^K + x_{Eh}^A \leq 103$$

This is constraint 17. Similarly, the other constraints in this group are designed which are based on these types of restrictions discussed in Chapter V.

The last criterion used in the programming is that each acre in the irrigable command area should receive irrigation at least for one season during a year. For this purpose, constraints 24, 25 and 26 are written.

The constraints are as follows:

- (1) $x_{Ph}^K + x_{BTh}^K + x_{BYh}^K + x_{Eh}^A + x_{Oh}^K + x_{Dh}^K + x_{Ch}^{SK} + x_{Vh}^K + x_{Nh}^K \leq 103$
- (2) $x_{Wh}^R + x_{Jh}^R + x_{Eh}^A + x_{Oh}^R + x_{Vh}^R + x_{Ch}^R \leq 103$
- (3) $x_{Eh}^A + x_{Dh}^S + x_{Ch}^{SK} + x_{Vh}^S \leq 103$
- (4) $x_{Pm}^K + x_{BTm}^K + x_{BYm}^K + x_{Cm}^{SK} + x_{Vm}^K + x_{Nm}^K \leq 79$
- (5) $x_{Jm}^R + x_{Jm}^R + x_{Vm}^R + x_{Cm}^R \leq 79$
- (6) $x_{Vm}^S + x_{Cm}^{SK} \leq 79$
- (7) $x_{Bt1}^K + x_{By1}^K + x_{N1}^K \leq 90$
- (8) $x_{J1}^R + x_{G1}^R \leq 90$
- (9) $\frac{1}{10} x_{Ph}^K + \frac{1}{10} x_{Pm}^K + \frac{1}{125} x_{BTh}^K + \frac{1}{125} x_{BTm}^K + \frac{1}{125} x_{Bt1}^K + \frac{1}{125} x_{BYh}^K + \frac{1}{125} x_{BYm}^K + \frac{1}{125} x_{By1}^K + \frac{1}{65} x_{Eh}^A + \frac{1}{95} x_{Oh}^K + \frac{1}{80} x_{Dh}^K + \frac{1}{105} x_{Ch}^{SK} + \frac{1}{105} x_{Cm}^{SK}$

$$\begin{aligned}
 & + \frac{1}{95} X_{Vh}^K + \frac{1}{95} X_{Vm}^K + \frac{1}{95} X_{Nh}^K + \frac{1}{95} X_{Nm}^K + \frac{1}{95} X_{N1}^K \\
 & \leq 2.50
 \end{aligned}$$

$$\begin{aligned}
 (10) \quad & \frac{1}{80} X_{Wh}^R + \frac{1}{80} X_{Wm}^R + \frac{1}{105} X_{Jh}^R + \frac{1}{105} X_{Jm}^R + \frac{1}{105} X_{J1}^R \\
 & + \frac{1}{55} X_{Eh}^A + \frac{1}{75} X_{Oh}^R + \frac{1}{75} X_{Vh}^R + \frac{1}{75} X_{Vm}^R + \frac{1}{105} X_{Gh}^R \\
 & + \frac{1}{105} X_{Gm}^R + \frac{1}{105} X_{G1}^R \leq 2.50
 \end{aligned}$$

$$\begin{aligned}
 (11) \quad & \frac{1}{35} X_{Eh}^A + \frac{1}{55} X_{Dh}^S + \frac{1}{65} X_{Ch}^{SK} + \frac{1}{65} X_{Cm}^{SK} + \frac{1}{55} X_{Vh}^S \\
 & + \frac{1}{55} X_{Vm}^S \leq 1.25
 \end{aligned}$$

$$\begin{aligned}
 (12) \quad & \frac{1}{105} X_{Jh}^R + \frac{1}{105} X_{Jm}^R + \frac{1}{105} X_{J1}^R + \frac{1}{10} X_{Ph}^K + \frac{1}{10} X_{Pm}^K + \frac{1}{65} X_{Eh}^A \\
 & + \frac{1}{95} X_{Oh}^K + \frac{1}{80} X_{Dh}^K + \frac{1}{95} X_{Ch}^{SK} + \frac{1}{95} X_{Cm}^{SK} + \frac{1}{95} X_{Vh}^K \\
 & + \frac{1}{95} X_{Vm}^K \leq 2.50
 \end{aligned}$$

$$(13) \quad X_{Jh}^R + X_{Jm}^R + X_{J1}^R \geq 85$$

$$(14) \quad X_{BTh}^K + X_{BTm}^K + X_{BT1}^K + X_{BYh}^K + X_{BYm}^K + X_{BT1}^K \geq 75$$

$$(15) \quad X_{Oh}^R \leq 25$$

$$(16) \quad X_{Vh}^K + X_{Vm}^K \leq 31$$

$$(17) \quad X_{Oh}^R + X_{Oh}^K + X_{Vh}^K + X_{Eh}^A \leq 103$$

$$(18) \quad X_{Vh}^R + X_{Oh}^K + X_{Vh}^K + X_{Eh}^A \leq 103$$

$$(19) \quad x_{Vm}^R + x_{Vm}^K \leq 79$$

$$(20) \quad x_{Jh}^R + x_{Ph}^K + x_{Ch}^K + x_{Dh}^K + x_{Vh}^K + x_{Ch}^{SK} + x_{Eh}^A \leq 103$$

$$(21) \quad x_{Jm}^R + x_{Pm}^K + x_{Vm}^K + x_{Cm}^{SK} \leq 79$$

$$(22) \quad x_{Dh}^S + x_{Vh}^S + x_{Wh}^R + x_{Ch}^R + x_{Vh}^R + x_{Eh}^A \leq 103$$

$$(23) \quad x_{Vm}^S + x_{Vm}^R + x_{Vm}^R \leq 79$$

$$(24) \quad x_{Ph}^K + x_{BTh}^K + x_{BYh}^K + x_{Eh}^A + x_{Oh}^K + x_{Dh}^K \\ + x_{Ch}^{SK} + x_{Vh}^K + x_{Nh}^K + x_{Wh}^R + x_{Jh}^R + x_{Oh}^R \\ + x_{Vh}^R + x_{Ch}^R + x_{Dh}^S + x_{Vh}^S \geq 103$$

$$(25) \quad x_{Pm}^K + x_{BTm}^K + x_{BYm}^K + x_{Cm}^{SK} + x_{Vm}^K + x_{Em}^K \\ + x_{Vm}^R + x_{Jm}^R + x_{Vm}^R + x_{Gm}^R + x_{Vm}^S \geq 79$$

$$(26) \quad x_{BT1}^K + x_{EY1}^K + x_{N1}^K + x_{J1}^R + x_{G1}^R \geq 90$$

The optimum solution obtained for the above linear programming problem is given below.

	<u>Crops</u>	<u>Season</u>	<u>Soil type</u>	<u>Area (acres)</u>
x_{Eh}^A	Sugarcane	Annual	Heavy	45
x_{Ch}^K	Onion	Kharif	Heavy	30

	<u>Crops</u>	<u>Season</u>	<u>Soil type</u>	<u>Area (acres)</u>
X ^R _{Ch}	Onion	Rabi	Heavy	28
X ^K _{Dh}	Groundnut	Kharif	Heavy	28
X ^K _{Vm}	Vegetables	Kharif	Medium	31
X ^K _{BYm}	Hybrid bajra	Kharif	Medium	48
X ^K _{BYl}	Hybrid bajra	Kharif	Light	53
X ^R _{Jm}	Jowar	Rabi	Medium	48
X ^R _{Jl}	Jowar	Rabi	Light	37
X ^R _{Wh}	Wheat	Rabi	Heavy	30
X ^R _{Wm}	Wheat	Rabi	Medium	10
Gross cropped area =				388
Total net income =				Rs. 3,76,315

By following the above cropping pattern the maximum total net income of Rs. 3,76,315 can be obtained satisfying all the 26 constraints mentioned.

CHAPTER VI

REPAYMENT OF LOANS

6.0 Introduction

It has already been pointed out in Chapter II that the financial profitability calculus of the projects may not alone settle the question between the banks which finance the projects and the beneficiaries when the problem of actual repayment of loans of the projects arises. The reasons for this are two: (1) Financial profitability, as calculated earlier, only implies that the (discounted) total returns are greater than the (discounted) total costs, and therefore full payment of the loans is possible. But when it comes to actual payment, this may not be always feasible. If a farmer making the investment, is not left with a surplus that enables him to enjoy at least a minimum level of living after repayment of the loan every year, he may not be very enthusiastic about the project or, what is more likely, he may not care to repay the loan; and (2) the problem would be further complicated if the financing agency wants to recover the loans in a shorter period than might be feasible. We propose to examine the question of repayment of loans of the projects from these points of view in this chapter. To examine the question of repayment of loans, it is necessary to consider the repayment capacity of the farmers, i.e., the annual net

income of the farmers that can be available for the repayment of loans after meeting the minimum consumption needs of the households, and other essential expenses. These calculations would also help the financing agencies to estimate the time period over which they can reasonably expect to recover the loans and decide if any flexibility in this regard may be necessary..

It has also been indicated in Chapter II that general practice of the financial institutions in India in prescribing the repayment schedule often fails to take into account the lapse of time after the disbursement of the loan before the benefits begin to accrue to the farmers. This results in enforcement of instalments of repayment on some farmers who have not been able to avail of the irrigation facility for sometime because of delays on account of technical or financial reasons like land leveling, etc. Therefore, we propose to take this factor into account while estimating the repayment of loans without extending the period stipulated by the banks.

Like in the preceding chapter, the Koregaon-Mul lift irrigation scheme is undertaken for estimation of the repayment of loans by the farmers in detail. In the case of the rest of the projects, we shall discuss only the results and avoid repetition of common procedures and problems. We shall first propose some changes in the present method of determining the repayment schedule by

the bank, giving reason for the proposed changes and accordingly calculate the repayment of loans after considering the repayment capacity of the farmers in the project.

6.1 Repayment Schedule

According to the bank which has financed the project, repayment should be made in seven equated annual instalments from the date of disbursement of the loan. This implies that the bank safely assumes that once the money is made available for construction of the project, the benefits of irrigation, too, accrue to all concerned in the first year itself. However, this does not happen for the reason mentioned in Chapter II that the development of irrigation is a slow process, as experience everywhere shows. Thus, benefits from a given irrigation project accrue to different farmers from different dates and also, in respect of a given farmer, for varying periods for different parts of his total irrigable area. In these circumstances, to expect the repayment of loans right from the end of the first year after disbursement from the farmers who are not able to avail of the irrigation facility until after lapse of a longer period is improper. In the light of this, the financing agency's repayment schedule looks rigid. To avoid this, we take into account the area likely to be irrigated every year from the beginning

and the period over which such benefits will accrue to the different farmers, without extending the total period of repayment prescribed by the bank, as discussed below.

The amount of loan disbursed by the bank to the project in 1969 was Rs. 1,49,522. Water from the project was released for irrigation in 1970-71 and it is estimated that the total command area of the project would come under irrigation by 1976-77. It means that the area which would come under irrigation during 1970-71 would receive the benefits of irrigation over the life of the project, i.e., for 30 years. But, the area that would come under irrigation for the first time in 1976-77 would receive the benefits of irrigation for only 24 years. Therefore, the total amount of loan (principal) to be repaid should be distributed among the farmer-members on the basis of their area to be irrigated and the period over which such benefits would accrue to them. This is seen from Table 6.1 which shows that the per acre amount of principal to be repaid is smaller for the lands which begin to receive water later than 1970-71. The farmers who are to receive irrigation from the project for a longer period will have to repay a larger amount of the total loan on a per acre basis.

Given this division of the total loan repayable by the different farmers (or rather plots of land) who will

Table 6.1. Distribution of the loan on the basis of the irrigated area and the period of benefits in the Korasaon-Mul lift irrigation scheme

Years	Irrigated area (acres)	Increase in the irrigated area over the last year (acres)	No. of years the benefits of irrigation will accrue over the project life (i.e., 30 years)	Irrigated area over the project life Cols. (3 x 4) (acre-years)	Percentage distribution of area in col. (5) to its total	Loan to be repaid by the area in col. (3) (Total Loan x col. (6) as % (Rs.)	Per acre cols. (7 ÷ 3) (Rs.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1970-71	102	102	30	3,060	10.37	60,362	592
1971-72	117	15	29	835	5.74	8,583	572
1972-73	147	30	28	840	11.08	16,567	552
1973-74	199	52	27	1,404	18.52	27,691	533
1974-75	234	35	26	910	12.00	17,943	513
1975-76	253	19	25	475	6.27	9,375	493
1976-77	272	19	24	456	6.02	9,601	474
Total	-	272	-	7,580	100.00	1,49,522	550

receive water from different years, the annual equated instalments of loan to be repaid by each year-category at the interest rate of 9.5 per cent, can be worked out without extension of the period prescribed by the bank, that is, seven years. According to the proposed method, the farmers who avail of the irrigation facility in 1970-71 should start the repayment of their loans at the end of that year and consequently complete it within the seven equated annual instalments, i.e., in 1976-77. Similarly, the farmers who receive the benefits of irrigation in 1971-72 should repay the first instalment of their loans at the end of the same year, i.e., in 1971-72 and subsequently complete the repayment in 1976-77, that is, in six equated annual instalments; and, so on, as worked out in Table 6.2.

It is seen from the above discussion that the proposed repayment schedule gives some relief to the farmers who begin receiving irrigation water late ; in two ways: relief in the total amount of principal to be repaid and the necessary postponement of the date from which the first instalment would be due from them, as shown in Tables 6.1 and 6.2 respectively. In this sense, this repayment schedule would be more equitable than the present schedule followed by the bank. On the other hand, some hardship may be caused to the cultivators who begin repayment late, say, in the fifth, sixth or the seventh year in as much

Table 6.2. Repayment schedule according to the proposed method in the Koregaon-Mul lift irrigation scheme

Years	Area receiving irrigation from the year (acres)	1970-71 (Rs.)	1971-72 (Rs.)	1972-73 (Rs.)	1973-74 (Rs.)	1974-75 (Rs.)	1975-76 (Rs.)	1976-77 (Rs.)
1970-71	102	12,195	12,195	12,195	12,195	12,195	12,195	12,195
1971-72	15	-	2,126	2,126	2,126	2,126	2,126	2,126
1972-73	30	-	-	5,173	5,173	5,173	5,173	5,173
1973-74	52	-	-	-	11,346	11,346	11,346	11,346
1974-75	35	-	-	-	-	10,281	10,281	10,281
1975-76	19	-	-	-	-	-	8,446	8,446
1976-77	19	-	-	-	-	-	-	16,989
Total	272	12,195	14,321	14,994	30,840	41,121	49,567	66,556

as they have to repay the total amount in three, two or even a single year. How difficult this may prove to be can be assessed only after estimating the repaying capacity of the farmers, to which we shall now turn. It may, however, be noted that for those who delay the use of irrigation water in their fields for reason other than unavoidable technical difficulties, this scheme of repayment may work as a spur to earlier utilisation of the irrigation facility.

6.2 Repayment Capacity of the Farmers

As mentioned in Chapter II, while calculating the annual repayment capacity of the farmers, we should take into account their total annual current income and the estimated expenditure on the minimum need-based level of living, margin to take care of improvement in the standard of living over and above the estimated minimum consumption need due to higher income from irrigation, adverse weather, etc., and the repayment of pre-existing liabilities. We shall estimate these in turn and then calculate the surplus (repayment capacity) from which the sum for repayment has to come.

The total annual current income of the farmers includes the aggregate of income derived by them from the command area of the project, from the land outside the project and from other sources of income like wages, off-farm activities,

etc. Income from the command area to be taken for the purpose of repayment is calculated by deducting the operation and maintenance costs of the project, and the cost of land levelling (interest on the cost) from the value of gross receipts from land after irrigation. Family labour for this purpose is not treated as item of cost, since the return to family labour is a part of the total income of the farm household from irrigated agriculture. In the beginning of the project (1970-71 to 1972-73), the farmers received income from the irrigated as well as from the unirrigated land in the command area. Therefore, the total income from the command area (irrigated plus unirrigated) is taken into account for repayment of loans during that period. The land outside the project was predominantly dry. The crop pattern on this land is estimated on the basis of data collected during 1972-73 and the crop pattern estimated under irrigation in the project area. The income from the crop pattern on this land is calculated by taking the per acre income from the irrigated and unirrigated crops estimated earlier. The income from the other sources represents the income during 1972-73.

The expenditure on the minimum annual need-based level of living of a member of the farm family, worked out in Chapter II, came to Rs. 521. To get the family expenditure on this account, this amount is multiplied by the number of members in the family. A desired margin to take

care of improvement in the level of living, possible increase in liabilities, adverse weather and cost-price relations, etc., is arbitrarily decided to be 10 per cent of the total annual current income of the farm family. The annual repayment of pre-existing liabilities represents the amount of loan in 1970-71.

Thus, the repayment capacity gives the surplus in the annual income of the farm family over the aggregate expenditure on account of essential consumption expenditure, margin to take care of increased consumption, etc., and repayment of pre-existing liabilities. It needs to be mentioned that the repayment schedule worked out in the above tables (Tables 6.1 and 6.2) is for the project as a whole. However, the repayment capacity from which the amount of loan has to be met every year is calculated for the average farm family in the different size groups of land holdings in the subsequent analysis (Table 6.3). The ideal estimation of repayment of loans would be for every single cultivator separately in each size group of land holdings. However, the necessary details were not available and even if such details could have been made available, the whole exercise would have become extremely difficult. The calculations of the repayment capacity of the average farm family in each size group of land holdings are separately presented in Table 6.3. It is seen from the table that the surplus available for ^{repayment} by the farmers in

the first group was negative during 1970-71 and 1971-72, and became positive later. It was positive from the beginning in the case of the second and the third groups. However, the farmers will be able to repay the loans only when the surplus available for repayment will be equal to or greater than the annual instalment of repayment worked out earlier. Now we shall examine the repayment of loans.

6.3 Repayment of Loans

The calculations of the repayment of loans are also presented in Table 6.3. The annual instalments of loan to be repaid by the average farm family in each size group of land holdings are worked out from Table 6.2. Annual surplus after repayment of loans is also shown in the table. Besides, an attempt is made in this analysis to show how soon the bank can reasonably expect to recover its loans from the farmers and whether any flexibility in this regard would be necessary. To distinguish between the two ways of calculations mentioned, the former is referred to as '(a)' and the latter as '(b)' in the table.

It is observed from the table that according to the repayment schedule (a), the farmers in the first group would not be able to repay the loans during 1970-71 and 1971-72 since they would have no surplus for repayment in these years. Similarly, in 1972-73, though the surplus of the farmers becomes positive, they would not be able to

Table 6.1. Average per family repayment of loans in the different size groups of the cultivated holdings in the Koregaon-Mul lift irrigation scheme. (in rupees)

Group 1: Less than 10.00 acres

Items	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77
A. Income of the family							
(1) Income from the command area	977	1,087	1,305	2,260	2,690	3,177	3,784
(2) Income from the land outside the command area	869	869	869	869	869	869	869
(3) Income from other sources	1,517	1,517	1,517	1,517	1,517	1,517	1,517
Total income (1+2+3)	3,363	3,473	3,691	4,646	5,076	5,563	6,170
B. Minimum need-based level of living	3,011	3,011	3,011	3,011	3,011	3,011	3,011
C. Margin to take care of increased consumption, etc.	336	347	369	465	508	556	617
D. Repayment of pre-existing liabilities							
(a)	134	134	134	134	134	134	134
(b)	18	115	311	454	-	-	-
E. Repayment capacity = [A-(B+C+D)]							
(a)	-118	-19	177	1,036	1,423	1,862	2,408
(b)	-	-	-	717	1,557	1,996	2,542
F. Repayment of loans							
(a)	134	157	214	338	451	543	729
(b)	-	-	-	717	1,557	261	-
G. Surplus = (E-F)							
(a)	-252	-176	-37	698	972	1,319	1,679
(b)	-	-	-	-	-	1,735	2,542

Continued..

Table 6.3: contd.

Group 2: 10.00 to 19.99 acres

Items	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77
A. Income of the family							
(1) Income from the command area	2,196	2,441	2,931	5,078	6,044	7,135	8,500
(2) Income from the land outside the command area	3,441	3,441	3,441	3,441	3,441	3,441	3,441
(3) Income from other sources	615	615	615	615	615	615	615
Total income = (1+2+3)	6,252	6,497	6,987	9,134	10,100	11,192	12,556
B. Minimum need-based level of living	4,805	4,805	4,805	4,805	4,805	4,805	4,805
C. Margin to take care of increased consumption, etc.	625	650	699	913	1,010	1,119	1,256
D. Repayment of pre-existing liabilities							
(a)	230	230	230	230	230	230	230
(b)	822	456	-	-	-	-	-
E. Repayment capacity = [A-(B+C+D)]							
(a)	592	812	1,253	3,156	4,055	5,038	6,265
(b)	-	576	1,483	3,416	4,285	5,268	6,495
F. Repayment of loans							
(a)	300	352	479	759	1,011	1,219	1,637
(b)	-	576	1,483	2,971	-	-	-
G. Surplus = (E-F)							
(a)	292	460	774	2,427	3,044	3,819	4,628
(b)	-	-	-	445	4,285	5,268	6,495

Continued..

Table 6.3: contd.

Group 3: 20.00 and above acres

Items	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77
A. Income of the family							
(1) Income from the command area	4,027	4,477	5,377	9,314	11,086	13,089	15,591
(2) Income from the land outside the command area	6,737	6,737	6,737	6,737	6,737	6,737	6,737
(3) Income from other sources	1,305	1,305	1,305	1,305	1,305	1,305	1,305
Total income= (1+2+3)	12,069	12,519	13,419	17,356	19,128	21,131	23,633
B. Minimum need-based level of living	5,692	5,692	5,692	5,592	5,692	5,692	5,692
C. Margin to take care of increased consumption, etc.	1,207	1,252	1,312	1,735	2,913	2,113	2,363
D. Repayment of pre-existing liabilities							
(a)	906	906	906	906	906	906	906
(b)	4,912	-	-	-	-	-	-
E. Repayment capacity = [A-(B+C+D)]							
(a)	4,264	4,669	5,479	9,022	10,617	12,420	14,672
(b)	258	5,575	6,385	9,928	11,523	13,326	15,578
F. Repayment of loans							
(a)	550	616	879	1,391	1,855	2,236	3,002
(b)	258	5,575	2,440	-	-	-	-
G. Surplus = (E-F)							
(a)	3,714	4,023	4,600	7,631	8,762	10,184	11,670
(b)	-	-	3,945	9,928	11,523	13,326	15,578

repay the loans since the amount of repayment is greater than the surplus available. Therefore, the farmers would be defaulters of the bank during 1970-71 to 1972-73.

The farmers would also not be able to repay even their pre-existing loans in that period. However, they will be able to repay the loans one year before the stipulated period, that is, by the end of six years instead of seven, if the bank takes a flexible approach to repayment and starts the recovery in the fourth year, i.e., during 1973-74 as shown in (b). In this approach, it is assumed that the farmers will repay the pre-existing loans first.

According to the repayment schedule, the farmers in the second and the third groups will be able to repay the instalments of loan in the first year itself. However, their repayment capacity is high enough to justify a reduction in the repayment period from 7 years to 4 years and 3 years in the case of the second and the third groups respectively.

Now we can say that the Koregaon-Mul lift irrigation scheme not only passes the test of financial profitability but also the test of repayment of loans, and hence is a worthwhile proposition from the view point of the financing bank.

The procedure of estimating the repayment of loans in the case of the rest of the lift irrigation schemes is the same as in the case of the Koregaon-Mul lift irri-

gation scheme discussed above. It is necessary to note only the results. Examination of the estimates (Tables 6.4 to 6.15) shows that all the farmers in the different size groups of land holdings in each lift irrigation scheme can repay the loans within the period stipulated by the financing banks. In the case of the farmers in small size groups of land holdings, it is, however, essential to postpone the date of payment of the first instalment of the loan till they acquire the necessary repayment capacity. On the other hand, the repayment capacity of the farmers in big size groups of landholdings is so high as to justify a reduction in the period of repayment. Thus, all the lift irrigation schemes are financially feasible propositions from the view point of the financing banks.

These calculations would also help the financing agencies to estimate the time period over which they can reasonably expect to recover the loans from the farmers and decide whether any flexibility in this regard may be necessary. Financing agencies some times come into difficulties since they do not have these data before them. For application of the proposed repayment schedule as discussed earlier, the financial institutions will have to estimate the area likely to come under irrigation for every year of the individual farmers in the command area of the project. This, of course, requires detailed field investigation before sanctioning the necessary finance to the

project.

So far we have seen that all the lift irrigation schemes selected for the study are justified on financial grounds and are also self-liquidatory in character. However, for any irrigation project, the ultimate interest is with the productivity or total return to the society of all the resources devoted to it. This is a measure of the social benefit of the project and is undertaken in Chapter VII.

Table 6.4. Distribution of the loan on the basis of the irrigated area and the period of benefits in the Naigson lift irrigation scheme

Years (1)	Irrigated area (acres) (2)	Increase in the irrigated area over the last year (acres) (3)	No. of years the benefits of irrigation will accrue over the project life (i.e. 30 years) (4)	Irrigated area over the project life Cols. (3 x 4) (acre-years) (5)	Percentage distribution of area in col. (5) to its total (6)	Loan to be repaid by the area in col. (3) (Total Loan x col. (6) as $\frac{2}{3}$) (Rs.) (7)	Per acre cols. (7 ÷ 3) (Rs.) (8)
1970-71	43	43	30	1,290	36.26	27,738	645
1971-72	54	11	29	319	8.97	6,862	624
1972-73	68	14	28	392	11.02	8,430	602
1973-74	91	23	27	621	17.45	13,349	580
1974-75	127	36	26	936	26.30	20,119	559
Total	-	127	-	3,558	100.00	76,498	602

Table 6.5. Repayment schedule according to the proposed method in the Naigaon lift irrigation scheme.

Years	Area receiving irrigation from the year (acres)	1970-71 (Rs.)	1971-72 (Rs.)	1972-73 (Rs.)	1973-74 (Rs.)	1974-75 (Rs.)	1975-76 (Rs.)	1976-77 (Rs.)
1970-71	43	5,604	5,604	5,604	5,604	5,604	5,604	5,604
1971-72	11	-	1,700	1,700	1,700	1,700	1,700	1,700
1972-73	14	-	-	2,632	2,632	2,632	2,632	2,632
1973-74	23	-	-	-	5,459	5,459	5,459	5,459
1974-75	36	-	-	-	-	11,529	11,529	11,529
Total	127	5,604	7,304	9,936	15,405	26,934	26,934	26,934

Table 6.5. Average per family repayment of loans in the different size groups of the cultivated holdings in the Naigao lift irrigation scheme

(in Rupees)

Group 1: Less than 5.00 acres

Items	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77
A. Income of the family							
(1) Income from the command area	1,059	1,302	1,636	2,596	3,692	3,820	4,040
(2) Income from the land outside the command area	-	-	-	-	-	-	-
(3) Income from other sources	735	735	735	735	735	735	735
Total income=(1+2+3)	1,794	2,035	2,371	3,331	4,427	4,555	4,775
B. Minimum need-based level of living	2,125	2,125	2,125	2,125	2,125	2,125	2,125
C. Margin to take care of increased consumption, etc.	179	203	237	333	443	455	477
D. Repayment of pre-existing liabilities							
(a)	36	36	36	36	36	36	36
(b)	-	-	9	249	-	-	-
E. Repayment capacity = [A-(B+C+D)]							
(a)	- 565	- 329	- 27	837	1,823	1,939	2,137
(b)	- 510	- 293	-	624	1,859	1,975	2,173
F. Repayment of loans							
(a)	135	176	239	371	649	649	649
(b)	-	-	-	624	1,859	393	-
G. Surplus = (E-F)							
(a)	- 681	- 505	- 266	466	1,174	1,290	1,488
(b)	- 510	- 293	-	-	-	1,582	2,173

Continued..

Table 8.6: contd.

Group 2: 5.00 to 9.99 acres

Items	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77
A. Income of the family							
(1) Income from the command area	864	1,063	1,336	2,120	3,014	3,119	3,299
(2) Income from the land outside the command area	3,998	3,998	3,998	3,998	3,998	3,998	3,998
(3) Income from other sources	894	894	894	894	894	894	894
Total income=(1+2+3)	5,756	5,955	6,228	7,012	7,906	8,011	8,191
B. Minimum need-based level of living	3,371	3,371	3,371	3,371	3,371	3,371	3,371
C. Margin to take care of increased consumption, etc.	576	595	623	701	791	801	819
D. Repayment of pre-existing liabilities							
(a)	64	64	64	64	64	64	64
(b)	345	-	-	-	-	-	-
E. Repayment capacity = [A-(B+C+D)]							
(a)	1,745	1,925	2,170	2,876	3,680	3,775	3,937
(b)	1,464	1,989	2,234	2,940	3,744	3,839	4,001
F. Repayment of loans							
(a)	110	143	195	302	528	638	528
(b)	1,464	195	-	-	-	-	-
G. Surplus = (E-F)							
(a)	1,635	1,782	1,975	2,574	3,152	3,217	3,409
(b)	-	1,794	2,234	2,940	3,744	3,839	4,001

Continued..

Table 6.6: contd.

Group 3: 10.00 and above acres

Items	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77
A. Income of the family							
(1) Income from the command area	2,981	3,543	4,452	7,067	10,049	10,397	10,998
(2) Income from the land outside the command area	4,296	4,296	4,296	4,296	4,296	4,296	4,296
(3) Income from other sources	817	817	817	817	817	817	817
Total income=(1+2+3)	7,994	8,556	9,565	12,180	15,162	15,510	16,111
B. Minimum need-based level of living	4,360	4,360	4,360	4,360	4,360	4,360	4,360
C. Margin to take care of increased consumption, etc.	799	866	956	1,218	1,516	1,551	1,611
D. Repayment of pre-existing liabilities							
(a)	268	268	268	268	268	268	268
(b)	1,454	-	-	-	-	-	-
E. Repayment capacity = [A-(B+C+D)]							
(a)	2,557	3,162	3,981	6,334	9,018	8,331	9,872
(b)	1,381	3,430	4,249	6,602	9,286	9,599	10,140
F. Repayment of loans							
(a)	367	478	650	1,008	1,762	1,762	1,762
(b)	1,381	3,430	1,159	-	-	-	-
G. Surplus = (E-F)							
(a)	2,200	2,684	3,331	5,326	7,256	7,569	8,110
(b)	-	-	3,090	6,602	9,286	9,599	10,140

Table 6.7. Distribution of the loan on the basis of the irrigated area and the period of benefits in the Khangsou-Tek lift irrigation scheme

Years	Irrigated area (acres)	Increase in the irrigated area over the last year (acres)	No. of years the benefits of irrigation will accrue over the project life (i.e., 30 years)	Irrigated area over the project life Cols. (3 x 4) (acre-years)	Percentage distribution of area in col. (5) to its total	Loan to be repaid by the area in col. (3) (Total Loan x col. (6) as $\frac{1}{100}$) (Rs.)	Per acre cols. (7 + 3) (Rs.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1970-71	143	143	30	4,290	57.09	1,02,970	720
1971-72	154	21	29	609	8.10	14,610	696
1972-73	173	14	28	392	5.22	9,415	672
1973-74	200	22	27	594	7.90	14,249	648
1974-75	225	25	26	650	8.65	15,602	624
1975-76	245	20	25	500	6.65	11,994	600
1976-77	265	20	24	480	6.39	11,525	576
Total	-	265	-	7,515	100.00	1,80,365	681

Table 6.9. Repayment schedule according to the proposed method in the Khangson-Tek lift irrigation scheme

Years	Area receiving irrigation from the year (acres)	1970-71 (Rs.)	1971-72 (Rs.)	1972-73 (Rs.)	1973-74 (Rs.)	1974-75 (Rs.)	1975-76 (Rs.)	1976-77 (Rs.)
1970-71	143	20,804	20,804	20,804	20,804	20,804	20,804	20,804
1971-72	21	-	3,621	3,621	3,621	3,621	3,621	3,621
1972-73	14	-	-	2,940	2,940	2,940	2,940	2,940
1973-74	22	-	-	-	5,838	5,838	5,838	5,838
1974-75	25	-	-	-	-	8,940	8,940	8,940
1975-76	20	-	-	-	-	-	10,810	10,810
1976-77	20	-	-	-	-	-	-	21,753
Total	265	20,804	24,425	27,365	33,203	42,143	52,953	74,706

Table 6.9. Average per family repayment of loans in the different size groups of the cultivated holdings in the Khangaon-Tek lift irrigation scheme.

Group 1: Less than 5.00 acres

(in Rupees)

Items	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77
A. Income of the family							
(1) Income from the command area	1,461	1,662	1,794	2,709	3,304	3,826	4,442
(2) Income from the land outside the command area	82	82	82	82	82	82	82
(3) Income from other sources	1,065	1,065	1,065	1,065	1,065	1,065	1,065
Total income (1+2+3)	2,608	2,809	2,941	3,856	4,451	4,973	5,589
B. Minimum need-based level of living	3,039	3,039	3,039	3,039	3,039	3,039	3,039
C. Margin to take care of increased consumption, etc.	261	281	294	386	446	497	559
D. Repayment of pre-existing liabilities							
(a)	55	55	55	55	55	55	55
(b)	-	-	-	390	-	-	-
E. Repayment capacity = [A-(B+C+D)]							
(a)	- 747	- 566	- 447	376	911	1,382	1,936
(b)	- 692	- 511	- 392	41	966	1,437	1,991
F. Repayment of loans							
(a)	176	206	231	281	356	448	631
(b)	-	-	-	41	966	1,437	91
G. Surplus = (E-F)							
(a)	- 923	- 772	- 678	95	555	934	1,305
(b)	- 692	- 511	- 392	-	-	-	1,900

Continued..

Table 6.9 : contd.

Group 2: 5.00 to 9.99 acres

Items	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77
A. Income of the family							
(1) Income from the command area	2,944	3,349	3,615	5,457	6,654	7,709	8,949
(2) Income from the land outside the command area	1,243	1,243	1,243	1,243	1,243	1,243	1,243
(3) Income from other sources	717	717	717	717	717	717	717
Total income = (1+2+3)	4,904	5,309	5,575	7,417	8,614	9,669	10,909
B. Minimum need-based level of living	4,104	4,104	4,104	4,104	4,104	4,104	4,104
C. Margin to take care of increased consumption, etc.	490	530	557	742	861	967	1,091
D. Repayment of pre-existing liabilities							
(a)	236	236	236	236	236	236	236
(b)	310	673	424	-	-	-	-
E. Repayment capacity = [A-(B+C+D)]							
(a)	74	439	673	2,335	3,413	4,362	5,478
(b)	-	-	490	2,571	3,649	4,598	5,714
F. Repayment of loans							
(a)	355	417	467	556	719	903	1,274
(b)	-	-	490	2,571	1,442	-	-
G. Surplus = (E-F)							
(a)	- 281	22	211	1,769	2,694	3,459	4,204
(b)	-	-	-	-	2,207	4,598	5,714

Continued..

Table 6.9: Contd.

Group 3: 10.00 to 14.99 acres

Items	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77
A. Income of the family							
(1) Income from the command area	5,728	6,518	7,034	10,620	12,950	15,001	17,416
(2) Income from the land outside the command area	1,786	1,786	1,786	1,786	1,786	1,786	1,786
(3) Income from other sources	668	668	668	668	668	668	668
Total income=(1+2+3)	8,182	8,972	9,488	13,074	15,404	17,455	19,870
B. Minimum need-based level of living	4,477	4,477	4,477	4,477	4,477	4,477	4,477
C. Margin to take care of increased consumption, etc.	818	852	949	1,307	1,540	1,745	1,937
D. Repayment of pre-existing liabilities							
(a)	371	371	371	371	371	371	371
(b)	2,013	-	-	-	-	-	-
E. Repayment capacity = [A-(B+C+D)]							
(a)	2,516	2,818	3,691	6,919	9,016	10,862	13,035
(b)	874	3,189	4,062	7,290	9,387	11,233	13,406
F. Repayment of loans							
(a)	690	810	908	1,101	1,398	1,756	2,478
(b)	874	3,189	3,313	-	-	-	-
G. Surplus = (E-F)							
(a)	1,826	2,008	2,783	5,818	7,618	9,106	10,557
(b)	-	-	749	7,290	9,387	11,233	13,406

Continued..

Table 6.9: contd.

Group A: 15.00 and above acres

Items	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77
A. Income of the family							
(1) Income from the command area	4,311	4,906	5,294	7,994	9,747	11,291	13,103
(2) Income from the land outside the command area	6,133	6,133	6,133	6,133	6,133	6,133	6,133
(3) Income from other sources	1,215	1,215	1,215	1,215	1,215	1,215	1,215
Total income=(1+2+3)	11,664	12,259	12,647	15,347	17,100	18,644	20,451
B. Minimum need-based level of living	5,270	5,270	5,270	5,270	5,270	5,270	5,270
C. Margin to take care of increased consumption, etc.	1,166	1,226	1,265	1,535	1,710	1,864	2,046
D. Repayment of pre-existing liabilities							
(a)	397	397	397	397	397	397	397
(b)	2,153	-	-	-	-	-	-
E. Repayment capacity= [A-(B+C+D)]							
(a)	4,831	5,366	5,715	8,145	9,723	11,113	12,748
(b)	3,075	5,763	6,112	8,542	10,120	11,510	13,145
F. Repayment of loans							
(a)	520	610	683	829	1,053	1,323	1,866
(b)	3,075	2,033	-	-	-	-	-
G. Surplus = (E-F)							
(a)	4,311	4,755	5,032	7,316	8,670	9,790	10,882
(b)	-	3,730	6,112	8,542	10,120	11,510	13,145

Table 6.10. Distribution of the loan on the basis of the irrigated area and the period of benefits in the Pimpri-Vaghare lift irrigation scheme.

Years	Irrigated area (acres)	Increase in the irrigated area over the last year (acres)	No. of years the benefits of irrigation will accrue over the project life (i.e., 30 years)	Irrigated area over the project life Cols. (3 x 4) (acre-years)	Percentage distribution of area in col. (5) to its total	Loan to be repaid by the area in col. (3) (Total Loan x col. (6) as %) (Rs.)	Per acre cols. (7 + 3) (Rs.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1970-71	9	9	30	270	16.08	11,255	1,251
1971-72	19	10	29	290	17.27	12,039	1,209
1972-73	32	13	28	364	21.68	15,176	1,167
1973-74	42	10	27	270	16.08	11,256	1,126
1974-75	52	10	26	260	15.49	10,843	1,084
1975-76	61	9	25	225	13.40	9,380	1,042
Total	-	61	-	1,679	100.00	70,000	1,148

Table 6.11. Repayment schedule according to the proposed method in the Pimpore-Waghare lift irrigation scheme

Years	Area receiving irrigation from the year (acres)	1970-71 (Rs.)	1971-72 (Rs.)	1972-73 (Rs.)	1973-74 (Rs.)	1974-75 (Rs.)	1975-76 (Rs.)	1976-77 (Rs.)
1970-71	9	2,274	2,274	2,274	2,274	2,274	2,274	2,274
1971-72	10	-	2,995	2,995	2,995	2,995	2,995	2,995
1972-73	13	-	-	4,739	4,739	4,739	4,739	4,739
1973-74	10	-	-	-	4,612	4,612	4,612	4,612
1974-75	10	-	-	-	-	6,213	6,213	6,213
1975-76	9	-	-	-	-	-	8,451	8,451
Total	61	2,274	5,269	10,008	14,620	20,833	29,284	29,284

Table 5.12. Average per family repayment of loans in the different size groups of the cultivated holdings in the Pimpore-Waghare lift irrigation scheme.

(in Rupees)

Group 1: Less than 5.00 acres

Items	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77
A. Income of the family							
(1) Income from the command area	22	419	894	1,646	2,459	3,245	3,590
(2) Income from the land outside the command area	73	73	73	73	73	73	73
(3) Income from other sources	3,770	3,770	3,770	3,770	3,770	3,770	3,770
Total income=(1+2+3)	3,865	4,262	4,737	5,489	6,302	7,088	7,433
B. Minimum need-based level of living	3,041	3,041	3,041	3,041	3,041	3,041	3,041
C. Margin to take care of increased consumption, etc.	385	426	474	549	630	709	743
D. Repayment of pre-existing liabilities							
(a)	19	19	19	19	19	19	19
(b)	93	-	-	-	-	-	-
E. Repayment capacity = [A-(B+C+D)]							
(a)	419	776	1,203	1,840	2,612	3,319	3,630
(b)	345	795	1,222	1,899	2,631	3,338	3,649
F. Repayment of loans							
(a)	74	110	210	475	676	951	951
(b)	345	795	1,222	324	-	-	-
G. Surplus = (E-F)							
(a)	345	666	993	1,405	1,937	2,368	2,679
(b)	-	-	-	1,575	2,631	3,338	3,649

Continued..

Table 6.12: contd.

Group 2: 5.00 and above acres

Items	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77
A. Income of the family							
(1) Income from the command area	69	1,291	2,758	5,078	7,535	10,008	11,071
(2) Income from the land outside the command area	741	741	741	741	741	741	741
(3) Income from other sources	6,604	6,604	6,604	6,604	6,604	6,604	6,604
Total income=(1+2+3)	7,414	8,636	10,103	12,423	14,930	17,353	18,416
B. Minimum need-based level of living	4,617	4,617	4,617	4,617	4,617	4,617	4,617
C. Margin to take care of increased consumption, etc.	741	864	1,010	1,242	1,493	1,735	1,842
D. Repayment of pre-existing liabilities							
(a)	123	123	123	123	123	123	123
(b)	610	-	-	-	-	-	-
E. Repayment capacity = [A-(B+C+D)]							
(a)	1,933	3,032	4,353	6,441	8,597	10,878	11,834
(b)	1,445	3,155	4,476	6,554	8,820	11,001	11,957
F. Repayment of loans							
(a)	227	527	1,001	1,462	2,083	2,928	2,928
(b)	1,446	3,155	4,001	-	-	-	-
G. Surplus = (E-F)							
(a)	1,706	2,505	3,352	4,979	6,614	7,950	8,906
(b)	-	-	475	6,554	8,820	11,001	11,957

Table 6.13. Distribution of the loan on the basis of the irrigated area and the period of benefits in the Bhade lift irrigation scheme

Years	Irrigated area (acres)	Increase in the irrigated area over the last year (acres)	No. of years the benefits of irrigation will accrue over the project life (i.e., 30 years)	Irrigated area over the project life Cols. (3 x 4) (acre-years)	Percentage distribution of area in col.(5) to its total	Loan to be repaid by the area in col.(3) (Total Loan x col.(6) as %) (Rs.)	Per acre cols. (7 ÷ 3) (Rs.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1972-73	400	400	30	12,000	50.35	2,01,400	503
1973-74	556	156	29	4,524	18.98	75,920	487
1974-75	817	261	28	7,308	30.67	1,22,680	470
Total	-	817	-	23,832	100.00	4,00,000	490

Table 6.11. Repayment schedule according to the proposed method in the Bhade lift irrigation scheme.

Years	Area receiving irrigation from the year (acres)	1972-73 (Rs.)	1973-74 (Rs.)	1974-75 (Rs.)	1975-76 (Rs.)	1976-77 (Rs.)	1977-78 (Rs.)	1978-79 (Rs.)	1979-80 (Rs.)
1972-73	400	38,440	38,440	38,440	38,440	38,440	38,440	38,440	38,440
1973-74	156	-	17,516	17,516	17,516	17,516	17,516	17,516	17,516
1974-75	261	-	-	34,899	34,899	34,899	34,899	34,899	34,899
Total	817	38,440	55,956	90,855	90,855	90,855	90,855	90,855	90,855

Table 5.15. Average per family repayment of loans in the different size groups of the cultivated holdings in the Shade lift irrigation scheme. (in rupees)

Group 1: Less than 2.50 acres

Items	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80
A. Income of the family								
(1) Income from the command area	1,109	1,406	1,924	1,976	2,015	2,082	2,082	2,082
(2) Income from the land outside the command area	-	-	-	-	-	-	-	-
(3) Income from other sources	1,375	1,375	1,375	1,375	1,375	1,375	1,375	1,375
Total income (1 + 2 + 3)	2,484	2,781	3,299	3,351	3,390	3,457	3,457	3,457
B. Minimum need-based level of living	2,675	2,675	2,675	2,675	2,675	2,675	2,675	2,675
C. Margin to take care of increased consumption, etc.	248	278	330	335	339	346	346	346
D. Repayment of pre-existing liabilities								
(a)	102	102	102	102	102	102	102	102
(b)	-	-	294	341	146	-	-	-
E. Repayment capacity = [A-(B+C+D)]								
(a)	- 541	- 274	192	239	274	334	334	334
(b)	- 439	- 172	-	-	230	436	436	436
F. Repayment of loans								
(a)	76	109	179	179	179	179	179	179
(b)	-	-	-	-	230	436	436	425
G. Surplus = (E-F)								
(a)	- 617	- 383	13	60	95	155	155	155
(b)	- 439	- 172	-	-	-	-	-	11

(continued)..

Table C.15: contd.

Group 2: 2.50 to 4.99 acres

Items	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80
A. Income of the family								
(1) Income from the command area	1,935	2,453	3,358	3,449	3,517	3,634	3,634	3,634
(2) Income from the land outside the command area	84	84	84	84	84	84	84	84
(3) Income from other sources	1,951	1,951	1,951	1,951	1,951	1,951	1,951	1,951
Total income(1+2+3)	3,970	4,488	5,393	5,484	5,552	5,669	5,669	5,669
B. Minimum need-based level of living	4,031	4,031	4,031	4,031	4,031	4,031	4,031	4,031
C. Margin to take care of increased consumption, etc.	397	449	540	548	552	557	557	557
D. Repayment of pre-existing liabilities								
(a)	220	220	220	220	220	220	220	220
(b)	-	8	622	639	-	-	-	-
E. Repayment capacity = [A-(B+C+D)]								
(a)	- 674	- 212	602	685	719	851	851	851
(b)	- 458	-	-	266	969	1,071	1,071	1,071
F. Repayment of loans								
(a)	312	191	312	312	312	312	312	312
(b)	-	-	-	-	969	1,071	35	-
G. Surplus = (E-F)								
(a)	- 810	- 403	290	373	437	539	539	539
(b)	- 458	-	-	-	-	-	1,036	1,071

Contd. ...

Table 6.15: contd.

Group 3: 5.00 to 9.99 acres

Items	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80
A. Income of the family								
(1) Income from the command area	3,649	4,627	6,333	6,506	6,633	6,854	6,854	6,854
(2) Income from the land outside the command area	1,967	1,967	1,967	1,967	1,967	1,967	1,967	1,967
(3) Income from other sources	1,126	1,126	1,126	1,126	1,126	1,126	1,126	1,126
Total income (1+2+3)	6,742	7,720	9,426	9,599	9,727	9,947	9,947	9,947
B. Minimum need-based level of living	4,018	4,018	4,018	4,018	4,018	4,018	4,018	4,018
C. Margin to take care of increased consumption, etc.	674	772	943	960	973	995	995	995
D. Repayment of pre-existing liabilities								
(a)	596	596	596	596	596	596	596	596
(b)	2,050	1,181	-	-	-	-	-	-
E. Repayment capacity = [A-(B+C+D)]								
(a)	1,454	2,334	3,869	4,025	4,140	4,338	4,338	4,338
(b)	-	1,749	4,465	4,621	4,736	4,934	4,934	4,934
F. Repayment of loans								
(a)	249	350	588	588	588	588	588	588
(b)	-	1,749	1,557	-	-	-	-	-
G. Surplus = (E-F)								
(a)	1,205	1,974	3,281	3,437	3,552	3,750	3,750	3,750
(b)	-	-	2,908	4,621	4,736	4,934	4,934	4,934

Continued..

Table 6.15: contd.

Group A: 10.00 and above acres (Less than 50% irrigable area)

Items	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80
A. Income of the family								
(1) Income from the command area	4,317	5,474	7,492	7,696	7,847	8,109	8,209	8,109
(2) Income from the land outside the command area	3,458	3,458	3,458	3,458	3,458	3,458	3,458	3,458
(3) Income from other sources	1,381	1,381	1,381	1,381	1,381	1,381	1,381	1,381
Total income(1+2+3)	9,155	10,313	12,331	12,535	12,686	12,948	12,948	12,948
B. Minimum need-based level of living	4,360	4,360	4,360	4,360	4,360	4,360	4,360	4,360
C. Margin to take care of increased consumption, etc.	916	1,031	1,233	1,253	1,269	1,295	1,295	1,295
D. Repayment of pre-existing liabilities								
(a)	1,020	1,020	1,020	1,020	1,020	1,020	1,020	1,020
(b)	3,860	1,614	-	-	-	-	-	-
E. Repayment capacity = (A-(B+C+D))								
(a)	2,860	3,902	5,718	5,902	6,037	6,273	6,273	6,273
(b)	-	3,308	6,738	6,922	7,057	7,293	7,293	7,293
F. Repayment of loans								
(a)	295	428	696	696	696	696	696	696
(b)	-	3,308	477	-	-	-	-	-
G. Surplus = (E-F)								
(a)	2,565	3,476	5,022	5,206	5,341	5,577	5,577	5,577
(b)	-	-	6,261	6,922	7,057	7,293	7,293	7,293

Continued..

Table 6.15: contd.

Group 5: 10.00 and above acres (More than 50% irrigable area)

Items	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80
A. Income of the family								
(1) Income from the command area	12,875	15,325	22,345	22,954	23,402	24,185	24,185	24,185
(2) Income from the land outside the command area	580	580	580	580	580	580	580	580
(3) Income from other sources	1,151	1,151	1,151	1,151	1,151	1,151	1,151	1,151
Total income(1+2+3)	14,607	17,055	24,077	24,685	25,133	25,916	25,916	25,916
B. Minimum need-based level of living	4,324	4,324	4,324	4,324	4,324	4,324	4,324	4,324
C. Margin to take care of increased consumption, etc.	1,461	1,806	2,408	2,468	2,513	2,592	2,592	2,592
D. Repayment of pre-existing liabilities								
(a)	2,301	2,301	2,301	2,301	2,301	2,301	2,301	2,301
(b)	8,822	3,558	-	-	-	-	-	-
E. Repayment capacity								
(a)	6,521	9,625	15,044	15,592	15,995	16,699	16,699	16,699
(b) = [A-(B+C+D)]	-	8,370	17,343	17,893	18,296	19,000	19,000	19,000
F. Repayment of loans								
(a)	879	1,272	2,076	2,076	2,076	2,076	2,076	2,076
(b)	-	8,370	3,077	-	-	-	-	-
G. Surplus = (E-F)								
(a)	5,642	8353	12,968	13,516	13,919	14,623	14,623	14,623
(b)	-	-	14,268	17,893	18,296	19,000	19,000	19,000

CHAPTER VII

SOCIAL COST-BENEFIT ANALYSIS OF THE LIFT IRRIGATION SCHEMES

7.1 A Methodological Overview

We have already seen in Chapter II that the methodology of comparing costs and benefits is the same whether we are seeking the financial or social returns of the project. The basic difference lies in the identification and valuation of "costs" and "benefits". In the financial profitability calculus undertaken in Chapter V, all the benefits and costs are measured at the farm level and accounted at their market prices. This approach is improper in the economic analysis since it is meant to assess the possible economics of the project from the social point of view, it uses accounting (shadow) prices, excludes taxes and includes subsidies. In this chapter, an attempt is made to estimating the social costs and returns of the projects proposed for the study.

In Chapter V, we have estimated the crop patterns in all the irrigable command areas of the projects in two situations, viz., with and without irrigation. Our task in this chapter is, therefore, only to estimate the stream of social income and social costs of the lift irrigation schemes over the life-time of the project, calculate the

benefit-cost ratios, as well as the internal rate of return and the net present worth of the projects. We shall now begin with the social costs of the projects.

Like in the financial analysis, the items of cost of cultivation of the irrigation project, viz., seeds, manure and fertilizers, fodder, insecticides and pesticides, repair charges on implements as well as depreciation on livestock, machinery and implements are valued at their market prices in the analysis because these are legitimate expenses from the society's point of view. Moreover, their social opportunity cost is considered to be equal to their market prices. However, items of expenditure like land revenue, local funds, cess, etc., are only taxes and are essentially transfer amounts from the social point of view. Therefore, in this analysis they are not taken into account as social cost. Similarly, taxes on mechanical and electrical equipments, and on electricity are also excluded from the analysis. Interest on crop loan is also not taken into account as a cost as it is a part of the total return to the society and it is that return including interest which our economic analysis is designed to estimate. Shadow price of labour is considered to be equal to the prevailing market wage rate for the reason discussed in Chapter II.

The outputs of the project are valued at their estimated relative domestic prices, for the reasons men-

tioned in Chapter II. Therefore, there is no difference in the value of gross produce between the financial analysis and economic analysis.

For the calculations of benefit-cost ratio and net present worth we have assumed a 15 per cent rate to represent the opportunity cost of capital because, as explained in Chapter II, this is the rate of social return that is expected on the public investment in connection with the national targets and the overall economic development programme. For computation of the benefit-cost ratio we do not make distinction between the project costs (capital, operation and maintenance costs) and the associated costs (production costs). We have compared the present worth of the value of gross produce (crop production) with the present worth of the gross costs. This is, of course, done after deducting the costs and returns without irrigation from the costs and returns with irrigation.

Estimates of the social costs and social returns of the lift irrigation schemes are presented in Tables 7.1 to 7.5. It is necessary to examine the benefit-cost ratio, net present worth and internal rate of return of each scheme.

7.2 Koregaon-Mul Lift Irrigation Scheme

It is seen from Table 7.1 that the benefit-cost ratio

Period	Capital costs	Operation and maintenance costs	Cost of land levelling	Net increase in the associated costs	Gross costs Cols. (2+3+4+5)	Net increase in the crop production	Net benefit cols.(7-6)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1970-71	2,07,412	12,040	2,731	75,822	2,98,005	1,41,805	-1,56,200
1971-72	-	12,040	3,130	86,904	1,02,074	1,62,531	60,457
1972-73	-	12,040	3,929	1,09,068	1,25,037	2,03,982	78,945
1973-74	-	12,040	5,295	1,67,555	1,84,890	3,47,599	1,62,709
1974-75	-	12,040	6,303	2,04,239	2,22,582	4,21,612	1,99,030
1975-76	-	12,040	7,227	2,41,122	2,60,389	5,00,971	2,40,582
1976-77	-	12,040	8,152	2,82,279	3,02,471	5,95,432	2,92,961
1977-78	-	12,040	8,152	2,89,876	3,10,068	6,22,281	3,12,213
1978-79	-	12,040	8,152	2,96,840	3,17,032	6,46,892	3,29,860
1979-80	-	12,040	8,152	3,03,803	3,23,995	6,71,503	3,47,508
1980-81	2 26,956*	12,040	8,152	3,03,803	3,50,951	6,71,503	3,20,552
1981-82 to 1989-90**	-	12,040	8,152	3,03,803	3,23,995	6,71,503	3,47,508
1990-91	26,956*	12,040	8,152	3,03,803	3,50,951	6,71,503	3,20,552
1991-92 to 1999-2000**	-	12,040	8,152	3,03,803	3,23,995	6,71,503	3,47,508
Total	2,61,324	3,61,200	2,24,263	81,33,568	89,80,355	1,77,44,668	87,64,313

* Replacement cost

** For these periods only yearly figures which remain constant over the years are presented

Benefit-cost ratio at 15% discount rate = 1.72
N.P.V. at 15% discount rate = Rs. 11,80,422
I.R.R. = 73%
At 10% reduction in the net increase in crop production
Benefit-cost ratio at 15% discount rate = 1.55
N.P.V. at 15% discount rate = Rs. 8,94,205
I.R.R. = 59%

of the Koregaon lift irrigation scheme is 1.72 while the net present worth of the scheme is Rs. 11.8 lakhs, at a social discount rate of 15 per cent. The internal rate of economic return, that is, the rate of discount at which the present value of the net benefit stream becomes zero is 73 per cent. One may say that the social rate of return on the investment is 73 per cent.

However, as mentioned in Chapter V, the reliability of the rate of return, or the net present worth or the benefit-cost ratio depends largely on the propriety of the projected costs and incomes. It would be useful to see how sensitive these are to alternative estimates of costs and incomes, or to alternative discount rates (in the case of benefit-cost ratio and net present worth). If we assume, as in Chapter V, the net crop production (Col.(7) in Table 7.1) after irrigation will be 10 per cent lower than what has been estimated by us, then the benefit-cost ratio will be 1.55, the net present worth Rs. 8.98 lakhs, and the internal rate of return 59 per cent.

In this particular lift irrigation scheme, we have also tried out for lower and higher rates of discount than the 15 per cent considered by us, to see how sensitive the benefit-cost ratio and the net present worth are to changes in the discount rate. The lower discount rates assumed in the alternative calculations are 12 per cent and 10 per cent and higher, 18 per cent and 20 per cent.

The revised calculations are as follows:

<u>Discount rate (Per cent)</u>	<u>Benefit-Cost ratio</u>	<u>Net present worth (Rs. in lakhs)</u>
10	1.63	15.62
12	1.61	12.58
15	1.55	8.98
18	1.50	6.63
20	1.46	5.47

It is seen from the revised calculations that the benefit-cost ratio is not very much sensitive to the alternative rates of discount, though of course the net present worth significantly changes.

7.3 Nairson Lift Irrigation Scheme

Table 7.2 reveals that the benefit-cost ratio of the project is 1.52, the net present worth is Rs. 5.36 lakhs, and the internal rate of return 48 per cent. However, in the sensitivity analysis, the benefit-cost ratio, the net present worth and the rate of return worked out to 1.37, Rs. 3.79 lakhs and 37 per cent respectively.

7.4 Nhamson-Tek Lift Irrigation Scheme

It is observed from Table 7.3 that the benefit-cost ratio of the lift scheme is 1.67. Net present worth of the project is Rs. 17.79 lakhs. The present worth of the net

Table 7.2. Social cost-benefit analysis of the Naigson lift irrigation scheme (in Rupees)

Period	Capital costs	Operation and maintenance costs	Cost of land levelling	Net increase in the associated costs	Gross costs Cols. (2+3+4+5)	Net increase in the crop production	Net benefits Cols. (7-6)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1970-71	1,83,476	11,885	2,744	49,040	2,47,145	88,695	-1,59,450
1971-72	-	11,885	3,410	60,928	76,223	1,10,196	33,973
1972-73	-	11,885	4,324	77,275	93,484	1,39,760	46,276
1973-74	-	11,885	5,904	1,06,606	1,24,395	2,07,972	83,577
1974-75	-	11,885	8,275	1,55,349	1,75,509	2,99,429	1,23,920
1975-76	-	11,885	8,275	1,55,715	1,75,875	3,05,145	1,29,270
1976-77	-	11,885	8,275	1,55,346	1,76,505	3,15,016	1,38,510
1977-78 to 1979-80**	-	11,885	8,275	1,57,293	1,77,453	3,29,824	1,52,371
1980-81	20,453*	11,885	8,275	1,57,293	1,97,906	3,29,824	1,31,918
1981-82 to 1989-90**	-	11,885	8,275	1,57,293	1,77,453	3,29,824	1,52,371
1990-91	20,453*	11,885	8,275	1,57,293	1,97,906	3,29,824	1,31,918
1991-92 to 1999-2000**	-	11,885	8,275	1,57,293	1,77,453	3,29,824	1,52,371
Total	2,24,382	3,56,550	2,31,532	43,78,998	51,91,462	90,52,165	38,60,703

* Replacement cost.

** For these periods only yearly figures which remain constant over the years are presented.

Benefit-cost ratio at 15% discount rate = 1.52
 N.P.V. at 15% discount rate = Rs. 5,35,775
 I.R.R. = 48%
 At 10% reduction in the net increase in crop production
 Benefit-cost ratio at 15% discount rate = 1.37
 N.P.V. at 15% discount rate = Rs. 3,79,355
 I.R.R. = 37%

Table 7.3. Social cost-benefit analysis of the Khaogson-Tek lift irrigation scheme (in Rupees)

Period (1)	Capital costs (2)	Operation and maintenance costs (3)	Cost of land levelling (4)	Net increase in the associated costs (5)	Gross costs Cols. (2+3+4+5) (6)	Net increase in the crop production (7)	Net benefits Cols. (7-6) (8)
1970-71	4,64,456	24,193	3,694	1,46,798	6,39,141	3,02,408	-3,36,733
1971-72	-	24,193	4,243	1,68,609	1,97,045	3,47,337	1,50,292
1972-73	-	24,193	4,602	1,82,869	2,11,664	3,76,715	1,65,051
1973-74	-	24,193	5,573	2,42,512	2,72,278	5,39,247	2,66,969
1974-75	-	24,193	6,966	3,01,005	3,32,164	6,65,636	3,33,472
1975-76	-	24,193	8,106	3,54,567	3,86,866	7,78,047	3,91,181
1976-77	-	24,193	9,245	4,11,619	4,45,057	9,04,221	4,59,164
1977-78	-	24,193	9,245	4,19,560	4,52,998	9,35,539	4,82,541
1978-79	-	24,193	9,245	4,26,058	4,59,496	9,61,165	5,01,669
1979-80	-	24,193	9,245	4,32,554	4,65,992	9,86,790	5,20,798
1980-81	1,72,126*	24,193	9,245	4,32,554	4,38,118	9,86,790	3,48,672
1981-82 to 1989-90**	-	24,193	9,245	4,32,554	4,65,992	9,86,790	5,20,798
1990-91	1,72,126*	24,193	9,245	4,32,554	6,38,118	9,86,790	3,48,672
1991-92 to 1999-2000*	-	24,193	9,245	4,32,554	4,65,992	9,86,790	5,20,798
Total	6,09,708	7,25,790	2,55,064	1,17,37,231	1,35,26,793	2,65,32,905	1,30,06,112

* Replacement cost.
 ** For these periods only yearly figures which remain constant over the years are presented.

Benefit-cost ratio at 15% discount rate = 1.67
 N.P.W. at 15% discount rate = Rs. 17,78,742
 I.E.R. = 66%
 At 10% reduction in the net increase in crop production
 Benefit-cost ratio at 15% discount rate = 1.50
 N.P.W. at 15% discount rate = Rs. 13,34,745
 I.E.R. = 52%

benefit stream of the project becomes insignificant at the discount rate of 66 per cent. This is social rate of return on the investment. In the sensitivity analysis, the project gives the benefit-cost ratio of 1.5, the net present worth of Rs. 13.35 lakhs, and the rate of return of 52 per cent.

7.5 Pimpore-Waghare Lift Irrigation Scheme

Table 7.4 shows that the benefit-cost ratio of the lift scheme is 1.48, while the net present worth of the scheme is Rs. 3.64 lakhs. The present value of the net benefit stream of the project becomes insignificant at 42 per cent discount rate which is the rate of return on the investment. In the sensitivity calculus of the project, the benefit-cost ratio worked out to 1.33, the net present worth came to Rs. 2.52 lakhs, and the rate of return on the investment arrived at 34 per cent.

7.6 Bhade Lift Irrigation Scheme

Table 7.5 reveals that the lift scheme gives the benefit cost ratio of 1.53, the net present worth of Rs.26.09 lakhs, and the internal rate of return of 77 per cent. In the sensitivity calculus, however, the project gives the benefit-cost ratio of 1.38, the net present worth of Rs.18.59 lakhs, and the internal rate of return of 58 per cent.

Thus, examination of the estimates shows that all the

Table 7.1. Social cost-benefit analysis of the Pimpore-Naghere lift irrigation scheme, (in Rupees)

Period (1)	Capital costs (2)	Operation and maintenance cost (3)	Cost of land levelling (4)	Net increase in the associated costs (5)	Gross costs Cols. (2+3+4+5) (6)	Net increase in the crop production (7)	Net benefits (Cols. 7-6) (8)
1970-71	1,24,040	9,898	105	17,071	1,51,114	27,365	-1,23,749
1971-72	-	9,898	227	36,769	46,894	58,940	12,046
1972-73	-	9,898	373	60,408	70,677	96,830	26,153
1973-74	-	9,898	535	84,235	94,668	1,43,230	48,562
1974-75	-	9,898	705	1,09,002	1,19,605	1,92,397	72,792
1975-76	-	9,898	852	1,29,268	1,40,018	2,36,240	96,222
1976-77	-	9,898	852	1,25,523	1,36,273	2,42,856	1,06,583
1977-78	-	9,898	852	1,21,549	1,32,339	2,49,802	1,17,463
1978-79 to 1979-80**	-	9,898	852	1,18,218	1,28,968	2,55,756	1,26,788
1980-81	10,115*	9,898	852	1,18,218	1,39,083	2,55,756	1,16,673
1981-82 to 1989-90**	-	9,898	852	1,18,218	1,28,968	2,55,756	1,26,788
1990-91	10,115*	9,898	852	1,18,218	1,39,083	2,55,756	1,16,673
1991-92 to 1999-2000**	-	9,898	852	1,18,218	1,28,968	2,55,756	1,26,788
Total	1,44,270	2,96,940	23,245	32,84,659	37,49,114	68,74,292	31,25,178

* Replacement cost.

** For these periods only yearly are figures which remain constant over the years are presented.

Benefit-cost ratio at 15% discount rate = 1.48
 N.P.V. at 15% discount rate = Rs. 3,63,679
 I.R.R. = 42%
 At 10% reduction in the net increase in crop production
 Benefit-cost ratio at 15% discount rate = 1.33
 N.P.V. at 15% discount rate = Rs. 2,52,021
 I.R.R. = 34%

Table 7.5. Social cost-benefit analysis of the Bhade lift irrigation scheme

(in Rupees)

Period	Capital costs	Operation and maintenance costs	Cost of land levelling	Net increase in the associated costs	Gross costs cols. (2+3+4+5)	Net increase in the crop production	Net benefits cols. (7-8)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1972-73	7,36,214	39,893	10,876	2,16,156	10,03,139	4,20,992	- 5,82,147
1973-74	-	39,893	18,497	3,75,571	4,34,361	7,31,474	2,97,113
1974-75	-	39,893	32,905	6,53,878	7,26,676	12,73,506	5,46,830
1975-76	-	39,893	32,905	6,60,034	7,32,832	13,01,090	5,68,258
1976-77	-	39,893	32,905	6,64,574	7,37,372	13,21,433	5,84,061
1977-78 to 1981-82**	-	39,893	32,905	6,72,494	7,45,292	13,56,948	6,11,656
1982-83	1,55,921*	39,893	32,905	6,72,494	9,01,213	13,56,948	4,55,735
1983-84 to 1991-92**	-	39,893	32,905	6,72,494	7,45,292	13,56,948	6,11,656
1992-93	1,55,921*	39,893	32,905	6,72,494	9,01,213	13,56,948	4,55,735
1993-94 to 2001-02**	-	39,893	32,905	6,72,494	7,45,292	13,56,948	6,11,656
Total	10,48,058	11,96,790	9,51,113	1,93,82,563	2,25,78,522	3,89,72,195	1,63,93,673

* Replacement cost

** For these periods only yearly figures which remain constant over the years are presented

Benefit-cost ratio at 15% discount rate = 1.53
 N.P.V. at 15% discount rate = Rs. 25,08,934
 I.R.R. = 77%
 At 10% reduction in the net increase in crop production
 Benefit-cost ratio at 15% discount rate = 1.38
 N.P.V. at 15% discount rate = Rs. 18,59,149
 I.R.R. = 58%

lift irrigation schemes are not only financially feasible but are also justifiable in terms of social cost-benefit analysis.

The financial as well as social returns of the projects so far estimated by us were based on the given pumping capacity of the projects and the irrigation duty of the individual crops in the region, and therefore, as mentioned in Chapter V, they do not necessarily tell us what is the most economic use of given volume of water available for irrigation. Water being the scarcest factor in the drought prone regions of Western Maharashtra, it is necessary to use it most economically, such that from the social point of view, the net crop production due to the given quantum of water is maximised. We shall examine this question in the next chapter.

CHAPTER VIII

SOCIAL USE OF WATER FOR IRRIGATION

In many parts of the country and surely in the 'dry' regions of Maharashtra, water is the scarcest factor in agriculture - even scarcer than land. Estimates by hydrologists and engineers suggest that the total known potential of surface and underground water supply in the State would be inadequate to provide irrigation to more than 30 per cent of the net cultivated area in the State, under the existing pattern of use of irrigation water.¹ Water being the scarcest factor, it is necessary to use it most economically, such that from the social point of view, the net output due to water is maximised.

In Chapter V we found that given the pumping capacity of the lift irrigation scheme, sugarcane turned out to be the most profitable crop compared to any single crop or combination of crops. It might appear that this has finally answered the question raised above. But, it is necessary to remember that, sugarcane turned out to be the most profitable crop, given the capacity of the pump installed, and the 'duty' of different irrigated crops. But it was also noted in Chapter V (refer Appendix 5.2) that sugarcane will use much more irrigation water than any alternative individual crop or combination of crops. It is therefore not quite correct to say that this demonstrates

¹Report of the Irrigation Commission 1972, Vol. II, Government of India, Ministry of Irrigation and Power, New Delhi, 1972, p. 232.

sugarcane to be the best use of a given quantity of irrigation water. For this purpose it is necessary to show if the same quantity of water as sugarcane takes in each season cannot be more profitably used by other crops. This would, of course, need installation of greater pumping capacity, since given the water pumping capacity of the existing pump and the duty of individual crops, more area than calculated there (refer Table 7 in Chapter V) cannot be irrigated in a season, inspite of the availability of water in the stream. It is, therefore, necessary to estimate the relative returns from irrigating sugarcane and other crops with a given quantity of water after accounting for the differential costs of such irrigation, in order to answer the question raised at the beginning of this chapter.

One important implication of this approach must be spelt out here. Given the quantity of water for irrigation, it is not always necessary to spread its use over the 12 months or 3 seasons of the year. Such spreading is necessary if sugarcane is to be grown. But it is not necessary if the given quantity of water is to be used for seasonal crops only. Of course, all the water used during the three seasons, cannot be used only in one season, kharif, since rainfall is spread over the entire kharif season and therefore all the water cannot be available for use only in the kharif season. However, the quantum

of water impounded behind a dam across a river or a stream at the end of the kharif season can be used in the subsequent rabi and summer seasons or only during the rabi season. If therefore the total irrigation water is to be used in 8 months of the year, i.e., during the kharif and rabi seasons, then the pumping capacity will have to be larger.

The alternative possibilities mentioned above will require not only larger pumping capacity but may also require a larger command area. Both these aspects will have to be taken into account in estimating the most economic use of a given quantity of water for irrigation.

It may be noted here that while we have examined this question in connection with a lift irrigation scheme, the problem is equally or even more relevant in the case of a canal irrigation project. In such cases the overwhelming part of the water impounded behind the dam flows into the reservoir during the rainy season, and the question is one of distributing this water in the next 4 or 6 months. The extra cost for covering a wider area under seasonal crops includes the cost of lengthening and widening the distributing channels which is equivalent to increasing the pumping capacity of the lift in our case. This approach may not work in the case of wells or even of streams across which there are no storage reservoirs, where the total water becomes available in smaller or larger

quantities spread over the whole year, and not at a point of time as in the case of a reservoir. Hence the use of the entire water cannot be capsuled into a shorter period than that over which it becomes available by natural process. In our case studies, though the lifts are put up on a river, this river, Pawana - Mula - Mutha is like a canal since the flow of water in it during the year is regulated from the dams constructed upstream. In any case, we do the exercise on the assumption that the total water used with sugarcane as one of the crops (as in the cropping pattern worked out in Chapter V) can also be available for use in only two seasons - Kharif and rabi. This approach is relevant for all canal irrigation projects in the region and hence this exercise.

In estimating the most economic use of a given quantity of water for irrigation, we first calculate the irrigable area under the crops with the quantity of water and the net incomes from such crops over the income under unirrigated condition. This gives the net return or benefit stream. We then work out the pumping capacities required for the irrigable area under the crops and consequently, calculate the project costs. Finally, we calculate the net present worth of the income from the crops and draw conclusions.

We propose to examine the question raised in this chapter by taking the Koregaon-Mul lift irrigation scheme

is an example. The data relating to this project, required for the analysis, are already presented in Chapter V. It was seen in Chapter V that the total quantum of water that will be used by the Koregaon project under the planned cropping pattern is 9,173 acre-inches a year. The cropping pattern will be as follows:

Crops	Area (acres)	Per acre irri- gation water requirements of the crops (acre-inches)	Total water to be used (acre-inches) Cols.(2 x 3)
(1)	(2)	(3)	(4)
<u>Kharif</u>			
Sugarcane*	45	18.00	810
Onion	30	12.50	375
Groundnut	28	12.00	336
Vegetables	31	10.00	310
Hybrid bajra	101	7.50	757
<u>Rabi</u>			
Sugarcane	45	35.00	1575
Onion	28	30.00	840
Wheat	40	18.00	720
Local jowar	85	12.00	1020
<u>Summer</u>			
Sugarcane	45	54.00	2430
	<u>388</u>		<u>9173</u>

* Sugarcane is an annual crop

It may be recalled that, given the pumping capacity of the pump put up and the irrigation duty of various crops in the region, though sugarcane was the most profitable, the planned cropping pattern under the project would comprise not only sugarcane but also a few more crops in kharif and rabi seasons. The limit to sugarcane area was put by the area under sugarcane that could be irrigated in summer. As a result, the estimated area under sugarcane used only a part of the total pumping capacity in the kharif and rabi seasons. The other crops used the surplus pumping capacity in both the seasons.

The question now raised is, is this the most economic use of the total 9,173 acre-inches of water that will be consumed by this crop area? We shall start answering that question by first presenting the following Table 8.1. The table shows the total area under each individual crop that could be irrigated if all the 9,173 acre-inches of water were to be used exclusively for that crop. The last column of the table also shows the net income that would be generated by such irrigation, for every one of the crops.

This table shows that the net income generated by using the entire water to grow sugarcane will be lower than that generated by using the water to grow any other crop listed there. Of course, one has to take into account the cost of pumping this water to the individual crops,

Table 8.1. Irrigable area under the individual crops with the water available and the net income from each under irrigation

Crops	Season	Total water available for irrigation (acre-inches)	Per acre irrigation water requirements of the crops (acre-inches)	Irrigable area under the crops cols.(3÷4) (acres)	Per acre net income from the crops (Rs.)	Net income with irrigation cols. (5 x 6) (Rs.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Hybrid bajra	Kharif	9,173	7.50	1,223	368	4,50,064
Hybrid jowar	Kharif	9,173	9.00	1,019	750	7,64,250
Groundnut	Kharif	9,173	12.00	764	803	6,13,492
Onion	Kharif	9,173	12.50	734	1,064	7,80,976
Vegetables	Kharif	9,173	10.00	917	707	6,48,319
Wheat	Rabi	9,173	18.00	510	609	3,10,590
Local jowar	Rabi	9,173	12.00	764	536	4,09,504
Hybrid jowar	Rabi	9,173	15.00	612	720	4,40,640
Onion	Rabi	9,173	30.00	306	1,197	3,66,282
Cotton	Summer and Kharif	9,173	24.00	382	1,053	4,02,246
Sugarcane	Annual	9,173	107.00	86	3,542	3,04,612

as also some other costs, before comparing the relative economics of the use of water for different crops. We, however, do not propose to do this exercise; because, as mentioned in the beginning of this chapter, it is not meaningful to consider the use of all this water for growing a single crop in a single season - kharif or rabi. The proper approach is to think of the use of this total water in two seasons, kharif and rabi. We, therefore, proceed to that exercise.

Given the total quantity of water available for irrigation in the two seasons (i.e., 5 months), the question arises about its division between the two seasons. The cropping pattern to use this water would be determined by the quantum available in each season. A large number of possibilities are open for this purpose. But they would naturally require different capital cost of installing necessary pumping capacity. The cheapest capital cost would be attained by installing such a water discharge pumping capacity as would be used to the maximum in each season while pumping 9,173 acre-inches of water during the two seasons together. We shall therefore work out one division of the total water between the two seasons in such a manner that the pumping capacity can be fairly fully used in each season. We also choose a second alternative method of dividing the water between the two seasons from the many possible alternatives: this one is

to make half of the total water available in each of the two seasons. We work out below the economics of each of these two alternative divisions of the total irrigation water in the project. We present first the exercise on the assumption that half of the total water supply of 9,173 acre-inches is to be used in each of the two seasons, kharif and rabi.

Assuming that half the total water is available in each season, Table 8.2 shows the area irrigable under each crop in each season if the total water for the season is to be used by the crop alone. We admit only five possible crops in the kharif season and four in rabi season. Sugarcane is ruled out as a three seasonal crop; cotton is also ruled out since it requires water in summer season.

The total area that can be provided with irrigation will depend on whether the same land will grow the irrigated crops in both the kharif and rabi seasons, or different lands will be provided with water in the two seasons. For example, if hybrid bajra is grown in kharif season, 611 acres can be irrigated. If any rabi season crop is to be irrigated on the same land then the net irrigated area will be 611 acres. But if the rabi crops were to be grown by irrigating land other than these 611 acres irrigated in the kharif season, then the total net irrigated area will be larger than 611 acres (by the area under the particular rabi crop). Both methods of irrigating

Table 4.2. Irrigable area under the crop combinations with the water available and the net increase in the income from each under irrigation

Sr. No.	Crops	Season	Total water available for irrigation (acre-inches)	Per acre irrigation water requirements of the crops (acre-inches)	Irrigable area under the crops cols. (4-5) acres	Total (acres)	Net income with irrigation (Rs.)	Net income without irrigation (Rs.)	Net increase in the income cols. (8-9) (Rs.)	Total (Rs.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	[Hybrid bajra Wheat	Kharif Rabi	4,586 4,586	7.50 18.00	611] 255]	866	[2,24,848 1,55,295	61,778 -	1,63,070] 1,55,295]	3,18,365
2	[Hybrid bajra Local jowar	Kharif Rabi	4,586 4,586	7.50 12.00	611] 382]	993	[2,24,848 2,04,752	61,778 -	1,63,070] 2,04,752]	3,67,822
3	[Hybrid bajra Hybrid jowar	Kharif Rabi	4,586 4,586	7.50 15.00	611] 306]	917	[2,24,848 2,20,320	61,778 -	1,63,070] 2,20,320]	3,83,390
4	[Hybrid bajra Onion	Kharif Rabi	4,586 4,586	7.50 30.00	611] 153]	764	[2,24,848 1,83,141	61,778 -	1,63,070] 1,83,141]	3,46,211
5	[Hybrid jowar Wheat	Kharif Rabi	4,586 4,586	9.00 18.00	510] 255]	765	[3,82,500 1,55,295	51,566 -	3,30,934] 1,55,295]	4,86,229
6	[Hybrid jowar Onion	Kharif Rabi	4,586 4,586	9.00 30.00	510] 153]	663	[3,82,500 1,83,141	51,566 -	3,30,934] 1,83,141]	5,14,075
7	[Groundnut Wheat	Kharif Rabi	4,586 4,586	12.00 18.00	382] 255]	637	[3,06,746 1,55,295	38,624 -	2,68,122] 1,55,295]	4,23,417
8	[Groundnut Onion	Kharif Rabi	4,586 4,586	12.00 30.00	382] 153]	535	[3,06,746 1,83,141	38,624 -	2,68,122] 1,83,141]	4,51,263
9	[Onion Wheat	Kharif Rabi	4,586 4,586	12.50 18.00	357] 255]	622	[3,90,488 1,55,295	37,107 -	3,53,381] 1,55,295]	5,08,676
10	[Vegetables Wheat	Kharif Rabi	4,586 4,586	10.00 18.00	459] 255]	714	[3,24,513 1,55,295	45,409 -	2,78,104] 1,55,295]	4,33,399
	Sugarcane	Annual	9,173	107.00	86	86	3,04,612	8,695	2,95,917	2,95,917

land in the two seasons have their advantages and disadvantages. Irrigating the same land in both the seasons will economise in the total cost of developing the land to make it fit for irrigation, in digging water channels to reach water to wider area and consequent loss of water through seepage, etc. On the other hand, irrigating different pieces of land in the two seasons will provide one-season irrigation to more land area, and consequently to larger number of farmers than would be possible otherwise. We would think that in a region like Western Maharashtra, where water is the scarcest factor in agriculture, leading to great uncertainty in crop yields, assured crop on some land in one season to a larger body of cultivators would be socially more desirable than irrigating the same land in two seasons. We shall, therefore, do our calculations on the assumption that different plots of land will be given irrigation water in the kharif and rabi seasons.

Since five irrigated crops are possible in kharif and four in rabi, 20 (= 5 x 4) crop combinations (not on the same land) are possible. However, we rule out the following 10 crop combinations (see next page).

Rabi jowar (local as well as hybrid) is planted early; therefore, it will require irrigation when onion, or vegetables or groundnut or hybrid jowar in kharif season are still in their fields and are requiring irrigation

Kharif crops	Rabi crops
1. Onion	Local jowar
2. Onion	Hybrid jowar
3. Onion	Onion
4. Vegetables	Local jowar
5. Vegetables	Hybrid jowar
6. Vegetables	Onion
7. Groundnut	Local jowar
8. Groundnut	Hybrid jowar
9. Hybrid jowar	Local jowar
10. Hybrid jowar	Hybrid jowar

water. (This possibility does not exist in the case of hybrid bajra which is harvested in time to release the pump for watering the newly planted rabi jowar). This will put pressure on the pumping capacity in this common period of watering. Therefore, the eight crop combinations featuring rabi jowar (local or hybrid) are ruled out. The other two are ruled out because it is unlikely that people will grow only two onion crops in a year with all its fluctuations in prices and the risks of pests, etc. Similarly with regard to vegetables in kharif followed by onion in rabi. We are therefore left with 10 possible crop combinations in the two seasons. The net incomes

from these combinations, as well as the total area irrigated under each combination are given in Table 8.2.

Column (8) in Table 8.2 gives the net income from irrigation of the two crops in the combination. But we need to calculate the net increase in the income on these lands as a result of irrigation over and above the net income that would be produced on these lands under unirrigated condition. For this purpose we assume that the land irrigated during the kharif season would produce an unirrigated kharif crop in the absence of irrigation, but the land irrigated in rabi season would remain fallow in rabi season without irrigation. This appears a proper assumption in view of the fact that this is mainly a kharif area with only a very small proportion of land being put to unirrigated crops in the rabi season. Therefore, the average per acre net income from unirrigated land in the kharif season is considered as income foregone on this land as a result of irrigation, and is therefore deducted from the net income under irrigation in kharif in order to arrive at the net incremental annual income from irrigation in the kharif season. No such deduction is needed from the net income from the irrigated rabi crops. The total of the incremental income from the two irrigated crops in each combination is given in Column (11) of Table 8.2.

The data in this column shows that the highest incre-

mental net income (Rs. 5.14 lakhs) is generated if the water is used to irrigate 510 acres under hybrid jowar in kharif and 153 acres under onion in rabi (Total: 663 acres) season, and the lowest (Rs. 3.16 lakhs) by irrigating 611 acres under hybrid bajra in kharif and 255 acres under wheat in rabi. The other eight combinations yield net incremental incomes in between these two limits.

The important point to note, however, is that even the lowest incremental income generating crop combination gives a better income than that using the same total quantity of water to grow sugarcane alone. The incremental income from using the total water in growing only sugarcane (of course not with equal use of water in all seasons) is given in the last row of Table 8.2 for comparison.

This, however, does not yet establish the superiority of any of these crop patterns over sugarcane in using the given quantum of irrigation water, because the capital and maintenance costs of pumping water for the different crop combinations, as also some other costs have to be taken into account. We now proceed to estimate these costs.

Table 8.3 presents the details of the project costs - capital cost, replacement cost, annual repair, operation and maintenance costs, as well as the annual cost of land development for irrigating the areas under the 10 different crop combinations, as well as for sugarcane. The pumping capacity is estimated in the following manner.

Table #.1. Estimated pumping capacities required and the project costs for irrigating the area under the crop combinations

Sr. No.	Crops	Season	Irrigable area under the crops (acres)	Duties of the crops (acres)	Pumping capacities required for the irrigable area under the crops cals. (L 15) (cusecs) (6)	Project costs			
						Capital cost (Rs.) (7)	Replacement cost (Rs.) (8)	Annual Operation and maintenance costs (Rs.) (9)	Annual cost of land levelling (Rs.) (10)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	[Hybrid bajra Wheat]	Kharif Rabi	611 255	125 80	4.89] 3.19]	4,50,920	58,582	23,550	16,437
2	[Hybrid bajra Local jowar]	Kharif Rabi	611 382	125 105	4.89] 3.64]	4,66,618	58,582	23,550	18,847
3	[Hybrid bajra Hybrid jowar]	Kharif Rabi	611 306	125 80	4.89] 3.82]	4,72,897	58,582	23,550	17,405
4	[Hybrid bajra Onion]	Kharif Rabi	611 153	125 75	4.89] 2.04]	4,10,803	58,582	23,550	14,501
5	[Hybrid jowar wheat]	Kharif Rabi	510 255	105 80	4.86] 3.19]	4,48,836	58,223	23,406	14,520
6	[Hybrid jowar Onion]	Kharif Rabi	510 153	105 75	4.86] 2.04]	4,08,719	58,223	23,406	12,584
7	[Groundnut Wheat]	Kharif Rabi	382 255	80 80	4.77] 3.19]	4,42,585	57,145	22,972	12,090
8	[Groundnut Onion]	Kharif Rabi	382 153	80 75	4.77] 2.04]	4,02,468	57,145	22,972	10,154
9	[Onion Wheat]	Kharif Rabi	367 255	95 80	3.86] 3.19]	3,79,380	46,243	18,590	10,406
10	[Vegetables Wheat]	Kharif Rabi	459 255	95 80	4.83] 3.19]	4,45,752	57,863	23,261	13,552
	Sugarcane	Annual	86	35*	2.46* 4.92**	1,70,862 3,41,724	29,471 58,942	11,847 23,694	1,632 1,632

* Duty of the crop in summer
* Without electricity failure
** With electricity failure

The duty of a crop (Col. 5) tells us the area that can be irrigated by a pump with one cusec discharge capacity (working 16 hours a day), given the water requirement of the crop and the intervals in which the crop land should receive irrigation. Since we have already estimated the total area that can be irrigated by the given total quantity of water in the season (Col. 4), the capacity of the pump, in cusecs, required to irrigate this area is calculated by dividing the figure in column (4) by the figure in column (5). This is given in column (6). The pumping capacity of the pump required in the two seasons for a given crop combination is of course different. The installed capacity of the pump must therefore be the higher of the two. For calculating the pumping capacity required for irrigating sugarcane (given in the last line of the table) two alternative assumptions are made. The highest capacity is required in the summer season. But, as mentioned in Chapter V, in this region electricity fails frequently during summer. Therefore, to supply the required water double the estimated pumping capacity has to be installed. We have given two estimates of capital cost for sugarcane: with no electricity failure and with failure - one cost being double that of the other.

The actual cost of the pumpset with 2.5 cusec discharge capacity, currently used in the Koregaon project, was given in Chapter V. The value of electric pumpsets with higher

discharge capacities necessary for the calculations in Table 8.3 have not been obtained from the market. Instead, we have estimated the value of pumpsets with higher discharge capacity as only a multiple of the value of the 2.5 cusec discharge capacity pumpset. A four cusec capacity pumpset is thus estimated to cost 1.6 times the 2.5 cusec capacity pumpset, and so on. This is of course a clear over estimation; the prices of pumpsets do not increase at the same rate as the capacity of pump. We, however, consider this as no serious difficulty since this will only underestimate the net benefit or the net present worth under the alternative irrigation patterns being examined in this chapter. If these alternatives still turn out to be profitable, then the case becomes stronger since it is clear that the costs are sure to be less and hence the net benefits larger. It is, of course, possible to think that these costs may not be much less than estimated, if one puts up not a single higher-capacity pump, but two pumps of half the required capacity. This may be useful to provide against dislocation due to breakdown of a pumpset.

The capital cost of the required pumpsets and the associated buildings, pipelines, etc., are given in column (7) of Table 8.3. The replacement cost (cost of mechanical and electric portion) to be incurred once in 10 years over the life of the project is given in column (8). The annual repair, operation and maintenance costs of the

pumping equipment are given in column (9). The last item of capital cost relates to the cost of land development. Irrigating a larger area will mean developing a larger area for irrigation. This total cost, estimated in the manner explained in Chapter V, is shown in column (10).

Instead of estimating the annual net benefits (i.e., the incremental net income due to irrigation minus the annual capital, repair, operation and maintenance and land development costs) for each of the alternatives we have estimated the net present worth of the project under the different alternative uses of irrigation water using a 9.5 per cent discount or interest rate, as in Chapter V. It is necessary to point out here that, as in Chapter V, it has been assumed that the project (in the case of each alternative cropping pattern) will come to full maturity in the course of 10 years from the beginning, and the flow of income and expenditure has been worked out accordingly, and then the entire net benefit stream discounted to the present. The net present worth of the project in the case of every one of the alternative water - use patterns is given in column (6) of Table 6.4.

Examination of the data in column (3) of Table 6.4 shows that 9 of the 10 alternative patterns of use of 9,173 acre-inches of water examined by us will give a higher total net present value than its use exclusively for sugar

Table 8.4. Net present worth of the projects under the crop combinations.

Sr. No.	Crops	Season	Irrigable area under the crops (acres)	Total (acres)	Present worth of the project costs (Rs.)	Present worth of the net increase in the income (Rs.)	Net present worth cols. (7-6) (Rs.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	[Hybrid bajra Wheat	Kharif Rabi	611 255]	866	8,02,999	22,01,969	13,98,970
2	[Hybrid bajra Local jowar	Kharif Rabi	611 382]	993	8,36,292	25,44,033	17,07,741
3	[Hybrid bajra Hybrid jowar	Kharif Rabi	611 306]	917	8,30,682	26,51,717	18,21,035
4	[Hybrid bajra Onion	Kharif Rabi	611 153]	764	7,51,134	23,94,552	16,43,418
5	[Hybrid jowar Wheat	Kharif Rabi	510 255]	765	7,84,415	33,63,003	25,78,588
6	[Hybrid jowar Onion	Kharif Rabi	510 153]	663	7,32,550	35,55,600	28,23,050
7	[Groundnut Wheat	Kharif Rabi	382 255]	637	7,54,765	29,28,558	21,73,793
8	[Groundnut Onion	Kharif Rabi	382 153]	535	7,02,900	31,21,161	24,18,261
9	[Onion Wheat	Kharif Rabi	367 255]	622	6,45,075	35,19,250 (28,96,360)	28,72,175 (22,50,285)
10	[Vegetables Wheat	Kharif Rabi	459 255]	714	7,73,286	29,97,589	22,24,303
	Sugarcane	Annual	86	86	3,00,630* 5,88,424**	20,45,704 20,45,704	17,45,074 14,57,280

* without electricity failure
** with electricity failure

cane under the present pattern of power supply in summer, as well as in 6 alternative patterns, higher than the total net present value (Rs. 20.79 lakhs) that may be obtained under the crop pattern arrived at in Chapter V. (The crop combinations with hybrid bajra in kharif give the lower net present worth). Pure sugarcane is more profitable than 3 of the 10 alternatives examined by us - hybrid bajra in kharif and wheat or local jowar or onion in rabi on 866 acres, 993 acres and 764 acres respectively if we assume that there will be no failure of electricity in summer, which will reduce the capital cost of the pumpsets for sugarcane to half the estimated. But even under such optimistic assumption, use of the total water for either sugarcane or for the crop pattern examined in Chapter V is a less economic proposition than the alternative uses listed in this chapter. The best economic use appears to be onion in kharif and wheat in rabi season giving about double the net present value than that under pure sugarcane. It covers 622 acres which is 7.23 times the area that will be irrigated with pure sugarcane, and 2.29 times the net area that will be irrigated as per the crop pattern worked out in Chapter V. The number of farmers benefitting will also be proportionately larger. The widest coverage of area will be under kharif hybrid jowar and rabi wheat, and its net present value will be higher than under sugarcane exclusively or the cropping pattern examined in

Chapter V, though of course, less than under kharif onion and rabi wheat. It is possible that onion being a crop subject to serious fluctuations in prices from year to year, will be a risky crop. To take account of this, we have estimated the net incremental income from irrigated kharif onion by assuming the price of onion to be 10 per cent less than that used earlier, without any reduction in average per acre cost and yield. The revised calculations (see the bracketed entries in Table 8.4 line 9) no doubt reduce the net present worth of this alternative from its position of pre-eminence. But it still proves superior to pure sugarcane as also to the pattern worked out in Chapter V.

It may incidentally be noted here that at the given pumping capacity of the project even if sugarcane turned out to be the most profitable, pure sugarcane under the assumption of no power failure in summer in the alternative analysis in this chapter is less profitable than the crop pattern worked out in Chapter V, though in both the cases pumping capacity is more or less the same. This is because, the planned crop pattern in Chapter V would comprise not only sugarcane but also a few more crops in kharif and rabi seasons as the limit to sugarcane area was put by the area under sugarcane that could be irrigated in summer. As a result, estimated area under sugarcane used only a part of the total pumping capacity in kharif and rabi

seasons. The other crops used the surplus pumping capacity in both the seasons. This is not possible if only sugarcane is grown with the given quantum of irrigation water. Therefore, as it is, at the given quantity of water pure sugarcane is less profitable than the seasonal crops. Use of 9,173 acre-inches of water purely for sugarcane, at the same pumping capacity, is less profitable than for the crop pattern estimated in Chapter V.

To sum up, therefore, we find that if all the water used by the project in the manner worked out in Chapter V, were to be used in only 8 months (kharif and rabi) to grow seasonal crops over a much wider area covering a larger number of farmers, with, of course, the help of bigger capacity pumps, the economies of such water use would be much better.

The above exercise was done under the assumption that of the total water available for irrigation, half would be used in kharif and the other half in rabi. This, as we have seen, results in the pumping capacity being considerably underutilised in the rabi season. It would be useful to examine the results arrived at by distributing the water such that the pumping capacity is fully used in both the seasons, thereby economising on the capital cost of the project.

The calculations for this are presented in Tables 8.5,

8.6, 8.7 and 8.8. Table 8.5 shows the estimated pumping capacity required and the distribution of the total water in the two seasons. The installed pumping capacity is estimated as follows. The duty of each crop under irrigation shows how many acres can be irrigated during the season with the help of a pump with one cusec discharge, working 16 hours a day, given the per acre water requirement of the crop and the intervals in which water is to be supplied. This duty expressed in acres, multiplied by the total irrigation water required per acre during the season, gives the total water the crop will require. A one cusec capacity pump will be fully used to supply water to a crop of this area. This calculation has been done for each crop in each season, and for the different kharif-rabi crop combinations. The total water needed with one cusec discharge from the pump in each kharif-rabi crop combination is given in column(7) of Table 8.5. Given the total available irrigation water of 9,173 acre-inches, the capacity of the pump to be installed for each combination is given in column (9). The last column shows the division of the total water between the kharif and rabi seasons. It is seen that except in three combinations, in all the other combinations the division of the total water is about 40:60 or 45:55 between the kharif and rabi seasons.

After working this out, the rest of the calculations

Table 2.5. Estimated pumping capacities required and the percentage distribution of the total water in kharif and rabi seasons

Sr. No.	Crops	Season	Per acre irrigation water requirements of the crop (acre-inches)	Duties of the crops (acres)	Irrigation water that can be used with one cuseca pumping capacity. cols. (4 x 5) (acre-inches)	Total (acre-inches)	Total water available for irrigation	Pumping capacities required for the total water available for irrigation. cols. (8+7) (Cuseca)	Irrigable area under the crops cols. (5 x 9) (acres)	Percentage distribution of the total water available for irrigation in two seasons
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	[Hybrid bajra wheat]	Kharif Rabi	7.50 18.00	125 80	937 1,440]	2,377	9,173	3.86	[462 309	39.43 60.57
2	[Hybrid bajra Local jowar]	Kharif Rabi	7.50 12.00	125 105	937 1,260]	2,197	9,173	4.17	[521 438	42.66 57.34
3	[Hybrid bajra Hybrid jowar]	Kharif Rabi	7.50 15.00	125 80	937 1,200]	2,137	9,173	4.29	[536 343	42.42 56.18
4	[Hybrid bajra Onion]	Kharif Rabi	7.50 30.00	125 75	937 2,250]	3,187	9,173	2.88	[360 215	29.41 70.59
5	[Hybrid jowar wheat]	Kharif Rabi	9.00 18.00	185 80	945 1,440]	2,385	9,173	3.85	[404 308	39.64 60.36
6	[Hybrid jowar Onion]	Kharif Rabi	9.00 30.00	105 75	945 2,250]	3,195	9,173	2.87	[301 215	29.53 70.47
7	[Groundnut wheat]	Kharif Rabi	12.00 18.00	80 80	960 1,440]	2,400	9,173	3.82	[306 306	40.00 60.00
8	[Groundnut Onion]	Kharif Rabi	12.00 30.00	80 75	960 2,250]	3,210	9,173	2.86	[229 214	29.91 70.09
9	[Onion wheat]	Kharif Rabi	12.50 18.00	95 80	1,187 1,440]	2,627	9,173	3.49	[332 279	45.19 54.81
10	[Vegetables wheat]	Kharif Rabi	10.00 18.00	95 80	950 1,440]	2,390	9,173	3.84	[355 307	39.75 60.25
	Sugarcane	Annual	107.00	35*	3,745	3,745	9,173	2.46* 4.92**	66	100.00

* Duty of the crop in summer
* without electricity failure
** with electricity failure

Table 8.6. Irrigable area under the crop combinations with the water available and the net increase in the income from each under irrigation

Sr. No.	Crops	Season	Irrigable area under the crops (acres)	Total (acres)	Net income with irrigation (Rs.)	Net income without irrigation (Rs.)	Net increase in the income cols. (6-7) (Rs.)	Total (Rs.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	[Hybrid bajra Wheat	Kharif Rabi	482 309	791	[1,77,376 1,84,181	48,735 -	[1,28,641 1,84,181]	3,15,822
2	[Hybrid bajra Local jowar	Kharif Rabi	521 438	959	[1,91,728 2,34,768	52,678 -	[1,39,050 2,34,768]	3,73,818
3	[Hybrid bajra Hybrid jowar	Kharif Rabi	536 343	879	[1,97,248 2,46,960	54,195 -	[1,43,053 2,46,960]	3,90,013
4	[Hybrid bajra Onion	Kharif Rabi	360 216	576	[1,32,480 2,58,552	36,400 -	[96,080 2,58,552]	3,54,632
5	[Hybrid jowar Wheat	Kharif Rabi	404 308	712	[3,03,000 1,87,572	40,848 -	[2,62,152 1,87,572]	4,49,724
6	[Hybrid jowar Onion	Kharif Rabi	301 215	516	[2,25,750 2,57,355	30,434 -	[1,95,316 2,57,355]	4,62,671
7	[Groundnut Wheat	Kharif Rabi	306 306	612	[2,45,718 1,86,354	30,940 -	[2,14,778 1,86,354]	4,01,132
8	[Groundnut Onion	Kharif Rabi	229 214	443	[1,83,887 2,56,158	23,154 -	[1,60,733 2,56,158]	4,16,891
9	[Onion Wheat	Kharif Rabi	332 279	611	[3,53,248 1,69,911	33,569 -	[3,19,679 1,69,911]	4,89,590
10	[Vegetables Wheat	Kharif Rabi	365 307	672	[2,58,055 1,86,963	36,905 -	[2,21,150 1,86,963]	4,04,113
	Sugarcane	Annual	86	86	3,04,612	8,695	2,95,917	2,95,917

Table #.7. Project costs for irrigating the area under the crop combinations

Sr. No.	Crops	Season	Pumping capacities required for the irrigable area under the crops (Cusecs)	Project costs			
				Capital cost (Rs.) (5)	Replacement cost (Rs.) (6)	Annual operation and maintenance costs (Rs.) (7)	Annual cost of land leveling (Rs.) (8)
(1)	(2)	(3)	(4)				
1	[Hybrid bajra Wheat	[Kharif Rabi]	3.86	4,02,752	46,243	14,590	14,994
2	[Hybrid bajra Local jowar	[Kharif Rabi]	4.17	4,35,068	49,957	20,043	14,202
3	[Hybrid bajra Hybrid jowar	[Kharif Rabi]	4.29	4,47,618	51,395	20,179	15,943
4	[Hybrid bajra Onion	[Kharif Rabi]	2.84	3,00,499	34,502	13,870	10,932
5	[Hybrid jowar Wheat	[Kharif Rabi]	3.85	4,01,709	46,123	14,542	13,514
6	[Hybrid jowar Onion	[Kharif Rabi]	2.87	2,99,456	34,343	13,822	9,794
7	[Groundnut Wheat	[Kharif Rabi]	3.82	3,98,579	45,764	14,397	11,616
8	[Groundnut Onion	[Kharif Rabi]	2.86	2,98,412	34,263	13,774	4,404
9	[Onion Wheat	[Kharif Rabi]	3.49	3,64,146	41,810	16,408	11,597
10	[Vegetables Wheat	[Kharif Rabi]	3.84	4,00,666	46,003	14,493	12,755
	Sugarcane	Annual	2.46* 4.92**	1,70,462 3,41,724	29,471 52,942	11,447 23,694	1,632 1,632

* Without electricity failure
 ** With electricity failure

Table 2.2. Net present worth of the projects under the crop combinations.

Sr. No.	Crops	Season	Irrigable area under the crops (acres)	Total (acres)	Present worth of the project costs (Rs.) (6)	Present worth of the net increase in the income (Rs.) (7)	Net present worth sole. (7-6) (Rs.) (8)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	[Hybrid bajri wheat	Kharif Rabi	182] 309]	791	6,92,495	21,91,299	14,98,804
2	[Hybrid bajra Local jowar	Kharif Rabi	521] 438]	959	7,63,446	25,55,512	18,21,666
3	[Hybrid bajra Hybrid jowar	Kharif Rabi	536] 343]	879	7,67,408	26,97,525	19,30,117
4	[Hybrid bajra Onion	Kharif Rabi	360] 216]	576	5,14,670	24,52,412	19,38,142
5	[Hybrid jowar wheat	Kharif Rabi	404] 308]	712	6,79,366	31,10,516	24,31,150
6	[Hybrid jowar Onion	Kharif Rabi	301] 215]	516	5,04,232	32,00,064	26,95,832
7	[Groundnut Wheat	Kharif Rabi	306] 306]	612	6,61,865	27,74,429	21,12,564
8	[Groundnut Onion	Kharif Rabi	229] 214]	443	4,91,842	28,43,427	23,91,585
9	[Onion wheat	Kharif Rabi	332] 279]	611	6,10,699	33,46,249	27,75,550
10	[Vegetables Wheat	Kharif Rabi	355] 307]	672	6,71,499	28,22,714	21,50,915
	Sugarcane	Annual	86	86	3,00,630*	20,46,704	17,46,074
					5,84,424**	20,46,704	14,59,280

* Without electricity failure

** With electricity failure

are as in the earlier exercise. They are given in Tables 8.6, 8.7 and 8.8. It is necessary to note only the results. In the first place, all the alternatives worked out are preferable to pure sugarcane under the present pattern of power supply in summer; 6 out of the 10 alternatives are preferable to the ^{crop} pattern worked out in Chapter V. Pure sugarcane is more profitable than only one of the 10 alternatives examined by us - kharif hybrid bajra and rabi wheat on 791 acres, under the assumption that there will be no failure of electricity in summer. All this only reinforces our earlier contention. Secondly, despite the economy in capital cost every combination does not show improvement in the net present worth over the equal-water-distribution schemes discussed earlier. This is because in some cases the economy in capital cost has been upset by the greater reduction in area under higher net income generating crops; for example, in the case of kharif onion and rabi wheat where reduction in area under kharif onion has upset the effects of the net reduction in capital costs of the project. On the whole, while some combinations have improved their net present worth, the situation has become marginally inferior in case of others. It means that merely economising on one line may not improve the situation all along; the total of all costs and all returns have to be examined to find an optimal solution. We have tried out two of the most likely

alternatives, and found that both situations yield a much more economical use of the given quantum of irrigation water, than the one based on a given area and a given pumping capacity where sugarcane becomes the dominant crop. This merely goes to show that there are many superior alternative use patterns of the total irrigation water, based on seasonal crops than the one worked out in Chapter V.

This exercise helps us to look at the larger question of the best use of canal water in the dry regions of Western Maharashtra.

In the lift irrigation scheme under examination, concentrating use of the given volume of water in two seasons (or 8 months) with no sugarcane, increases the total net irrigated area to at least two times what is currently worked out to be. Even the current use under the lift is much larger because of the given capacity of the lift and the failure of power in summer. Otherwise, the net irrigated area would be even smaller - as is shown by the maximum of 86 acres under sugarcane in the illustrative tables in this chapter. For a canal irrigation system primarily designed to meet the needs of sugarcane, the increase in area under seasonal irrigation would be much larger than the two-fold increase observed in this exercise, if the water of the reservoir is given only to seasonal crops in the 8 months of kharif and rabi. In

view of the severe shortage of water in this region and the uncertainty of yield due to the semi-arid conditions of agriculture, this alternative acquires great importance. The questions that are raised in this context are, of course, complex: there is the question of the larger capital cost involved in covering wider area under seasonal irrigation; there are the existing industrial structures based on large tracts of a sugarcane area under canal irrigation. All these require careful study and examination.² What the exercise in this chapter suggests is that there is a strong economic case for a different pattern of use of irrigation water from reservoirs than has been followed during the last so many decades. It is clear, at least in this case, that the present practice does not lead to the most economic use of water from the social point of view.

²In this context, the Committee to Study the Introduction of Eight Monthly Supply of Water on the Irrigation Projects in Maharashtra, after recommending the use of surface water for seasonal crops, without sugarcane, in water-scarcity basins of the State goes on to add: "The problem of existing sugarcane irrigated by surface water in water-scarcity areas is a complex one. This is a matter of rectifying evident imbalance and inequity in the use of surface water which have historically developed but without at the same time, disrupting the sugar economy of the State." Government of Maharashtra, Interim Report of the Committee..... February, 1979, pp. 70-73.

CHAPTER IX

PROBLEMS OF THE LIFT IRRIGATION SCHEMES

9.0 I n t r o d u c t i o n

In view of the very limited water resources over the large parts of Maharashtra and the necessity to make it available for agriculture at the quickest, great emphasis has been put on lifting water from rivers and streams with the help of pumps. There are certain advantages of the lifts over the other sources of irrigation. With the help of the lifts, it is possible to irrigate lands located at the higher level where sinking of wells is impossible since underground water is at a great depth, and where construction of canals is difficult. Large amount of public and private funds are currently tied up in lift irrigation projects. It is, however, felt that the implementation and working of such projects have, in many instances, been highly unsatisfactory. Many schemes have remained incomplete or taken a long period to complete, despite the receipt of the necessary finance. In other instances, the full capacity of schemes that have been completed and are in operation have not been utilised. In many examples, loans taken for the projects have not been repaid. Consequently, some schemes have been locked up after the physical plants have been installed, while

some others have been taken over by the state. Nevertheless, usefulness of the lifts in general for growth of agricultural production in the preponderantly 'dry' regions of the State cannot be questioned. Therefore, the losses involved in the schemes make the financial institutions and the State Government hesitant about encouraging these in still large numbers. Under the circumstances, it is necessary to examine the reasons or circumstances leading to delay in the completion of the projects, delay in the full utilisation of the irrigation potential created, and delay in the repayment of loans, in regard to such irrigation schemes. We propose to do this, with regard to the schemes studied here, in this chapter.

We have seen in Chapter V that every one of the four schemes selected from the Lift Irrigation Federation of Haveli Taluka, District Pune, took more than four years to complete, and, further, it was estimated that these schemes would come to the full development of irrigation in the course of 8 to 10 years from the beginning. On the other hand, the construction of the scheme located at village Bhade (Taluka Khandala, District Satara) was completed in less than a year and it was estimated that this project would not take more than six years to reach the stage of full utilisation of irrigation from the beginning. Had the former projects also been completed and the full irrigation potentials been utilised in a

shorter period, as in the case of the Bhade project, the benefits of the projects would have been much larger than those estimated by us in Chapter V. For, the interest calculated as a cost on the capital locked up over the period of construction would have been reduced by reduction in the period from four years to less than one year. Moreover, the full income stream would have accrued at the end of six years instead of 8 to 10 years from the beginning of irrigation. The point can be illustrated with one of the four schemes, viz., the Koregaon-Mul Lift Irrigation Scheme.

Table 9.1 shows that the net present worth of that project would have been Rs. 24.12 lakhs if it had been completed in a year and the full potential income been generated at the end of six years from the date of commencement of irrigation. This is higher by Rs. 3.33 lakhs than the net present value of Rs. 20.79 lakhs worked out in Chapter V. Therefore, the delay may be said to have resulted in a loss of the net present value of Rs. 3.33 lakhs. This raises a number of questions:

- (1) One year is considered adequate to construct such lift irrigation schemes. Then why were four years necessary in the case of each of the four schemes in Haveli Taluka studied here?
- (2) Why is it estimated to take 6 to 10 years to develop the irrigated lands to their full

Table 9.1. Financial profitability of the Koregaon-Mul lift irrigation scheme under the early utilisation of irrigation

(in Rupees)

Period	Capital costs	Operation and maintenance costs	Cost of land leveling	Net increase in the associated costs	Gross costs cols. (2+3+4+5)	Net increase in the crop production (7)	Net benefits cols. (7-6)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1970-71	1,59,552	12,040	1,704	84,029	2,57,335	1,49,930	-1,07,405
1971-72	-	12,040	2,888	1,42,457	1,57,385	2,54,179	96,794
1972-73	-	12,040	5,163	2,54,715	2,71,918	4,54,476	1,82,558
1973-74	-	12,040	5,163	2,77,140	2,94,343	5,26,073	2,31,730
1974-75	-	12,040	5,163	2,92,732	3,09,935	5,55,855	2,45,920
1975-76 to 1979-80**	-	12,040	5,163	3,22,691	3,39,894	6,71,503	3,31,609
1980-81	29,951*	12,040	5,163	3,22,691	3,69,845	6,71,503	3,01,658
1981-82 to 1989-90**	-	12,040	5,163	3,22,691	3,39,894	6,71,503	3,31,609
1990-91	29,951*	12,040	5,163	3,22,691	3,69,845	6,71,503	3,01,658
1991-92 to 1999-2000*	-	12,040	5,163	3,22,691	3,39,894	6,71,503	3,31,609
Total	2,19,464	3,61,200	1,49,156	91,18,348	98,48,168	1,87,28,088	88,79,920

300

* Replacement cost

** For these periods only yearly figures which remain constant over the years are present.

Net present worth at 9.5% discount rate

= Rs.24,11,789

irrigation potential, when the Bhade scheme was expected to take only six years' time?

- (3) Finally, despite the fact that all the beneficiary-farmers were estimated (Chapter VI) to be able to repay the loans within the stipulated period (or even earlier), why is it that the actual performance in this matter was tardy in the four lift schemes in Haveli Taluka, but not in Bhade? In fact, during a recent visit to the lift schemes it was learnt that the beneficiaries in Haveli Taluka had not repaid a single paise of the loan, while those in Bhade had repaid all the instalments in time.

We shall begin with examining the reasons leading to the delay in construction of the four projects selected from the Haveli Taluka Lift Irrigation Federation.

9.1 Reasons for the Delay in Construction of Schemes

Generally, construction of a lift irrigation scheme of a moderate size can be completed within a year if the necessary finance is available in time. However, as mentioned earlier, all the four lifts in Haveli Taluka took more than four years to complete the construction work. The most important reasons for the delay are inadequate finance and improper planning from the very beginning. This needs a little explanation.

As mentioned in Chapter III, the Government of Maharashtra launched a special Rabi Campaign Programme for development of irrigation in the drought prone regions of the State in 1966. Under the Programme, the Revenue Department of the State Government stipulated financial assistance (i.e., loans) at the rate of Rs. 375 per acre of the potentially irrigable area to the individual farmers, irrespective of the total investment likely to be incurred for the purpose. Since construction of lifts was the only way open for many farmers in Haveli Taluka, who had lands near river banks, to irrigate their lands, they took advantage of this facility. Some political and social workers from the Taluka came forward and formed the Lift Irrigation Federation of Haveli Taluka and persuaded the farmers to come together under the Federation for proper planning and execution of the lifts. This idea was accepted by a large number of cultivators and 42 lift irrigation schemes in different villages of the Taluka were prepared under the supervision of the Federation. These schemes were submitted to the State Government for provision of loans under the Rabi Campaign. Joint loans were sanctioned and disbursed against the security of the land of the cultivator-members on 26th February 1966 to every one of the 42 schemes by the State. However, while sanctioning the loans, the State Government did not examine carefully the technical basis and financial feasibility of the

schemes, since the Government was in a hurry to disburse the funds to promote irrigation activity. Consequently, the Federation also did not take great care in formulating the scheme and working out the technical and financial feasibility. However, when following the sanction of the loans by the Government, the detailed plans of the schemes were worked out by the Federation, it became clear that the estimated amount of investment in each scheme would be much in excess of the loans disbursed by the State Government.

Nevertheless, construction of all the schemes started within a couple of months from the date of disbursement of the loans by the Government in the hope that the additional funds required could be obtained from the banking agencies on hypothecation of the capital work. When the construction of the lifts was in progress the Federation approached various banks to secure the additional funds for completion of the projects. But, none of the banks was prepared to finance the schemes only on the hypothecation of the capital work. In addition to hypothecation, the banks wanted first-hand mortgage of the lands under the projects; but, as mentioned above, these lands had already been mortgaged to the Government against the loans taken. The Government on its part expressed its inability to provide the additional funds for completion of the schemes. However, the Government expressed its willingness not only to release

the mortgage, of course, on the repayment of the loans taken from it, but also to guarantee the refund of any larger loans that the societies may be able to obtain from a commercial bank, for repaying the State loans and completing the projects. Thereafter, the Federation approached one of the commercial banks for approval of the loan proposals. The bank rejected 26 proposals out of the 42, on the ground of feasibility and agreed to finance the remaining 16 schemes. The loans were disbursed on 9th October 1969 and construction of the 16 schemes was completed by early 1970. (Our sample of the four lifts belonged to these lifts). In addition to these 16 schemes, 7 more of the original 42 schemes were completed by 1972 as the Federation managed to secure additional funds for these projects from some other banks. Thus, in all 23 schemes were completed at the time when our field survey began in 1972.

Construction of the four lift irrigation schemes selected for study was completed in a couple of months from the date of disbursement (9th October 1969) of the bank loans. However, after installation of the electric pumps and completion of all other works, the Maharashtra State Electricity Board did not give power connections to the pumps for about six months because separate power lines and the transformers were yet to be fixed for the lifts. Ultimately, the lifts, the construction of which was started

in early 1966, could release water into the fields by May 1970, that is, four years after the commencement of the construction work.

It is obvious from the above discussions that the major difficulties in timely completion of the four schemes were inadequacy of the necessary finance and the lack of systematic planning from the beginning itself. The State Government which came out to help in creating the irrigation facilities did not give any attention to the extent of finance required for the schemes and their feasibility while advancing the initial loans. At the same time the Federation was equally unmindful of the necessity of properly formulating the schemes, and estimating the financial requirements, as would be clear from the facts that nearly half of the 42 schemes of the Federation originally sponsored by the Government, could not be approved of by any financial institution, and all the schemes discovered the inadequacy of the government loans soon after the schemes were worked out in detail to begin construction work. The Federation possibly thought that the additional funds needed could be secured easily and without delay from the banks, if so, this was most unreasonable expectation. Apart from the technical difficulties in the way of two financing agencies, to come in succession, to finance the project, it was necessary to ensure the technical and financial feasibility of the schemes which were to be financed by multiple

agencies. These failures have been the major reasons for considerable delay in the completion of the schemes.

Another problem which added to this difficult situation is the passiveness of the farmers who were members of the lift irrigation schemes. While the loans were taken in the names of the farmers and they mortgaged their lands, they or any one from amongst them took little or no initiative in organising the schemes and in following up on the implementation. The entire initiative was taken by some political-social workers, who organised the Federation and took all the initiative and interest in the projects. The trustees of the Federation consisted of five members, none of whom was a member of any one of the 42 lift irrigation schemes under it, nor held any land in any of these projects. The farmers under the schemes had no participation in the technical and financial policy formulations and decisions. Besides signing the mortgage papers, they had no participation in these projects until the water was made available to their fields. The political-social leaders of the Federation had many other preoccupations, and, in any case, depended more on their political strength rather than on the technical and financial feasibility and performance of the projects, to see them through. No wonder, they were not greatly exercised over the delay in the execution of the schemes and its financial and economic implications, which would have been expected to bother the farmer-members

of the schemes if they had been actively associated with it. The farmer-members, on their part, were quite passive, because of their implicit trust that the political-social workers would see to it that whatever the fate of the lift schemes, they (i.e., the farmers) would not come to any financial loss. If anything, they would gain something, however long it may take.

On the other hand, as mentioned earlier, construction of the lift located at village Bhade, was completed within a year. This was possible for the following reasons. Unlike in the earlier projects, the farmers took initiative in creating the irrigation potentials on their farms from the very beginning. As a result, formulation and implementation of the lift arose out of the 'group action' of the cultivators. Efficient leadership was provided from amongst the farmers themselves and by the Kumbkar Seeds and Agricultural Development Company, Limited, Phaltan, District Satara. We shall illustrate this point by giving the salient features in the formulation and implementation of the lift scheme.

When the idea of the lift was mooted in the village, the farmers prepared a plan of the project and approached various banks to secure the necessary finance for the lift. However, no bank agreed to finance the scheme because the lands of the majority of the farmers had already been mortgaged to either the Land Development

credit

Bank or the village co-operative/society. Therefore, it was neither possible for the banks to obtain first-hand mortgage of the lands as security, nor were the farmers in a position to repay all the outstanding dues and clear all the encumbrances on their lands, so that the bank could advance the loan against security of land.

Under these circumstances, the farmers approached the Nimbkar Company for assistance in formulation and implementation of the scheme. The Company guaranteed one of the leading banks the repayment of the total loan to the lift irrigation society, and at the same time laid down the following conditions with the farmers, for its services:

(1) The Nimbkar Company will complete the construction of the scheme through its own engineers and experts. For this, the Company will receive 10 per cent commission on the total expenditure on the project.

(2) The participating farmers will lease out, till the repayment of their total loan is complete, 25 per cent of their irrigable land under the scheme to the Company.

(3) The Company will decide on and supervise the crops to be grown in the total command area under the project, including both the leased land and the land under cultivation by the farmers.

(4) All the producers will have to sell their produce

to the Company or through the Company, till the repayment of the loan is complete.

(5) From the receipt of the sale of the farmers' produce all the dues of the different financing agencies will be paid first and then the balance will be paid to the farmers; and

(6) the Company will execute and supervise the project till the repayment is complete.

The farmers agreed to all these conditions and formed a Committee consisting of six of them. The Committee was given the power of attorney by the cultivators.

The capital cost of the project was estimated at Rs. 5.61 lakhs (including the 10 per cent commission to the Nimbkar Company). Since there were 574 acres to come under the lift irrigation scheme, the capital cost per acre came to roughly Rs. 1000. The Committee therefore decided to issue shares to its members of the value of Rs. 1000 per acre. All members were required to pay Rs. 200 per acre, being one-fifth of the share value, in the beginning and the remaining in four equal annual instalments. In fact, 35 cultivator-members of the scheme paid the full share value of Rs. 1000 per acre on 101 acres of their land right at the beginning; on the remaining land the members paid at the rate of Rs. 200 per acre. Thus, the Committee collected from the farmers Rs. 1.73 lakhs at the beginning towards the capital cost

of the project. The remaining Rs. 4 lakhs were obtained from a leading commercial bank as a loan, to be repaid in six years commencing from the second year after the date of disbursement of the loan.

The farmers' ability and willingness to raise such a significant part of the capital cost right at the beginning was a notable feature of this project. This was possible largely because some of the farmers were reasonably well off due to some irrigation under wells on parts of their total landholding. But there was also the advantage of their taking the initiative themselves, rather than some outsiders selling the idea and promising to do everything for them. That the cultivators were quite alert about their interest will also become clear from the fact that they released their 25 per cent land from lease with Nimbkar Company ahead of schedule by repaying the loans (or the remainder of the share value, plus interest) from the surplus on the 75 per cent land at their disposal.

The Nimbkar Company prepared the plan and started the construction on 1st December 1971 with the help of the share capital raised by the farmers well in advance. The bank sanctioned a loan of Rs. 4 lakhs for the scheme on 3rd April 1972 on the security of guarantee of repayment from the Nimbkar Company, the mortgage of some of the land in the command area and hypothecation of the

capital work. The loan was disbursed to the scheme on 22nd June 1972 and the project was completed by 18th September 1972, that is, within 10 months from the beginning of the construction.

The active participation of the farmers and the careful formulation and execution of the project by the Company, not only helped in completion of the project at the earliest, but also in full utilisation of irrigation.

9.2 Reasons for the Delay in Full Utilisation of Irrigation Potentials

It may be recalled (Chapter V) that the lift in Bhade village is expected to come to the full utilisation stage of irrigation in the course of six years from the beginning, while in the case of the other projects this period would be between 8 and 10 years. The time taken for full utilisation of irrigation would be mainly because of levelling land and making it suitable for irrigated farming. This work would be prolonged over a period of 5 to 7 years in the case of the projects in Haveli Taluka and only 3 years in the case of the project in Bhade village. The rest of the period, that is 3 years was considered necessary for the land which would come under irrigation for the first time, either after land levelling or otherwise, to reach the stage of full maturity of irrigated farming. For, as discussed in Chapter V, the

additional land that will come under irrigation every year will take some time to adjust to irrigation, and hence the estimated crop pattern and yields of the crops will not accrue immediately. These will come slowly and accumulate steadily till the stage of maturity is reached. On the basis of the information available to us, we estimate that the irrigable area will reach full maturity after receiving irrigation for three consecutive years. Therefore, this period of three years should not be considered as delay in full utilisation of irrigation. The reasons for the time taken for the work of land levelling are discussed below.

It was observed during the farm surveys that land levelling was essential in all the projects on 35 to 40 per cent of the total command area. However, it was estimated that the work of land levelling in the Bhade project would be completed in a shorter period than in the other projects. This was because the extent and the nature of work on the individual farms was different in the Bhade project from that of others. The Bhade scheme had many small farms and a few large farms. On the small farms, the extent of area to be levelled was much smaller than in the other projects. Besides, the gradient of land to be levelled was generally less on the Bhade farms. Therefore, the extent of work involved in levelling and making the land suitable for irrigation on these small

farms was less than in the case of the most farms in the other projects. Secondly, the bulk of the land requiring levelling in the Bhade scheme was concentrated on the lands of the big farmers who were well equipped with the land levelling equipments; some of them had tractors with land levelling accessories which were also available on rent for the work on the other farms.

Moreover, the Niabkar Company established a mechanical unit for land development in the village from which tractors as well as bullock driven equipments were made available on rent for the work. In addition to this, the Company insisted on the farmers to develop and make the lands suitable for irrigation, failing which, water was not to be supplied to the farms. Because of all these factors, the work of land development in the Bhade project started prior to irrigation in anticipation of the facility and was completed within three years from the beginning of the project.

In the other projects, despite the willingness of the farmers to hire the necessary machinery from the State Government (Command Area Development Authority), or from the neighbouring villages for land development, it was not available. Therefore, besides the greater extent of work on account of larger area and the greater gradient of land to be developed on the individual farms, the entire burden of the work fell on farm labour. Moreover, it was

reported by the farmers that it was possible to undertake this work only when bullocks and men were free from crop production work, and that was possible in summer. Even during summer, labour was not available for land development over the entire season because preliminary tillage operations were also due in summer for the forthcoming kharif crops. The farmers reported that every year hardly two months were available for the work. Thus, apart from the investment required for land development, the period available for the work every year was too short to complete the entire work sooner than in the estimated period. On the whole, the work on land development was very slow in these command areas. Moreover, the work was started after completion of the projects and not earlier in anticipation of the irrigation facility as in the case of the Bhade Scheme. On account of these factors we estimated that the work of land levelling in the command areas of the projects in Haveli Taluka would be completed in the course of 5 to 7 years from the beginning.

There were some other reasons for the delay in utilization of irrigation in these projects. A few farmers did not allow the water distributaries to pass through their fields, while some farmers did not bother to irrigate their lands in the beginning because they had more land in the neighbouring villages or had other

occupations elsewhere.

It is seen from the above discussions that the main problem in bringing the area under irrigation in an earlier period was levelling and making the land suitable for irrigated farming. Therefore, considering the necessity of making irrigation available to land at the quickest and the period available every year for land development with the help of farm labour, farm mechanisation in land levelling may help to some extent in this matter as in the case of the Bhade project. This is not possible for the majority of farmers in the State unless the necessary machinery is available on rent from some agency. The Command Area Development Authority has already taken up this work in the State, of course only on a small scale.

9.3 Reasons for the Delay in Repayment of Loans

We shall turn to the last of the three problems raised in the beginning of this chapter, viz., the very poor performance in regard to repayment of loans by farmers in the four schemes of Haveli Taluka, as against the timely repayment in Bhade. The terms and conditions put forth by the Nimbkar Company, as mentioned earlier, compelled the farmers in Bhade village to repay the loans in time. Not only did the Company require the farmers to sell all their produce from the command area cultivated by them through or to the Company, from which the loan

instalments and interests are to be deducted before the sale proceeds are handed over to the farmers, but the Company was to cultivate its per cent of the command area on its own, for which the rental to the farmers was to be the instalment of loan to be repaid and the interest. These stiff conditions made the farmers strive to repay the loans at the fastest and be freed from these requirements. Indeed, they repaid not only the loans relating to 75 per cent of the land they were themselves cultivating in time, but also from the surplus of this land repaid the loans of the 25 per cent leased out to the Company ahead of schedule, so that the Nimbkar Company had to release this land from lease earlier than anticipated and therefore could not carry out its plan of cropping on such land. The farmers, when interviewed expressed the view that if the Nimbkar Company had not put these conditions, they would not have cared to repay the loans within the stipulated period. They further opined that, in general, the farmers who create irrigation facilities on their farms by taking loans from the financial institutions and do not repay the loans for quite a long period were more often wilful defaulters. This means that unless stiff conditions, such as those laid down by the Nimbkar Company in execution of the scheme, are specified, repayment of loan by farmers is likely to be neglected and poor.

This appears to be the main reason why the benefi-

ciaries of the projects in Haveli Taluka have not repaid the loans inspite of having the necessary repayment capacity. It was learnt while discussing the problem of repayment with the farmers that neither the Lift Irrigation Federation of Haveli Taluka which formulated and implemented the schemes nor the State Government which has guaranteed repayment to the bank, has insisted with the farmers about repayment of the loans. The Federation has not formulated any plan of collecting the necessary instalments of loans for repayment from farmers. Nor does the bank, which advanced the loans, appear to have done anything for the repayment beyond writing letters once in every six months. Presumably, they rest on the State's guarantee of repayment, and do not feel called upon to do anything more in this direction.

Many lift irrigation schemes in the State are reportedly not functioning efficiently. The reasons identified above may go a long way in explaining this. Hurried and inadequate formulation of lift schemes with whatever finance is immediately available has resulted in prolonged periods of construction. Improper or inadequate arrangements for land development has further lengthened the period required to start irrigated farming on the command area. Absence of built in conditions which will make the farmers see the necessity and usefulness of timely repayment is another source of not merely failure of

financing agencies from recovering their funds, but also for tardy and negligent development of irrigated farming by the farmers. And finally, what is required is involvement of farmers in the formulation and execution of scheme, where they feel they have a stake and something to lose for their failures. Charitable outsiders are poor substitutes for this.

CHAPTER X

SUMMARY AND CONCLUSIONS

In many parts of India and certainly in the preponderantly 'dry' regions of Maharashtra, water being the scarcest factor in agriculture - even scarcer than land - it is necessary to use it most economically so that from the social point of view, the net output due to water is maximised. The project analysis techniques help in identifying the irrigation projects which render maximum return to the growth of the economy as well as to capital contributed by the participants. Therefore, proper economic evaluation of irrigation projects is of prime importance in the State.

However, the recent discussions on the criterion for the economic evaluation of irrigation projects and a review of this literature, as undertaken in Chapter II, bring out two important points: (1) The method of estimating the social benefits and costs, and consequently the procedure for calculating the benefit-cost ratios of the irrigation projects adopted in India in official as well as in many non-official studies suffer from some inconsistencies and errors. (2) Moreover, the exclusive concern with social cost-benefit analysis has resulted in attention not being given to the possibility of financial returns to the investment in the projects, as also to the possibility of

different types of farmers being able to bear the cost of irrigation. In the present context, therefore, it is of some interest to review the current method of economic evaluation of irrigation projects in India and design a proper criterion for the study of financial profitability and the social cost-benefit of the proposed irrigation projects.

In view of the very limited water resources over the large parts of Maharashtra and the necessity to make it available for agriculture at the quickest, great emphasis has been put on lifting water from rivers and streams with the help of pumps. It is, however, felt that though there are some advantages of the lifts over the other sources of irrigation, the execution and functioning of these projects have in many instances, been highly unsatisfactory. Under the circumstances, it is necessary to examine the possible economics of a few such schemes to highlight the problems faced by them.

Thus, the major objectives of the thesis are two fold: Firstly, to estimate the financial profitability and the social cost-benefit of some lift irrigation schemes by improving upon the methodology adopted by most of the studies in the country so far, and secondly, to study the problems associated in the formulation and implementation of the lift irrigation schemes in Maharashtra.

A total of five lift irrigation schemes - four from

Haveli Taluka of Pune District and one from Khandala Taluka of Satara District - were selected purposively for the study. The data required for the study were collected by the farm survey method and related to the year 1972-73.

In the financial profitability calculus, while estimating the economically efficient crop patterns, using the usual budgeting method, under the lift irrigation schemes, we found that given the capacity of the pump put up and the irrigation duty of various crops in the region, sugarcane turned out to be the most profitable crop compared to any single crop or combination of crops. The other crops came into the planned cropping pattern because the limit to area under sugarcane was put by the area under this crop that could be irrigated with the pumping capacity of the lift and the failure of the electricity in summer. Thus, the other crops used only the surplus pumping capacity of the lift in the kharif and rabi seasons. The same estimation of crop pattern is also attempted with the help of linear programming technique by using the Simplex method. It is seen from the results that the optimal crop pattern obtained in the linear programming method tallies with the economically efficient crop pattern estimated by us under irrigation.

However, the estimated crop pattern under the project does not necessarily tell us what is the most economic use of a given quantity of water that may be available for

irrigation. For, it is also pointed out that given the water discharge capacity of the pump and considering the three seasons together, sugarcane will use much more irrigation water than any alternative individual crop or combination of crops. Therefore, to know the best economical use of the total quantity of water used to irrigate sugarcane, a different approach is necessary. If the given pumping capacity cannot pump the total quantity of water used under sugarcane for seasonal crops because of the interval in which irrigation water is required for those crops, then the pumping capacity would have to be increased. Besides, the total water used for sugarcane over the three seasons can also be given to seasonal crops in kharif and rabi if the irrigation water is supplied from a reservoir. This would, of course, require even greater installation of pumping capacity, larger command area under the irrigation system, as also longer and wider water distributory channels over the area. Therefore, while the alternative returns to the given quantity of water may be higher than calculated in the planned cropping pattern for the given water discharge capacity of the pump, the costs may also be higher and the net profitability of the alternative use of irrigation water has to be accordingly worked out. We have undertaken this exercise by taking one of the five lift irrigation schemes under study, as an example, to which we shall turn subsequently.

It is observed in the financial analysis that all the five schemes selected for the study are financially profitable and give the internal rate of return in between 42 and 82 per cent. These lifts also prove to be profitable even under the assumption that if the net increase in crop production after irrigation is 10 per cent lower than what has been estimated by us, then the rate of return on the investments will be in the range of 34 to 64 per cent.

The financial analysis is extended to the repayment of loans after improving upon the general practice of the financial institutions in the country in prescribing the repayment schedule and considering the repayment capacity of the farmers.

The present repayment schedule followed by the financial institutions in the country often fails to take into account the lapse of time after the disbursement of the loan before the benefits begin to accrue to the cultivators. This results in enforcement of repayment on some farmers who have not been able to avail of irrigation facility for some time because of delays on account of technical or financial reasons like land development, etc. This is not proper. To overcome this common weakness, it is proposed that the total amount of principal to be repaid should be distributed among the farmer-members on the basis of their area to be irrigated every year from the beginning and the period over which such benefits would accrue to them.

The proposed repayment schedule gives some relief to the farmers who begin receiving irrigation water late in two ways: relief in the total amount of principal to be repaid, and the necessary staggering in the period from which the first instalment would be due from them. From this point of view, the proposed repayment schedule would be more equitable than the present schedule prescribed by the financial institutions in the country. On the other hand, some hardship may be caused to the farmers who begin repayment late because they will have to repay the total loan in a few years than stipulated by the bank or even in a single year. It may, however, be noted that the proposed method of repayment may act as an incentive to the farmers for earlier utilisation of irrigation.

It is found in the repayment analysis that all the farmers in the different size groups of land holdings in each project can repay the loans in the period stipulated by the banks. In the case of farmers in small size groups of land holdings, it is, however, essential to postpone the date of repayment of the first instalment of loan till they acquire the necessary repayment capacity. On the other hand, the repayment capacity of the farmers in big size groups of land holdings is so high as to justify a substantial reduction in the total period of repayment stipulated by the banks. These calculations would also help the financial institutions to estimate the period over

which they can reasonably expect to recover the loans from the farmers and decide whether any flexibility in this regard is necessary.

From the view point of the social cost-benefit analysis, it is observed that all the five lift irrigation schemes are economically feasible and give the benefit-cost ratios in between 1.48 and 1.72, and the social rate of return on the investments in the range of 42 to 77 per cent. Like in the financial analysis, if we assume that the net increase in crop production is 10 per cent lower than that has been estimated by us, then the ratios will be in between 1.33 and 1.55 and the rate of return in the range of 34 to 59 per cent. Thus, examination of the estimates shows that all the lift irrigation schemes are not only financially feasible but are also justifiable in terms of social cost-benefit analysis.

The question of most economic use of the given quantity of water, as mentioned earlier, is examined by taking one of the five lift irrigation schemes, viz., the Koregaon-Mul lift irrigation scheme in the Haveli Taluka, as an example. The total quantum of water that would be used by this project under the planned cropping pattern in a year is considered to be available for irrigation in kharif and rabi seasons or in eight months. Given the total quantity of water available for irrigation, the question is about its division between the kharif and rabi seasons. A large

number of alternative possibilities are open for this purpose. We have worked out the economics of two alternative divisions of the total water available for irrigation. One division is to use the total water between the two seasons in such a way that the pumping capacity can be fairly fully used in each season. The other is to make half of the total water available in each of the two seasons. In this analysis, we have considered five crops in the kharif and four crops in rabi seasons giving ten alternative possible crop combinations and worked out the economics of each crop combination in two of the most likely alternative divisions of the total water available for irrigation.

In both the alternative divisions of the total irrigation water we find that if all the water used by the existing project under the planned cropping pattern is to be used in kharif and rabi seasons to grow seasonal crops over a much wider area and so covering a large number of farmers, with the help of larger pumping capacity, the economics of such water use would be much better than the one based on the given area and the given pumping capacity where sugarcane becomes a dominant crop. The best economic use appears to be kharif onion and rabi wheat giving about twice the net present value than that under only sugarcane. It covers about seven times the area that will be irrigated under sugarcane, and about twice the net area that will be irrigated as per the planned cropping pattern

worked out under the existing project. The number of beneficiaries will also be proportionately larger.

This exercise would enable us to look forward at the larger question of the best use of canal water in the water-scarcity regions of Maharashtra. In the lift irrigation scheme under examination, use of the total volume of water in kharif and rabi seasons without sugarcane would increase the total net irrigated area to at least two times than what it is presently worked out to be. Even the present use under the lift is much larger for the seasonal crops because of the given capacity of the lift and the failure of electricity in summer. Otherwise, the net irrigated area would be even much smaller. For a canal irrigation system primarily designed to meet the needs of sugarcane, the increase in area under seasonal crops would be much larger than the two-fold increase observed in this analysis, if the water of the reservoir is given exclusively to seasonal crops in kharif and rabi. This alternative is of primary importance to Western Maharashtra facing severe shortage of water and uncertainty of yields. To be sure, the questions that are raised in this context are complex: the questions of larger capital cost involved in covering wider area under seasonal irrigation; the existing industrial structures based on large tracts of sugarcane area under canal irrigation, etc. These issues need careful study and examination. But undoubtedly there is a strong economic case for a

different pattern of use of irrigation water from reservoirs than has been hitherto followed. Also the study makes it clear that the present practice does not lead to the most economic use of water from the social point of view. It may be noted that the alternative use of irrigation water may act as a spur to use more and more underground water in the command areas of the canal irrigation projects because for the farmers who want to continue to grow sugarcane, underground water would be the only alternative left out.

The problems of the lift irrigation schemes in Haveli Taluka were of three types: (1) Delay in the construction of schemes, (2) delay in the full utilisation of irrigation potentials; and (3) delay in the repayment of loans.

The major problems in timely completion of the four schemes in the Haveli Taluka were inadequacy of the necessary finance and improper planning from the very beginning. The State Government which came forward to promote the irrigation activity did not give any attention to the extent of funds required for the schemes and their feasibility while advancing the loans. At the same time the Federation which executed the schemes was also unmindful of the necessity of properly formulating the schemes, and estimating the financial requirements. Further, the farmer-members remained as mere passive beneficiaries without showing any initiative and interest. The entire initiative was taken by some political-social workers who organised the Federation

and took all the initiative and interest in the projects. However, they had many other preoccupations and depended more on their political strength rather than on the technical and financial feasibility of the schemes.

The important problem in full utilisation of irrigation is levelling and making the land suitable for irrigated farming. In the case of projects in the Haveli Taluka the work of land development was considerable. As no land levelling machinery was available, the entire work was to be carried out by the farm labour. Moreover, it was possible to undertake this work only when bullocks and men were free from crop production work, and that was possible only in summer. Thus, the time available for the work every year was too short to complete the entire work sooner than in the estimated period. Besides, in the very nature of things, full utilisation of irrigation reaching its stage of maturity is a slow process.

Absence of stiff conditions compelling the farmers to repay the loans to the bank in Haveli Taluka resulted in the wilful default in repaying the loans by the farmers. In contrast, we see the farmers in Bhade village complying with the conditions laid down by the Nimbkar Company and repaying the loans in time.

Many lift irrigation schemes in the State are reportedly not functioning efficiently. The reasons identified

above go a long way in explaining this. Hurried and inadequate formulation of the lift schemes with whatever finance is immediately available results in prolonging the period of construction. Improper or inadequate arrangement for land development further delays the commencement of irrigated farming. Absence of built-in-conditions which will make the farmers see the necessity and usefulness of timely repayment is another source of not merely failure of financial institutions from recovering their funds, but also far tardy and negligent development of irrigated farming by the farmers. And finally, what is required is involvement of farmers in the formulation and execution of schemes, where they feel they have a stake and something to lose for their failures. Charitable outsiders are poor substitutes for this.

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