ECONOMIC ANALYSIS OF SELECTED IRRIGATION SYSTEMS IN HIMACHAL PRADESH : REVIEW OF ASSUMPTIONS AND ESTIMATES OF ECONOMIC RATE OF RETURN

SUBMITTED TO

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
NEW DELHI

UNDER HILL AREA LAND AND WATER DEVELOPMENT
PROJECT

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SEPTEMBER 1988

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A C K N O W L E D G E M E N T S

The valuable guidance and suggestions made during the course of the study and preparation of this report by Mr. G.E. Anders, Chief of IWR; Mr. D. Wendel, Deputy Chief; Dr. M.F. Walter, Adviser; Dr. B. Sen, Economist; and Mr. N.R. Banerjee, Project Officer of Irrigation Water Resources Division, USAID, New Delhi is gratefully acknowledged. Dr. Ramesh Bhatia, Mr. R P.S. Malik and Dr. R.K. Sharma were kind enough to advise on various aspects relating to economics and agro-economics as also in economic analysis methodology. But for their help and c.operation it would have been difficult to complete the work in such a short time and upto desired standard. Their contribution in this effort is gratefully acknowledged. Mr. Narinder Singh provided efficient computational assistance for which he deserves special thanks.

BASAWAN SINHA

ECONOMIC APPRAISAL OF SOME SELECTED IRRIGATION SCHEMES UNDER USAID HILL AREA LAND & WATER DEVELOPMENT PROJECT IN H.P.

Executive Summary

1. BACKGROUND

The United States Agency for International Development (USAID) is assisting the Government of Himachal Pradesh in its efforts directed towards rapid development of irrigated agriculture in the State under the Hill Area Land and Water Development Project (HALWD). The USAID intends to introduce new approaches to land and water management, as well as to support initiative in developing its land and water resources. It is a Seven Year Programme under which approximately 150 minor and 2000 micro Irrigation systems with emphasis on Irrigation planning and design, integrated upstream development, on-farm development works, users involvement, and associated support of human and institutional capabilities. The Minor Irrigation schemes planned comprise deep-drilled tubewells, Lift irrigation from rivers, Small reservoirs (tanks), and Diversion (flow) Irrigation works. Some of the schemes included in the programme are reported to be under execution.

2. SCOPE & OBJECTIVE

USAID, NEW DELHI under Purchase Order No. 386-0249-0-00-&223-00 dated July 15, 1988 intrusted the Job pertaining to estimation of the internal Rate of Return (IRR) of approximately eight small-scale irrigation proposals of which, two are high

lift pumping systems, two are gravity-flow stream diversion systems, two are tubewell pumping systems, and two are small storage or tank systems. It was also stipulated in the statement of work that the contractor will clearly state in his report the assumptions used in the IRR Analysis, will carry out Sensitivity Analysis for some important variables and will also carry out an analysis usings shadow prices for traded commodities, viz. electricity and water? based on values of alternative uses (if known).

3. SELECTION OF EIGHT SCHEMES

The following eight projects were selected in consultation with Shri N.R. Banerjee of USAID for estimation of IRR:

I. Tubewell Irrigation

1. Dhakeri Scheme in Solan District
2. Gugwara Scheme in Una District

II. High-Lift Irrigation

1. Bhawra Scheme in Kangra District
2. Neoli Therman Scheme in Kullu District

III. Storage Tank Irrigation

1. Gurla Scheme in Shimla District
2. Ropa-Buda Scheme in Mandi District.

IV. Flow Irrigation Scheme

1. Bari Kulwar Scheme in Mandi District
2. Nandpeer Scheme in Shimla

These eight schemes comprise all the four types of Irrigation works, are located in six districts of the State spread over three out of four Agro-Climatic Zones of Himachal Pradesh. And yet it would not be prudent to claim that the results of the instant study on the above mentioned individual schemes will be straight away applied to all schemes of corresponding type and size located elsewhere in the state because the soil characteristics, cropping pattern, consumers preference, design and the cost of the engineering structures with its appurtenent works, developmental prospects, etc. vary significantly in the hilly terrain especially of the type met within the hilly State of Himachal Pradesh.

3. An Overview on Parameters of Project Proposals:

After obtaining the data and informations contained in the project reports and estimates of the above mentioned eight schemes, a thorough analysis of the various parameters relevant to calculation of IRR was done by a team of experts in the fields of economics, agro-economics, water resources development and management, and other professionals and sub-professionals. This is presented in Section-I of the report.

The salient features having bearing on estimation of IRR noted are:

3.1 The existing cropping intensities in the command areas of all the eight selected schemes were very high, about 200% in un-irrigated condition.

3.2 Proposed irrigation intensities were more or less the same as the cropping intensities in pre-irrigation condition. In other words, the gross cropped areas (GCA) in with and without irrigation situation were equal.

3.3 Shift in cropping pattern from unirrigated to irrigated agriculture as proposed was largely in favour of cash crops, mainly vegetables in both Kharif and Rabi seasons.

3.4 Vegetables are grown in the command areas of Lift irrigation scheme)LIS), Kullu (2.03% in Kharif and 1.02% in Rabi), Una Tubewell scheme (6.34% in Rabi); Shimla Tank Scheme (11.11% in Kharif, 11.11% in Rabi and 11.11% Patato); and Mandi Flow Irrigation Scheme (0.87% aid). No vegetable is grown in command area of other four schemes.

3.5 The project estimates prepared were in detail so far as engineering works were concerned but how the choice was made in favour of the proposed structure

had not been given in the report. It was also not clear as to why costly piped water supply was provided in the Flow Irrigation Scheme. From the Project Reports it was also not clear as to whether Soil surveys and irrigability classification were conducted by the project authorities.

3.6 The project report did not contain discussions on and the basis of proposed cropping pattern, irrigation intensities, crop yields etc.

4. FIELD VISITS AND COLLECTION OF RELEVANT DATA & INFORMATIONS

As stated above, the project reports lacked in presentation of details relevant to irrigated agriculture envisaged in the proposals. In such an Area or Regional approach to planning for land and water resources development through a number of small size schemes, dotted over the in patches of cultivable lands of the hilly terrain, it would be too much to expect that for each individual minor irrigation scheme, elaborate details or determination of irrigation intensities crop-yield rates, farm cost, etc. will be made available. But, at least such a presentation on each agro-climatic Zone and on each type of scheme should have been made. These being not there, attempts were made to obtain as much as could be available from secondary sources.

A team of experts was deputed for this. The following offices/departments were contacted for collecting data on crop parameters-cropping pattern, crop yields and prices. The offices visited were :-

1. Agro-Economic Research Centre, H.P. University, Shimla.
2. Directorate of Agriculture, Govt. of H.P.
3. Directorate of Land Records, Govt. of H.P.
4. Directorate of Economics and Statistics, Govt. of H.P.
5. Office of the Chief Engineer (IIrg.), Govt. of H.P.
6. State Planning Board.

Data on cost of production of different field crops, horticultural crops, growth of agricultural development in different districts of H.P., market infrastructure, present methods of disposal of crop and horticulture produce practised by the farmers etc., were collected from the Agricultural Economics Research Centre, Shimla. In addition an important document obtained was an unpublished Ph.D. thesis on various aspects of vegetable production and marketing of vegetable crops in some of the selected districts of Himachal Pradesh. This study is based on a well defined stratified during the course of data collection under the comprehensive

In course of visit to the Directorate of Agriculture data on various aspects of crop cultivation specially the information relating to estimation of crop yields on the basis of crop cutting surveys were collected. In the cours of discussion with Dr. Mittal, Economist, Directorate of Agriculture it was revealed that separate yield estimates for irrigated and unirrigated yields of various crops were not available. The cyclostyled sheets issued by Dr. Mittal on the results of crop cutting experiments did not contain separate yield estimates for irrigated and unirrigated crops. Package of practices issued by the H.P. Krishi Vishwa Vidyalaya every year for Kharif and Rabi season was found more useful in this aspect.

An important source of documents that is, Season and Crop Report (ASCR) which give detailed information on variou aspects of agricultural production districtwise, cropping pattern, crop yields, farm harvest prices was obtained from the Directorate of Land records. Their report provides two types of yield estimates - the standard yield and the curren yield but does not distinguish between the irrigated and unirrigated crop yield. The intensive search for relevant data revealed that the ASCR was perhaps the only source of information in the State which provides such detailed estimates of various crop parameters at the district level. The latest Season and Crop Report available is for the year 1984-85

For time-series data on growth of agriculture in H.P. as also on various other aspects of agricultural economy, irrigation, infrastructure, etc., the Directorate of Economics & Statistics was contacted and various publications providing requisite information both at the district level as well as State level were collected.

To collect data on policy parameters the Plan documents of the Govt. of H.P. were collected. The document provides useful information not only in respect of the current state of affairs of various sectors of the Himachal's economy but also provides useful information on the priority areas of development in the State. It provides information on irrigation, crops, infrastructural development, etc.

The office of the Chief Engineer, Irrigation was also visited by the Team to collect information on the growth of irrigation and performance reports on different types of irrigation schemes. The officials over there were not aware of any Ex-post evaluation having been carried out ever on any irrigation project in the State.

The Team members had also informal discussions with a number of people who had intimate knowledge of agricultural economy of the State. Some of these people were in fact practising farmers and provided useful information on various

The visits of the team to various offices at Shimla, and some project sites, their discussions with knowledgeable professionals and farmers and the reports as well as other publications collected were found in objective assessment of the situation and in adopting pragmatic approach in economic analysis of the proposed schemes. It would not be an exaggeration to claim that in the situation obtaining nothing more could be collected and/or ascertained through extended field visits.

5. REVIEW OF RELEVANT PARAMETERS

This report presents the results of economic evaluation of eight small scale irrigation projects in Himachal Pradesh which are included under the HALWD project of the USAID. The report begins with a review of assumptions contained in the Project Reports suggested modification therein gives estimates of shadow prices for major outputs and inputs and provides a range of estimates of economic rate of return (ERR) under alternative assumptions.

The assumptions made in the project reports on various parameters are reviewed in the light of existing crop situation, relevant information/data from published and unpublished reports and discussions with experts and knowledgeable farmers in the field. Data on cost of production of different field crops horticultural crops in different districts of

of disposal of crop and horticultural produce were collected from the Agriculture Economic Research Centre, Directorate of Economics and Statistics, Directorate of Agriculture, Directorate of Land Records and State Planning Board. Since vegetable crops are very important components of benefits of these irrigation projects. Projects and not even secondary data were available on this, unpublished Ph.D. thesis was referred to for detailed information on various aspects of vegetable prices, yields, marketing practices etc. Based on these reports, observations and discussion the cropping pattern, yield levels, crop outflow prices have been modified and adjusted in subsequent economic analysis. Specifically the area under vegetables: Yield flows and prices used in the report reflect the existing area, marketability conditions given the fact that existing cropping intensity of 200% does not increase under irrigated conditions, the project proposals envisaged a major shift from cereals to cash crops, particularly vegetables. This shift has been moderated to some extent keeping in view the subsistence nature of farming, present level of vegetable cultivation, emphasis on growing vegetables in the State all over through an intensive Vegetable Cultivation programme and market-ability condition. The eixsting cropping pattern, the pattern envisaged in the project proposal, and

the pattern adopted in the report for economic appraisal are given in Table 1.1.2 of the Report. To illustrate the basis of modification, the cases of a few lift irrigation, tubewell and flow irrigation schemes appear worthwhile. In case of L.I.S., Kangra, the existing area under Cereals is 92.5% of the Gross Cropped Area (GCA). In the project proposal it was brought down to 67.5%. This has been increased to 72.5% in this report. Similarly, in case of Kullu L.I.S., the existing area under Cereals was brought down from 43.34% to 20.31% in the project proposals. This has been increased to 39.58% in this report for economic evaluation. So far vegetables are concerned, similar adjustments had to be made. In case of Kangra L.I. Scheme, there is no vegetable cultivation at present but 20% of the G.C.A. was proposed in the project proposals. This has been moderated to 15%. In L.I.S. Kullu, under existing conditions of 3.05% of G.C.A. is under vegetables and 45.18% under orchards. In the project proposals area under vegetable was increased from 3.05% to 26.89%. Keeping the area under orchards unchanged. This has been moderated to 9.14% under vegetables and area under orchard has been kept intacts. In case of Solan T.W. Scheme, the project proposals envisaged 22.29% of G.C.A., under vegetables against NIL area under existing conditions. This has been moderated to 13.43%. Similarly, in F.I.S., Shimla area under vegetables plus

potato has been kept at 39.72% against 49.69% proposed in the project proposals and 26.77% under existing conditions. All these will show that while objective of intensifying vegetable cultivation in the hill State has been the guiding factor in determining, crop intensities, the need for sustaining the pace of food production has not been lost sight of.

6. APPROACH TO ECONOMIC ANALYSIS

Economic Rates of Return (ERRs) for the eight projects have been calculated by estimating benefits and costs of the project using shadow prices for major outputs and inputs. The benefits of the project are essentially identified with direct primary benefits while indirect and induced effects of the project could not be incorporated due to lack of information. Similarly, only the direct costs have been considered and indirect costs including externalities and environmental impacts could not be quantified in short time available for the project and due to the fact that the individual schemes under appraisal were too small for any such meaningful analysis. Of course, a passing reference has been made in the report drawing attention towards preserving the fertility of the thin mantle of soil generally met with in hilly tarrain. The direct benefits of a project have been calculated as the value of the incremental

net farm income defined as "With project" minus "Without Project" i.e. the entire increase in net value added under "With Project" condition over that under "Without Project" condition is due to or attributable to irrigation.

Since in a developing country such as India, the prices of foodgrains and other agricultural commodities, major agricultural inputs (fertilizers, diesel oil, electricity) and components of project costs (cement, steel, unskilled labour) are "administered prices", these do not reflect their true social value or opportunity costs. Shadow prices for major outputs and inputs have been estimated as follows:

(i) Traded or tradable commodities (foodgrains, fertilizers, sugar) have been valued at c.i.f. or f.o.b. prices adjusted for the shadow exchange rate and domestic transport costs;

(ii) For the non-traded outputs (vegetables, apples) shadow prices are equated to the "consumers willingness to pay" as reflected by the market prices for these commodities;

(iii) Non-traded inputs (e.g. electricity) have been valued in terms of long-term marginal cost of supply. Cost of supply after taking into account the transmission and distribution losses.

Using these criteria, the estimated shadow prices for paddy are about 45 per cent higher than its market price while the shadow prices for wheat, barley and oilseeds are 74 per cent higher than their corresponding market prices. The estimated shadow prices for introgenous fertilizer and phosphatic fertilizers are 27 per cent and 13 per cent higher than their market prices, respectively. The estimated shadow price of electricity is almost 107 per cent higher than the tariff rate used in the tubewell and lift irrigation schemes. Given the resources and short time available for the project, it was not possible to estimate shadow wage rates for unskilled labour in each project region. A notional value of 0.4 has been used to convert the wage cost at market prices into wage cost at shadow prices. The possibilities of higher shadow wage rates have been considered through sensitivity analysis of capital costs. Since, estimation of shadow exchange rate and opportunity cost of capital were outside the scope of this project, notional values currently used in the Planning Commission for appraisal of projects have been adopted. A premium of 25 per cent on foreign exchange has been used to reflect its scarcity value i.e., a shadow price of Rs. 17.5 per U.S. dollar, as compared with the official exchange rate of Rs. 14 per U.S. dollar, The opportunity cost of capital in the Indian economy has been taken as 12 per cent. Sensitivity analysis

has been performed with respect to shadow exchange rate, capital costs, electricity price and value of output.

The results of using these shadow prices are that, except in the case of L.I.S. Kullu, the ERR at shadow prices is higher than the IRR at market prices. In Kullu, since orchards account for about 56 per cent of the total net benefit (where shadow price is considered equal to the market prices), the use of shadow prices on the benefit side does not increase the value of benefits while the use of shadow price for electricity almost doubles the O&M costs. These aspects are discussed in detail later.

7. ECONOMIC RATES OF RETURN

Economic Rates of Return or the Internal Rates of Return for all the eight projects have been calculated. One section has been devoted to each project. The IRRs for each project, one on market price and the other on shadow prices of inputs and outputs have been calculated. The results are as under:

PROJECT	IRR IN MARKET PRICE SOLUTION	IRR ON SHADOW PRICE SOLUTION
TW at Una	18.37%	26.0%
TW in Solan	15.38%	16.60%
L.I.S. in Kangra	20.32%	23.42%
L.I.S. in KULLU	11.71%	4.9%
Tank in Shimla	13.59%	21.0%
Tank in Mandi	22.9%	31.0%
F.I.S. in Mandi	13.45%	14.56%
F.I.S. in Shimla	20.3%	24.2%

It would be seen that in all cases except in case of Lift irrigation scheme in Kullu district the IRR in shadow price solution is more than that in market price solution. The details of IRR calculation in Table 3.2.4 show that (a) the net benefits increase from Rs. 10.85 lacs in market price solution to Rs. 12.78 lacs in shadow price solution; (b) O & M cost increases from Rs. 5.6 lacs to Rs. 9.94 lacs per annum; (c) it is mainly because of over 70% increase in the O & M cost that the IRR in shadow price solution is so low. This was inevitable because the project involves very high head lift consuming more electrical energy which was charged at subsidised rates in the market price solution. The real cost of energy being much more,

the value of O & M costs at shadow prices has gone up substantially. There are two lift irrigation schemes, one in Kangra involving a lift of 138.0 metres, and another in Kullu involving a lift of 151.0 metres, both having almost equal C.C.A. But, in Kangra L.I.S. the O & M cost at shadow prices is only Rs. 6.93 lacs as against Rs. 9.96 lacs in case of Kullu L.I. Scheme. This difference is mainly due to higher energy consumption in Kulu L.I.S., because the unit rates of energy are the same in both cases.

Some other factors also have caused lower value of IRR in Kullu L.I.Scheme. About 45% of G.C.A. is under horticulture which is reported to yield net annual benefits much less than that of the vegetables. Besides, the area under orchards is not available for raising more than one crop in the year. The capital cost of Kullu L.I. Scheme is also relatively higher than that of Kangra L.I. Scheme. The incidence of cost per hac. is Rs. 18,126.0 in Kullu L.I.S. as against Rs. 15,955.0 for the other L.I. Scheme. The incidence of cost in case of Kullu L.I.S will go up further if it is calculated reckoning the area under orchards as a single crop and not double crop as it has been done according to standard practices in agricultural economics.

The unit rate of Rs. 1.14 per KWH as adopted in shadow price solution could in no case be considered high because

it is almost the same as the actual cost incurred by Himachal State Electricity Board. It would not be out of place to mention here that in the Bihar Tubewell Project, 1986 (aided by the World Bank) a rate of Rs. 1.03 per unit had been adopted though the subsidised rates charged was only Re. 0.34 per unit.

The results of ERR estimation indicated that out of eight proposals under review, the following four needed to be carefully examined through sensitivity tests.

i) T.W. Scheme in Solan District
ii) L.I. Scheme in Kullu District
iii) Tank Scheme in Mandi District
iv) F.I. Scheme in Mandi District

RESULTS OF SENSITIVITY ANALYSES

Results of Sensitivity Analysis are presented in Section 6 of the Report. The conclusion drawn from the analysis as conducted has been that the L.I. Scheme in Kullu district and the T.W. Scheme in Solan district need further analysis specially with respect to level of benefits and shadow price of power. The other six schemes appear to be economically viable within expected range of uncertainties. The Tank Scheme in Shimla and F.I. Scheme in Mandi no doubt yield lower values of IRR (10.8% and 7.9% respectively when

tested for 25% reduction in gross value of output combined with 25% increase in capital cost, but since area under vegetable is not much higher than what exists under irrigated condition, there be no apprehension of fall in the value of outputs. In the case of F.I.S., Mandi the area under cash crops has also been substantially moderated for economic analysis, there should be no apprehension for 25% fall in the benefits. All the same, the F.I. Scheme, Mandi yields first 12% IRR when tested for 25% rise in capital alone. Therefore, there remains the need for closer watch on the capital cost.

The other two types of schemes are (i) the T.W. Scheme in Solan district and (ii) the L.I. Scheme in Kullu district in which use of electric power plays main role, especially in OMR costs. The IRR of T.W. S. in Solan decreases to 12% when tested for 10% decrease in net benefits, drops down to 4.4% from 16.6% when tested for 25% fall in gross value of output (GVO) but increases to 20.9% when tested for 10% increase in GVO. The ERR decreases to 14.8% (from 16.6%) in case of 33% increase in shadow price of electricity, and to 13.7% when tested for 25% increase in capital cost. Thus, this project is highly sensitive to GVO. In this scheme, the chance of 10% fall in GVO cannot be altogether ruled out because 43.43% GCA is now included under vegetables

against NIL in pre-project condition. But, even then the ERR equals the cut-off value of 12%. The L.I.S. in Kullu is the most critical case because the IRR is first 4.9% in the base case and when tested for 10% increases in the GVO, it rises to 7.0% only. As stated earlier, about 54.32% of the GCA is already vegetables (9.14%) and orchards (45%) and as such prospects of increase in GVO through increasing area under cash crops is rather bleak. However, the economics of orchards which are reported to be yielding higher value of benefits than that from vegetables and is the most dominant crops in the command of the scheme deserves further in-depth study if the decision is in favour of considering it for approval.

SOME OTHER ASPECTS OF INTEREST

Incidence of Irrigation Costs

The incidence of capital cost of tubewell scheme varies Rs. 22,780/- to Rs. 24,430/- per hectare of cultivated command area (CCA) while for the L.I.S. it varies from Rs. 31,640/- to Rs. 35,090/- per hactare. Except for F.I.S., Mandi where it is Rs. 18,120/- per hactare, in all others, the range is more or less the same as in T.W. and L.I.S. schemes. Since cropping intensity is taken as 200 per cent, the incidence cost per hactare of gross corpped area gets

reduced by one-half. Using a discount rate of 12% and 30 years life, the annualized capital costs are around Rs. 1,550/- per hactare (of GCA) for tubewell schemes and around Rs. 2,000/- to Rs. 2,200/- per hactare for lift irrigation schemes. The incidence of O & M costs at shadow prices is around Rs. 2,700/- per hactare of cropped area for tubewell projects. Thus, annual costs are of the order of Rs. 4,250/- per hactare of cropped area in tubewell schemes. In the case of L.I.S. the incidence of O & M costs at shadow prices Rs. 3,460/- per hactare for Kangra and Rs. 5,020/- per hactare for Kullu. This gives an incidence of annual costs of Rs. 5,460/- to Rs. 7,220/- per cropped hactare under lift irrigation schemes. Thus, even if only annual O & M costs have to be recovered from the farmer, the irrigation charges would have to be of the order of Rs. 3,500/- to Rs. 5,000/- per hactare for L.I. S. and Rs. 2,700/- per hactare for tubewell schemes.

REPLACEMENT LIFESPAN OF EQUIPMENT

The Project Reports estimate that the lifespan of pumping machinery will be 15 years. Accordingly there has been one replacement of machinery in a project life of 30 years. This has been adopted as such in the economic analysis. However, generally the replacement lifespan of pumping units in large size tubewells is taken as 10 years, that of the well as 10 years and that of the pumphouse and distribution chamber

as 20 years. Although taking two replacements of pumping units in the 30 years lifespan of the project may affect the ERR marginally, this factor may have to be taken into account in some projects.

INTRODUCTION

The State of Himachal Pradesh covering a vast area of 5,567,300 hectares is located in the North-West region of the country and lies in the lap of Himalayas comprising mountainous zones from low altitude of 350 metres to alpine heights of 6975 metres above msl. It extends between latitude 30°22' 44"N to 33° 12' 40"N and longtitude 75° 45' 55"E to 79° 04' 20"E. The rainfall varies from 350 mm to 3800 mm.

Due to hilly terrain, the economy of the State is predominantly agriculture. Of the total reporting area of 3215 thousand hectares in 1984-85 the net sown area was just 18 per cent and gross cropped area 31 per cent. The small and medium farmers predominate the agricultural scene with an average size of holding of 0.6 hectares. The average intensity of cropping during the year was 170.4. Maize and paddy in Kharif and Wheat in Rabi are the important cereal crops of the State accounting for almost 81 per cent of the gross cropped area.

On the basis of latitude, temperature, topography, rainfall and humidity, the State has been divided into following four agro climatic zones[1] :

1. For a detailed description of these zones, see Negi, G.C., "Development of Agriculture in Himachal Pradesh".

1. Sub-mountain and Low Hills Sub-tropical Zone;

2. Mid Hills and Sub-humid Zone;

3. High Hills Temperate Wet Zone;

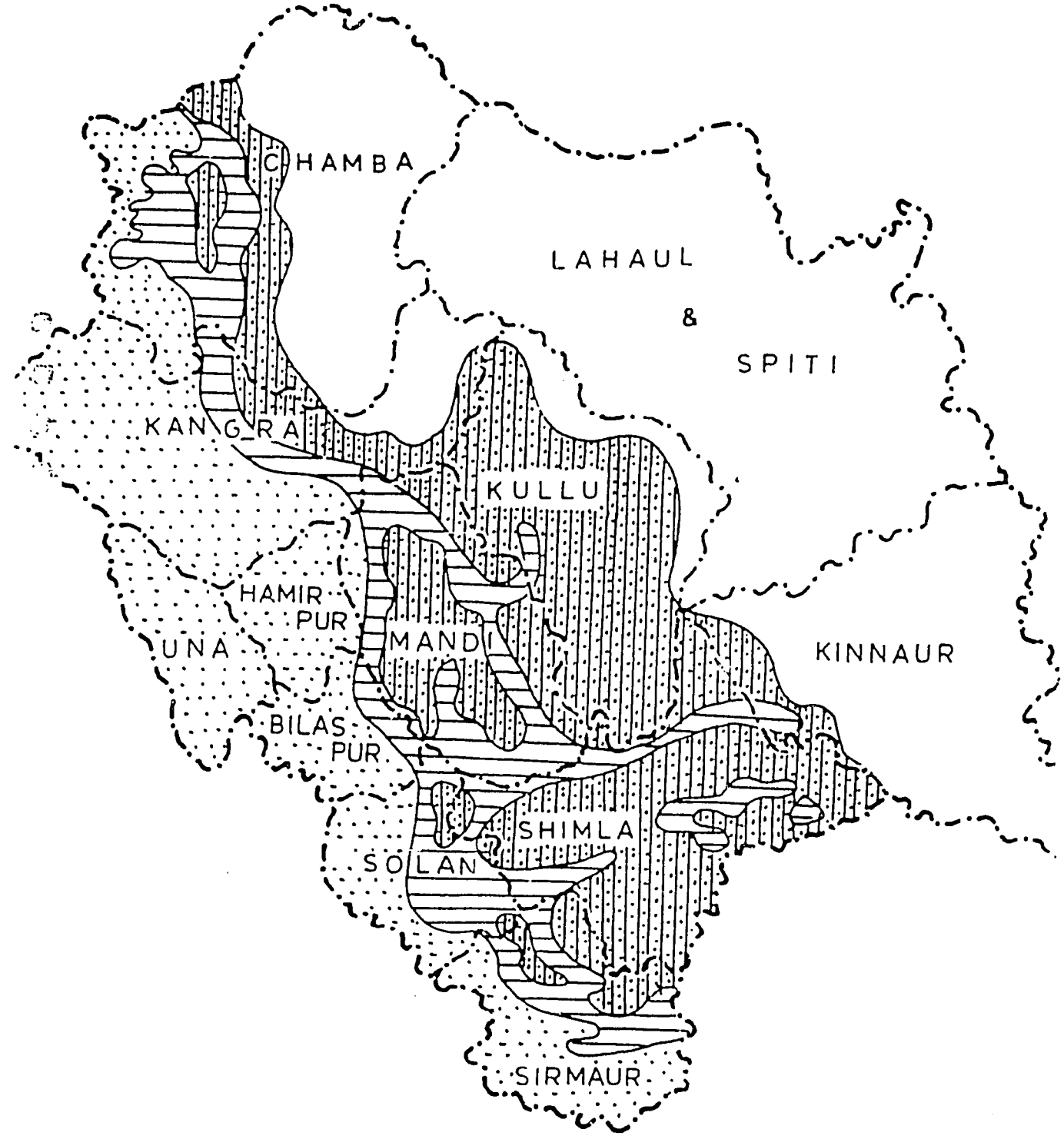
4. High Hills Temperate Dry Zone.

The broad division of the State into these zones is also depicted in the Map (attached).

Owing to peculiar agro-climatic conditions, the mountainous nature of tracks and pattern of land holding, extensive cultivation is not possible. Due to prevalence of traditional methods of cultivation, the average crop yields have been low as compared to yield levels realised in neighbouring States/areas. In 1984-85, the average yield levels realised in respect of the three important cereal crops - Maize, Rice and Wheat were 1897 kg., 1237 kg. and 696 kg per hectare. Under the given physical and climatic conditions, the only way to increase agricultural production and productivity is through intensive cultivation of available cultivated land. Among other constraints inhibiting intensive cultivation in the State is the lack of assured irrigation facilities.

During 1984-85, the net area irrigated to net sown area in the State was just 16.4 per cent while the proportion of gross area irrigated to gross area sown was slightly higher at 17.10 per cent. The proportion of area irrigated to area sown under the three important

AGRO-CLIMATIC ZONES OF HIMACHAL PRADESH



SUB-MONTANE AND LOW HILLS SUB-TROPICAL

MID HILLS SUB-HUMID

HIGH HILLS TEMPERATE WET

crops was 12.7 per cent for Maize, 30:5 per cent for Paddy and 38.5 per cent for Wheat. The State thus offers considerable scope for increasing agricultural production through provision of assured irrigation facilities.

The Government of Himachal Pradesh has been actively engaged in the development of irrigation facilities in the State. Due to peculiar conditions of the State, major and medium sources of irrigation are not practicable and minor and small scale irrigation is the only answer. Of the 95 thousand hectares of net irrigated area in the State during 1984-85, 88.2 per cent was irrigated by Kuhls, 7.6 per cent by canals, 0.8 per cent by tanks and 3.4 per cent by wells and tubewells. Upto March 1987, the State had an irrigation infrastructure of 221 Lift Irrigation Schemes, 378 Flow Irrigation Schemes and 88 Tubewells.

To supplement the efforts of the State Government in its endeavour to develop irrigation facilities in the State, the United States Agency for International Development (USAID) under its Hill Area Land and Water Development Project (HALWD) is assisting the State Government in its efforts. Under the HALWD project the USAID intends to introduce new approaches to land and water management, as well as to support State initiative in developing its land and water resources. It is a seven year effort to

develop approximately 150 minor and 2000 micro irrigation systems with emphasis on irrigation planning and design with integrated upstream development, farm levels works and user involvement and associated support of human and institutional capabilities.

This report presents detailed review of the assumptions made in eight small scale irrigation proposals submitted by USAID Project Cell in Shimla. The report deals with the following specific objectives :

1. Review of the assumptions contained in the Project Reports about the cropping pattern, crop yields, prices etc.
2. To calculate Internal Rate of Returns using the market prices as well as shadow prices for inputs and outputs.
3. To sensitivity test the IRR analysis with respect to changes in capital costs, operating and maintenance cost, output prices and changes in cropping patterns.

The eight project proposals involve four types of small irrigation systems, two each of (i) tubewell pumping system, (ii) high lift pumping system, (iii) small storage or tank system, and (iv) gravity flow stream diversion system. The details of the specific projects and their geographical locations are given in

Table 1 and are also depicted in the agro-climatic zone map. It will thus be seen that both the tubewell and one high lift irrigation schemes are located in Sub-mountain and Low Hills Sub-tropical Zone, one each of high lift, storage tank and flow irrigation are in High Hills Temperate Wet Zone and one each of tank irrigation and flow irrigation are located in Mid Hills Sub-humid Zone. In the High Hill Temperate Dry Zone none of these irrigation schemes is located.

TABLE 1 : DESCRITION OF PROJECTS UNDER REVIEW

Type of Project	Location (Village district)	CCA (Hects)	Agro-Climatic Zone
1. Tubewell (TW)	Dhakeri, Solan.	54.00	Sub-Mountain and Low Hill Sub-Tropical
	Gugwara, Una.	42.00	Sub-Mountain and Low Hill Sub-Tropical
2. High Lift Irrigation (LIS)	Bhaura, Kangra.	100.00	Sub-Mountain and Low Hill Sub-Tropical
	Neoli Therman, Kullu.	98.50	High Hills Temperate Wet
3. Storage Tank (TI)	Gurla, Shimla.	9.00	High Hills Temperate Wet
	Ropa-Buda, Mandi.	5.50	Mid Hills Sub Humid
4. Flow Irrigation (FIS)	Bari Kulwara, Mandi.	57.18	Mid Hills Sub Humid
	Nandpur, Shimla.	100.36	High Hills Temperate Wet

OUTLINE OF THE REPORT

The report is divided into six sections. In Section 1, we review the assumptions regarding the existing cropping pattern, crop yields, prices etc. as used in the project reports. This is followed by a description of the shadow price calculations and the details of sensitivity analysis carried out in the subsequent sections of the report. Sections 2 to 5 deal separately with each of the four types of irrigation schemes under review viz., Tubewell, High Lift Irrigation, Tank Irrigation and Flow Irrigation Scheme. In Section 6, we present the results of sensitivity analysis for all the four types of irrigation schemes.

SECTION 1

In this section we present a brief review of the crop parameters - cropping pattern, crop yields and output prices - as used in the various project reports and present our observations on these parameters. This is followed by a summary of the crop input cost and net benefits per hectare in the 'existing' as well as 'with project' conditions. The incidence of capital cost per hectare are presented thereafter followed by a review of IRR as presented in the project reports. The methodology of estimating shadow prices for various inputs and outputs is discussed alongwith the estimates used in this study. The parameter values chosen for sensitivity analysis are also described in this section.

1.1 Review of Crop Parameters

1.1.1 Cropping Pattern

We present in Table 1.1.1 the project-wise details of the 'existing' and 'with project' cropping pattern as given in the project reports. The comparative figures presented reveal considerable shifts in cropping pattern in all the locations with the availability of irrigation facilities. The proportion of area under 'cereal' crops (Paddy, Maize, Wheat and Barley) in all the project areas, except TW Solan, declines with the availability of irrigation while that under vegetables and potatoes

TABLE: 1.1.1 (Contd)

Crop	TI, Shimla		TI, Mandi		FIS, Mandi		FIS, Shimla		
	E	P	E	P	E	P	E	P	
ddy			15.45	26.37	21.14	9.64	7.47	7.47	
lze	27.78	22.22	34.55	18.18	28.86	24.23	11.96	4.98	
eat	38.89	27.78	50.00	44.55	43.72	8.17	18.43	19.93	
rley							7.47	2.49	
lses (Kharif)						8.03	9.96	4.98	
lses (Rabi)						8.03			
lseeds (Kharif)									
lseeds (Rabi)		11.11					17.94	10.46	
lseeds (Zaid)						8.17			
getables (Kharif)	11.11	11.11		5.45		4.02	7.65	17.62	Note-
getables (Rabi)	11.11	11.11				4.02	6.17	17.12	E - Existing
getables (Zaid)									
tato	11.11	16.67			0.87	16.06	12.95	14.95	P - Proposed
garcane									
chard									
dder (Kharif)									
dder (Rabi)				5.45	2.62	9.63			
llow					2.79				
tal	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	
A (Hec)	18.00	18.00	11.00	11.00	114.36	124.54	200.72	200.72	

TABLE 1.1.1 EXISTING (E) AND PROPOSED (P) CROPPING PATTERN (%) AS PER PROJECT REPORTS

Crop	LIS, Kangra		LIS, Kullu		TW, Solan		TW, Una	
	E	P	E	P	E	P	E	P
dy	10.00	30.00		5.08			8.04	5.47
ze	37.50	7.50	20.30	2.54	27.11	27.11	25.00	17.71
at	45.00	30.00	17.77	10.15	36.15	36.15	25.00	18.75
ley			7.60	2.54				
ses (Kharif)		2.50	5.08	5.08	13.85	4.52	7.68	7.29
ses (Rabi)	2.50		1.02	2.54	3.01	3.01	6.52	3.12
seeds (Kharif)					4.52	4.52	1.78	
seeds (Rabi)	5.00	7.50			8.44	2.40	2.14	6.25
seeds (Zaid)								3.12
etables (Kharif)		10.00	2.03	14.72		13.85		8.59
etables (Rabi)		10.00	1.02	12.17		8.44	6.34	10.16
etables (Zaid)								4.69
tato								4.69
jargane							10.00	6.25
hard			45.18	45.18				
lder (Kharif)							2.50	1.56
lder (Rabi)		2.50					5.00	2.35
llow					6.92			
tal	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
A (Hec)	200.00	200.00	197.00	197.00	108.00	108.00	84.00	96.00

(Contd.)

increases. The area under pulses and oilseeds show a mixed trend - in some locations the proportionate area under these crops increase, in some it declines while in others it remains unchanged.

In the 'cereals' group, the proportion of area under Maize and Wheat generally declines under the 'proposed' cropping pattern as compared to the 'existing' one in all the locations except in TW, Solan, where the proportionate area under these crops do not change, and FIS, Shimla, where the proportionate area under wheat slightly increases. In two of the eight locations (LIS, Kullu and FIS, Shimla) where Barley is cultivated, the proportionate area under Barley also declines. Paddy is cultivated in five of the eight project areas under the existing cropping pattern. With the availability of irrigation its cultivation extends to six locations. However, the proportionate area under Paddy in two of the five locations (TW, Una and FIS, Mandi) declines after availability of irrigation; in two others (LIS, Kangra and TI, Mandi) it increases while in FIS, Shimla the proportionate area under Paddy remains unaltered.

Pulses are currently cultivated in six of the eight project areas. With the availability of irrigation, the proportionate area under Pulses increases in LIS, Kullu and FIS, Mandi; declines in TW, Solan, TW, Una and FIS, Shimla; while in LIS, Kangra it remains unchanged. Similarly in six of the eight locations where oilseeds

are currently cultivated, the proportionate area under oilseeds increases in LIS, Kanga, TW, Una, TI, Shimla and FIS, Mandi while that in TW, Solan and FIS, Shimla it declines under 'with project' conditions.

The proportionate area under Vegetable Crops in all the project locations, except TI, Shimla, substantially increases in the 'proposed' cropping pattern over the 'existing' conditions. Even those project areas (LIS, Kangra, TW, Solan, TI, Mandi and FIS, Mandi), where vegetables are not currently cultivated, show significant shifts in favour of vegetable cultivation with the availability of irrigation. The area under Potatoes in all the four locations, where these are cultivated, is significantly higher under proposed cropping pattern as compared to the existing one.

Of the remaining crops, the proportionate area under sugarcane, which is cultivated only in TW, Una, declines after availability of irrigation, while that under orchards in LIS, Kullu remain at the same level. The cultivation of fodder crops, currently cultivated in TW, Una and FIS, Mandi, extends to two other project locations (LIS, Kangra and TI, Mandi) after the availability of irrigation.

Although the Project Reports contain very good data-base on technical and engineering assumptions, they do not provide adequate information on agroeconomic and

economic parameters used in the analysis. A perusal of the various project reports does not enable one to gather any information on the probable reasons for differentials in the magnitude of area shifts under different crops either in a specific project location or across different project locations. Even within those districts (Shimla and Mandi) where two projects (one each of TI and FIS) are located, there is no similarity in either the cropping pattern or the area shifts as a result of availability of irrigation. We assume such differentials to be the result of diffences in soil-agro-climatic donditions between specific project locations.

Due to small size of holding and poor resource base of a majority of farm households, the agriculture in the State is generally of subsistence nature, though the conducive agro-climatic conditions prevailing in the State offer considerable scope for cultivation of commercial crops such as potato, vegetables, ginger etc., specially during the off-season. With the availability of irrigation one would generally expect a decline in the area under cereal crops and increase in area under cash crops. The shifts in cropping pattern reported under 'existing' and 'with project' conditions in the project reports also broadly follow this trend. Within the cereals group, in Kharif one would expect a shift from rainfed Maize to irrigated Maize and irrigated paddy while in Rabi the expected movement of area will be

from rainfed wheat and Barley to irrigated Wheat. The magnitude of such shifts, however, will vary depending on theagro climatic conditions prevailing at the location of the project as well as on economic parameters. In addition, one of the major considerations for shift in favour of paddy cultivation is the reliability of availability of adequate water. Examining the magnitudes of area shifts suggested in the project report in the light of these observations, we broadly tend to agree with the magnitudes envisaged with minor modifications except in the case of FIS, Mandi where we expect a significantly higher proportion of area under wheat.

Apart from the above, the major shifts in cropping pattern envisaged in the project reports relate to shifts of cropping pattern in favour of vegetable crops. While cultivation of vegetables is highly remunerative in comparison to the cereal crops, in practice the scope for any large scale growth of cultivation of vegetable crops is limited on account of economic factors. In a recent study[1] carried out in the State, it was revealed that the three important constraints in the way of vegetable cultivation in Himachal Pradesh are : (i) lack of irrigation, (ii) weather fluctuations and (iii) incidence of pests. However, along with these problems the major

1. A Study of Economics of Vegetable Production in Himachal Pradesh, Ph.D. Thesis, submitted to the University of Meerut, Meerut, (1986).

constraints on expansion of area relates to vegetable marketing. A very large proportion of sampled vegetable growers cited non-availability and/or high cost of transport, lack of storage facilities, inadequate development of local markets and high variation in market prices of vegetables as the important constraining factors in increasing the area under vegetable cultivation.

Thus while non-availability of assured irrigation is one of the important factors constraining vegetable cultivation in the State, its role in bringing about any large scale changes in the cropping pattern in favour of vegetables cultivation need not be over emphasised unless corrective steps are simultaneously taken to improve other aspects of vegetable cultivation and marketing. Similar experiences have also been borne out by experiences of irrigation development in other areas/ regions in the State as well as other parts of the country For example, in the course of our field visit to the site of Tubewell Project at Dhakeri in district Solan, we visited a neighbouring village Kasroli which already has adequate irrigation facilities. On discussions with knowledgeable farmers it was revealed that though irrigation was available, only a few farmers were cultivating vegetables and that too on a very small portion of their land. The farmers attributed small size of holding, wide fluctuations in yields and prices of vegetables as the limiting factors even though from marketing point of

border of Ropar district of Punjab State and only about 50 kms. from Chandigarh.

Summing up, thus, with the availability of irrigation it is reasonable to expect a shift in favour of cultivation of more remunerative crops such as vegetables, however, in practical the magnitude of such shifts envisaged in some of the project reports may not be realised. A careful examination of the individual project reports in the light of above arguments lead us to believe that in general the expected shifts in favour of vegetable crops may be around 10 per cent of the net sown area in Kharif and around 10 to 15 per cent in Rabi, though the actual figures may vary from project to project. The expected shifts in favour of vegetable crops as reported in the project reports under LIS Kangra, TI Shimla and FIS Mandi appear to be reasonable while those envisaged under LIS Kullu, TW Shimla and Una and FIS, Shimla appear to be on higher side. We expect the area under vegetables in TW Solan to be 13.43 per cent against 22.20 per cent in the project report, in TW Una to be 17.85 per cent instead of 23.44 per cent and in FIS, Shimla to be 24.77 per cent in place of 34.74 per cent envisaged in the project report.

The details of revised cropping pattern as used by us in our subsequent IRR calculations for each of the eight project locations are shown in Appendix Tables 1.1 to 1.9 and are summarised in Table 1.1.2.

TABLE: 1.1.2 PERCENTAGE OF AREA PROPOSED (P) AND ACTUALLY USED (U) UNDER IMPORTANT CROPS

	LIS				TW				TI				FIS			
	Kangra		Kullu		Solan		Una		Shimla		Mandi		Mandi		Shimla	
	P	U	P	U	P	U	P	U	P	U	P	U	P	U	P	U
ly	30.00	32.50	5.08	10.15	-	-	5.47	6.26	-	-	26.37	25.00	9.64	9.64	7.47	9.97
e	7.50	10.00	2.54	8.12	27.11	35.96	17.71	20.24	22.22	22.22	18.18	17.25	24.23	24.23	4.98	7.47
t	30.00	30.00	10.15	17.77	36.15	36.15	18.75	21.43	27.78	27.78	44.55	42.24	8.17	23.44	19.93	24.91
- les	20.00	15.00	26.89	9.14*	22.29	13.43	23.44	17.85	22.22	22.22	5.45	10.34	8.04	8.02	31.74	24.77
to							4.69	5.36	16.66	16.66			16.06	8.03	14.95	14.95

*This comes to 16.67 per cent of the area cultivated under field crops (i.e. excluding Orchards).

Note: (P) has been taken from various project reports under 'with project' conditions.

(U) indicates the percentage area of each crop as used in this report.

For details see Appendix Tables 1.1 to 1.9

1.1.2 Crop Yields

We present in Table 1.1.3 the project-wise - crop-wise details of the 'existing' and 'with project' crop yields as given in the eight project reports. A perusal of the yield figures presented would reveal that existing crop yields in respect of major crops varied between 15 to 18 q for paddy, between 16 to 18 q for maize and between 12 to 15 q for wheat in various project locations. The 'with project' yields of these crops at all the locations has been respectively taken at 50, 30 and 30q for paddy, maize and wheat excepting Shimla where 'with project' yield of paddy has been taken at 35 quintals. In the case of vegetable crops the crop yields have been aimed at levels varying between 100 to 200 quintals per hectare. It would thus appear that the projected yield levels assumed in the project reports have been kept immune from being influenced by either the differences in agro-climatic conditions prevailing in different project locations or by the source of irrigation.

The estimates on crop yields of various crops in different districts of the State are available from the Annual Season and Crop Report (ASCR). The ASCR, however, does not distinguish between the yield levels of irrigated

TABLE: 1.3 CROP YIELDS OF IMPORTANT CROPS [illegible] AID WITH PROJECT (P) AS PER PROJECT REPORTS

Crop	TW				LIS				TI				FIS			
	Solan		Una		Kangra		Kullu		Shimla		Mandi		Mandi		Shimla	
	E	P	E	P	E	P	E	P	E	P	E	P	E	P	E	P
Paddy	-	-	15	50	18	50	-	50			18	50	18	50	18	50
Maize	18	30	18	30	18	30	16	30	16	25	18	30	18	30	20	30
Wheat	15	30	12	30	12	30	12	30	14	30	12	30	12	30	15	30
Barley							13	27							16	27
Mash	5	5.5			5	5.5								5	6	7
Gram	6	10		10										5		
Sarson	4	4.5	4	4.5	4					8					4	12
Sugarcane			275	400												
Potato									80	90			100	150	60	150
Tomato		200				200				150					70	200
Beans						150										
Capsicum						120										
Cauliflower		200				200										
Ladies Finger												150				
Onion		200												200		
Peas										120		100				80
Cabbage															55	100
Fodder			275	400		400						400	250	400		

and unirrigated crop.[1] Two types of yield estimates are however, provided - one is referred to as the 'Standard Yield' and the other is 'actually realised'. The latest ASCR relates to the year 1984-85.

For the purpose of comparison of the yield levels reported in the project reports under 'existing' conditions with the actually realised yield levels we take the higher of the 'standard' and 'actually realised' yield levels from ASCR. A comparison of the yield levels from the two sources reveal that while in general the figures tally for most of the crops, the yield levels used for wheat and pulses in the project report for 'existing' conditions are generally 30 to 35 per cent higher than actually realised in the district.

To comment on the yield levels projected for 'with project' conditions in the project reports, we consider

1. Estimates of crop yields in respect of some of the important crops are also available from the results of crop cutting experiments. Such estimates, however, also do not distinguish between the yield levels obtained in irri. and unirr. plots. Although data on State level estimates of crop-yields for a few important crops under irrigated and unirrigated conditions are available, however, their statistical validity has been questioned by the organisation publishing the data (see, 'Area and Production of Principal Crops in India', Directorate of Economics and Statistics, Ministry of Agricultural, New Delhi).

the current level of actually realised yields of different crop, the level of increase in fertiliser consumption envisaged in the reports, the yield levels prevailing under assured irrigated conditions in neighbouring areas/States, the maximum yield levels that have been achieved under experimental conditions and such other information available from other published and unpublished sources. The broad set of assumptions used by us in projecting the yield levels of various crops under 'with project' conditions differ somewhat between different crops. We describe below the procedure for arriving at a set of yield levels, for some of the important crops, under 'with project' conditions.

Paddy

The maximum currently realised yield levels reported in the State vary from 12 quintals in Una to about 25 quintals in Mandi and Shimla district. The 'with project' yield envisaged in the project reports for all the project locations is 50 quintals per hectare. In the neighbouring State of Punjab, Ludhiana is the most prosperous agricultural district. In this district, the main Kharif crop is paddy and the three year average (1983-84 to 1985-86) yield realised in the district was 54 quintals. In a recent study[1] on fertiliser consumption

1. Malik,R.P.S., "Regionwise Cropwise Fertiliser Consumption : A Study of Punjab", Agricultural Economics

it was reported that in the zone comprising Ludhiana, the average fertilizer dose acually applied to paddy by farmers was 222 kg. N, 24 Kg P, 6 Kg. K per hectare which is much higher than the one recommended by the scientists. The experimental yield level reported for this crop is 65 quintals with recommended dose of fertilizer. Thus in the actual field conditions the farmers by using much more than the recommended doses of fertilizers and cultivating under assured irrigated conditions are not able to realise the experimental yield levels.

Contrasting now the Ludhiana conditions with those prevailing in different districts of the State, it is observed that the current level of average fertiliser use on paddy in Himachal Pradesh is 22, 1, 1 which is expected to increase to the recommended level of 90, 40, 40 under 'with project' conditions. Even if assured irrigation is available and recommended levels of fertiliser dosage are used it seems rather difficult to achieve yield level of 50 quintals at all project locations. It is considered reasonable to expect that the yield levels with application of recommended doses of fertiliser under assured irrigation will increase the yield by 100 per cent over the currently prevailing yield levels. The yield levels thus worked out for different project locations vary from 25 to 50 quintals per hectare. These yield levels have been used in our subsequent analysis.

Maize

The yield level of maize reported under the 'existing' conditions in various project reports vary between 16 to 18 quintals per hectare while that proposed under 'with project' conditions in all the project locations has been taken at 30 quintals per hectare except TI Shimla where it has been taken at 25 quintals. The actually realised yield levels as per season and Crop Report vary between 17 and 22 quintals per hectare in different districts of the State. The current level of fertiliser use in Maize is 33, 5, 3 which is expected to rise to 90, 45, 30 under 'with project' conditions. Given the already fairly high levels of realised yield and the anticipated increase in fertiliser dosage with availability of irrigation, it seems reasonable to assume that the yield levels would rise to the levels as envisaged in the reports under 'with project' conditions.

Wheat

The yield level of wheat under the 'existing' conditions in various project reports have been taken between 12 and 15 quintals per hectare. The proposed yield levels under 'with project' conditions have been taken at 30 quintals in all the project locations. The actually realised yield level for wheat vary between 7 quintals in Solan to 15 quintals in Kullu. The current level of fertiliser consumption in wheat (12, 5, 3) is

expected to rise to (120, 60, 30) when irrigation is made available.

The three year average level of wheat yield realised in Ludhiana work out to about 38 quintals per hectare. The average fertiliser dosage used in Ludhiana are 109, 60, 8. The recommended yield levels as per package of practices is about 47 quintals per hectare.

A comparison of the fertiliser doses and yield levels realised and proposed in Himachal Pradesh and those actually prevailing in Ludhiana, Punjab would lead one to believe that the proposed 30 quintal/hectare yield level can be realised after the irrigation is made available. In our subsequent analysis, we therefore take yield level of 30 quintals per hectare for wheat at all locations.

Vegetables

The vegetable cultivation under the 'existing' conditions is not widespread. With the availability of irrigation, the vegetable cultivation is expected to be extended to all the project locations. The project reports do not give much information on the 'existing' yield levels of various vegetable crops prevailing in various project locations since there is either nil or very small area currently under vegetables. The data on yield levels of various vegetable crops is also not reported in any of the major statistical publications

of the State. Even the ASCR does not provide information on yield levels of various vegetable crops.

Under the defined data availability constraints, we have resorted to the study on vegetable production and marketing, referred to earlier, which provides a fairly good estimate of the yield levels of four important vegetable crops - Peas, Tomatoes, Cauliflower and Capsicum - based on a statistically randomly selected sample of vegetable cultivators. The estimated yields of these vegetable crops work out to 18, 81, 73 and 68 quintals per hectare respectively. Between 39 and 69 per cent of the sown area under these crops was irrigated and about 71 per cent of the vegetable area was fertilised. On our discussions with some knowledgeable farmers it was gathered that the yield level estimated for Peas was somewhat lower and this they attributed to unfavourable weather conditions and/or incidence of pest.

Assuming the estimated figures as representing the current level of yields obtainable in the State, under full irrigation coupled with recommended doses of fertilisers and plant protection measures one can expect the yield levels to almost double the existing levels. To correct for under-estimation of existing yield level of Peas, one can expect the yield level of Peas to increase three times this level. The yield level of Peas thus work out to 55 quintals, Tomato 150 quintals

for two tubewell projects differ considerably - it is 29.80 for TW Solan against 16.43 for Una. In the case of two LIS projects the IRR's do not differ substantially (20.31 for Kangra and 22.06 for Kullu). Of the two FIS, the IRR for Shimla project at 33.34 per cent is much higher than that of Mandi project which is 25.23 per cent. The IRR's in all the projects have been computed at market prices of inputs and outputs.

Limitations of IRR Estimates

It may be noted that the Internal Rates of Return calculated in the Project Reports are based on the following assumptions :

i. The benefits of the project are essentially identified with direct primary benefits while indirect and induced effects during the construction or operation of the project have not been included.[1] Similarly, only the direct costs have been considered and indirect costs including externalities and environmental impacts have been ignored.

ii. The direct benefits of a project have been calculated as the value of the incremental net farm income

1. For a detailed discussion of these questions as well as various aspects of Social Benefit Cost Analysis of Irrigation Projects, reference may be made to the book by Basawan Sinha and Ramesh Bhatia : Economic Appraisal of Irrigation Projects in India, Agricole Publishing Academy, New Delhi, 1982.

defined as "With Project" minus "Without Project" net farm income excluding water charges. This means that the entire increase in net value added under "With Project" condition over that under "Without Project" condition is due to or attributable to irrigation project.

iii. In calculating value of crop output as well as farm-level costs and projects costs, market prices of these commodities have been used. It is well known that in a developing country such as India, the prices of foodgrains and other agricultural products, major agricultural inputs (e.g., fertilizers) and components of project costs (e.g. cement, steel, electricity) are "administered prices" and these do not reflect their true social value or opportunity costs. Hence use of these prices for valuation of outputs and inputs does not reflect the real benefits and costs (of the project) from the viewpoint of society. This requires that benefits and costs be estimated at "shadow prices" rather than at market prices.

iv. In the case of unskilled labour, the government interventions such as 'minimum wage' legislation mean that project wage rates are higher than the opportunity cost of labour in alternative employment. In such a situation, the use of "shadow wage rate" would not only reflect the real costs of unskilled labour but would also incorporate the employment objective in the process of selection of projects. Similarly, the official exchange

rate does not reflect the true cost of using or earning (saving) foreign exchange. There is need for using a premium on foreign exchange to reflect the scarcity value of foreign currency saved as a consequence of the project or used directly or indirectly in the project.

v. The IRRs calculated in the Projects do not provide results of any sensitivity analysis with respect to plausible variations in some of the assumptions made in the valuation of benefits and costs. Since every benefit-cost analysis requires forecasting of the future behaviour of the variables which enter the stream of benefits and costs, there is an element of uncertainty in the values of IRR calculated. Sensitivity analysis may be performed with respect to values of important parameters (e.g. crops yields, output and input prices) in order to judge the robustness of the IRR values.

vi. The IRR does not give any explicit weights to the distribution of benefits among various categories of farmers. This could be done by putting a premium on benefits going to small and marginal farmers. Similarly, explicit weights could also be given to benefits going to a particular region in the State.

Indirect Benefits and Indirect Costs

Although the secondary (backward-linked and forward-linked induced) effects of an irrigation project

are quite widespread over time and space, these effects are rather difficult to quantify. In order to avoid selection of an uneconomic project on the basis of over-estimated indirect benefits, it is considered necessary to calculate the B/C ratio with only direct (primary) benefits and direct costs. The indirect effects of the project may be mentioned along with this B/C ratio or may be incorporated in another B/C ratio which takes into account both direct and indirect effects. However, due to non-availability of data, the ERR calculation in this report have been confined to direct benefits only.

Indirect costs of irrigation may include ecological damage affecting the sustainability of agriculture over time, water-logging and water-borne diseases etc. In the case of Himachal Pradesh, it is very important to understand, and quantify if possible, the likely ecological damage to the agro-eco system of hill agriculture arising out of heavy irrigation.[1] It is understood that the top soil in Himachal Pradesh farms is rather thin and it is necessary to speculate on the effects that irrigated crops such as paddy, wheat and vegetables may have on the long term sustainability of agriculture in the State. Such an analysis needs to be done for each project for a few agro-ecological climatic zones before any long term decisions

1. As discussed in Sinha and Bhatia (1982, pp. 176-178), there are conceptual problems in estimation of benefits from an irrigation project. In the absence of an international market for irrigation water, recourse is usually taken to value irrigation water indirectly i.e., in terms of the value of agricultural commodities and by products obtained from the use of water.

on irrigation projects are taken. It has not been possible to attempt any discussion on these ecological aspects in this Report on account of non-availability of any meaningful studies in the short period (four weeks) available to us.

Incremental Benefits due to Irrigation

As mentioned earlier, the IRRs calculated in the project reports, the entire increase in net value added under 'with project' conditions over that under 'without project' conditions has been attributable to the irrigation project. This may not be the case if positive interaction factors with respect to other inputs such as HYV seeds and fertilizers are taken into account. In the absence of any detailed information on water response functions at different levels of other inputs, it has not been possible to separate out the effect of irrigation water from the effects of using other inputs. This aspect has been partly covered by estimating the response of ERR to a reduction in value of output (by 10 per cent and 25 per cent) under Sensitivity Analysis.

16. Estimation of Shadow Prices

The criteria for estimation for shadow pricesfor outputs and inputs are as follows :

1. For details, see Sinha and Bhatia (1982, pp. 148-168).

i. Traded or tradable commodities have been valued at c.i.f. or f.o.b prices adjusted for the shadow exchange rate and domestic transport costs;

ii. Non-traded outputs have been valued at 'consumers' willingness to pay; and

iii. Non-traded inputs have been valued in terms of long-term marginal cost of supply.

Besides commodity shadow prices estimated as described above, notional values for shadow exchange rate, shadow price of unskilled labour and opportunity cost of capital[1] have been used. These are based on the values currently used by the Planning Commission for appraisal of projects.

Tradeable/Traded Commodities

In this category, the major commodities are Rice, Wheat, Maize, Sugar, Oilseeds, Nitrogenous, Phosphatic and Potassic fertilizers, Cement and steel. Table 1.5.1 gives details of the estimates of shadow prices for these commodities.

Major foodgrains are treated as traded commodity on the margin implying that if this project were not

1. It is considered beyond the scope of this study to actually estimate these shadow prices.

undertaken, the entire output of foodgrains would have been imported from abroad. The cost to the society of importing these commodities would depend upon :

i. the C.I.F. price of importing the commodity as projected for a future year, say 1995;

ii. the estimated shadow price of foreign exchange which would adequately reflect the opportunity cost of using this scarce resources; and

iii. the transport cost of moving these foodgrains from the port to the consuming centre including storage costs and losses. (Actually, it would be the difference in transport cost of moving foodgrains from a surplus state in the absence of the project).

Table 1.5.1 shows that rice (paddy), wheat, maize, nitrogenous fertilisers, phosphatic fertilisers and potassic fertilisers have been considered importable at the margin.

Sugar has been considered a potential export and the shadow price for sugarcane is based on this assumption. The c.i.f. prices for imports are based on the projected prices (for 1955) as estimated by the World

Bank in terms of constant (1986) dollars. It is assumed that these prices will prevail over the 30 year life of the project. It is further assumed that changes in prices of outputs and inputs will cancel out the effects of each other and the results of ERR calculations will not be influenced in any particular direction.

For example, for wheat, the estimated f.o.b. price is US $ 135 at the source of supply to which US $ 25 is added to account for international shipping and handling. This estimated c.i.f. price of US $ 160 is converted into rupees using a 25 per cent premium on foreign exchange over an official exchange rate of Rs. 14 per US $. Thus, at the estimated shadow price of foreign exchange at Rs. 17.5 per cent US $, the c.i.f. price for wheat is Rs. 2800. To this, we have added Rs. 680 per ton to account for domestic transport and processing cost.[1] The resulting estimate of shadow price at the farm is Rs. 3480 per ton or Rs. 3.48 per kg. The corresponding estimate for paddy is Rs. 3600 per tonne and for Maize is Rs. 2780 per tonne. The shadow prices for pulses and oilseeds have been derived by multiplying their market prices by the same ratio as that estimated for the shadow price of wheat to its market price.

1. This would depend upon the net effect on transport of foodgrains under the conditions of 'with' and 'without' project.

TABLE: 1.5.1 CALCULATION OF SHADOW PRICES FOR MAJOR OUTPUTS & INPUTS

	OUTPUT				INPUTS		
	Paddy	Wheat	Maize	Sugarcane	Nitrogen	Phosphate	Potash
A. Import Price (1995) US $/ton	141.1	135	95	44	361	315	138
B. International Shipping and Handling U.S. $/ton	7.1	25	25	-	33	33	33
C. CIF/FOB Price U.S. $/ton	149	160	120	44	394	348	171
D. CIF/FOB Price (assuming a Foreign exchange Premium of 25% and an official exchange rate of Rs.14 per US $)	2607	2800	2100		6895	6090	2992
E. Transport and Processing cost in Domestic Market	453	680	680		750	750	600
F. Shadow price at the Farm (Rs./ton)	3060	3480	2780		7645	6840	3592

Notes: (1) Import prices are from IBRD, 1987.
(2) The Price of Paddy is taken as 2/3 of the price of Rice.
(3) Price of Sugarcane has been calculated assuming that a ton of sugarcane yields 84.6 Kgs of sugar. It has been further assumed that the bagasse available from sugarcane compensates for the manufacturing costs of sugar. Price of sugar $ 524/ton. It is assumed that India is a net importer of foodgrains and a net exporter of sugar.
(4) Price of Urea (45%N) for 1995 is estimated $ 166/ton, while the price of TSP (45%P) is estimated $ 145/ton, and price of muriate of Potash (MOP, 60%K) is estimated $ 83/ton.

The shadow price for nitrogenous fertilizers is estimated from the c.i.f. price of US $ 394 per tonne of nitrogen. The equivalent price (c.i.f) in rupees is Rs. 6895 after taking a premium of 25 per cent for foreign exchange. The shadow price at the farm level is estimated at Rs. 7.645 per kg. of N. The corresponding prices for other fertilizers are Rs. 6.84 per kg. of $P_2 O_5$ and Rs. 3.592 per kg. of K.

The shadow prices for cement and steel have been estimated by giving a premium of 25 per cent on market prices assuming that under conditions of decontrolled system of market prices, these are equal to c.i.f or f.o.b. prices as the case may be.

Shadow Prices for Non-tradeable Outputs

The major non-tradeable output commodities are vegetables such as tomatoes, beans, peas, cauliflower etc. For these commodities, the shadow prices are to be equated to the 'consumers' willingness to pay. Since markets in these commodities are not controlled, free market prices, in fact, reflect the consumers' willingness to pay. Hence, we have used market prices to reflect shadow prices for vegetables.

Shadow Price of Electricity

In four projects where electricity is used for lifting/pumping water, the cost of electricity-use accounts

for a major share of operation and maintenance (O&M) costs. In all these projects, electricity has been priced at Rs. 0.55 per kwh. It is well known that the price of electricity, particularly in rural areas, is subsidized on account of socio-economic objectives of promoting agricultural development and providing electricity for lighting at prices which people can afford. According to a Planning Commission Report (1988)[1], the estimated losses of eleven[2] State Electricity Boards (excluding Himachal Pradesh) on account of supply of electricity to the agricultural sector for 1987-88 were Rs. 21 billion (approximately US $ 1.5 billion).

In Himachal Pradesh, the State Electricity Board incurred a loss of Rs. 435 million in 1987-88 since the estimated revenue receipts at Rs. 0.64 per kwh were around 60 per cent of the average cost of operation estimated at Rs. 1.14 per kwh. It may be noted that unit cost of operation in Himachal Pradesh is the third-highest (after Assam and Bihar) in the country. This is mainly on account of O&M costs and high interest charges.

1. Planning Commission : Annual Report on the Working of State Electricity Boards and Electricity Departments, Power and Energy Division, Government of India, April 1988 (Annexure 16).

2. These data relate to these States where agricultural load forms a significant proportion of the total. Since electricity consumption for agriculture is only 3 per cent of the total in Himachal Pradesh, these details are not given.

Thus, it may be seen that the price of electricity (Rs. 0.55 per kwh) used in the four projects evaluated here is rather low; almost one-half of the average cost of generation. This would be much lower compared with the actual cost of supplying power to the rural areas due to high transmission and distribution losses (estimated at 22 per cent in the case of Himachal Pradesh). However, it was not possible to adjust the unit cost of generation for distribution losses on account of non-availability of information. Since agriculture accounts only 3 per cent of the total electricity consumption, this adjustment is not considered necessary. Thus, it is assumed that the unit cost of supply of electricity (Rs. 1.14/kwh sold which takes into account the transmission and distribution losses) reflects the economic cost of providing electricity to rural areas. Thus, we have taken Rs. 1.14 as the shadow price of electricity used in the four irrigation projects being analysed here.[1]

In order to reflect the long term trends (1995 and beyond) in shadow price of electricity, we need to

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1. In the short-run, it may be tempting to equate the shadow price of electricity to its marginal product in alternative use in the context of overall power shortages. Even here, if the users find it economic to invest in captive power generation, the shadow price would equal the cost of diesel generation which is estimated to be at least Rs. 2 per kwh. However, this could not be taken as the long term prices.

while in the case of wheat the prices reported in the ASCR and project reports tally. For the p rpose of analysis we have used a price of Rs. 210 for paddy, Rs. 157 for maize and Rs. 200 for wheat. Similar procedures have been used for deriving the prices of other crops.

In the case of vegetable crops, the ASCR does not give any price data. For obtaining the estimates of farm gate prices of vegetables we use the estimates provided by the vegetable production and marketing study referred to above. According to the estimates provided by this study the prices of Peas prevailing were of the order of Rs. 292 per quintal, of Tomato Rs. 252 per quintal, of Cauliflower Rs. 300 and Capsicum Rs. 197 per quintal. The prices of Peas, Tomato and Cauliflower as used in the project reports are Rs. 150, Rs. 200 and Rs. 200 per quintal respectively. The prices of the above vegetable crops used in the project report are thus lower than actually realised by the farmers. We have therefore used the higher of the two sets of prices. For other vegetable crops for which estimates of prices from any other source were not available we have used the prices given in the project reports. The set of market prices used in our subsequent analysis are presented in Table 1.1.4.

1.2 Input Costs and Farm Returns

Table 1.2.1 gives the per hectare value of gross

and Cauliflower and Capsicum at 140 quintals each. These yield levels thus have been taken to represent the 'with project' yields in our subsequent analysis.

The set of yield levels for various crops as used in our subsequent analysis are presented in Appendix Tables 1.2 to 1.8.

1.1.3 Prices of Crop Output

We present in Appendix Table 1.10 a summary of prices of main products of different crops as used in the various project reports. It may be mentioned that the prices used under 'existing' as well as 'with project' conditions are the same. A perusal of the figures presented would reveal that for all the crops in all the project locations the same prices have been used, exception being paddy price in Kullu and paddy and barley price in Shimla. It is thus implicit that quality of the product does not differ as between different project locations and uniform prices prevail all over the State.

The ASCR referred to above also provides information on farm gate prices of various important crops in the State. A comparison of the prices used in the project reports with those reported in the ASCR would reveal that against a price of Rs. 212 for paddy reported in the ASCR the price used in the project report is Rs. 150. In the case of Maize prevailing farm gate price was around Rs. 160 as against Rs. 180 used in the project report

TABLE 1.1.4 MARKET PRICES OF MAIN PRODUCTS OF VARIOUS CROPS

Crop	As used Prices/Quintal	As per Project Report Price/quintel
Paddy	210	150
Wheat	200	200
Maize	157	180
Barley	168	160-175
Mash	600	600
Gram	600	450
Garson	600	600
Sugarcane	20	
Potato	100	100
Tomato	252	200
Beans	150	150
Capsicum	197	-
Cabbage	225	100
Peas	292	150
Cauliflower	300	200
Onion	80	80
Ladies finger	100	100
Carrot	80	80
Radish	80	80
Turnip	80	80
Mix Vegetables	120	120
Berseem	15	15

TABLE: 1.2.1 INPUT COSTS AND RETURNS PER HA OF GCA AS PER PROJECT REPORTS

oject	Existing				With Project				Per Cent Change			
	G.R	I.C.	N.R.	G.R/I.C	G.R.	I.C.	N.R.	GR/IC	GR	IC	NR	GR/IC
olan	3111	1634	1477	1.90	11083	3293	7790	3.36	256	102	427	77
na	3840	1925	1915	1.99	9618	3387	6231	2.84	150	76	225	43
Kangra	3149	1871	1278	1.68	10900	3576	7324	3.05	246	91	473	82
Kullu	3104*	1703*	1401*	1.82*	12221*	3311*	8910*	3.69*	294	94	536	103
Shimla	4747	2692	2055	1.76	9497	3806	5691	2.49	100	41	177	41
Mandi	3162	2011	1151	1.57	7643	3314	4329	2.30	142	65	276	46
Mandi	3213	1929	1284	1.67	7901	3722	4179	2.12	146	93	225	27
Shimla	4306	2180	2126	1.98	12226	3576	8650	3.42	184	64	307	73

Notes: G.R. - Gross Returns
I.C. - Input Cost
N.R. - Net Returns
* - Orchard Excluded

returns, input cost and net returns under the 'existing' as well as 'with project' conditions as given in the project reports. It will be seen that under the 'existing' conditions the gross returns, input cost and net returns per hectare in Shimla district (TI, FIS) are higher than the other project locations. After the availability of irrigation, the gross returns increase substantially in all the project locations. The increases in gross returns under TW and LIS are generally higher than that observed in TI and FIS. The increases in gross returns in TW Solan and Una are of the order of 256 and 150 per cent; in LIS Kangra and Kullu of 246 and 294 per cent while in TI Shimla and Mandi 100 and 142 per cent and in FIS Mandi and Shimla 146 and 184 per cent respectively.

After the availability of irrigation the input cost per hectare does not differ as between different project locations. The increase in input cost over the existing level in TW and LIS project locations is, however, generally higher than that under TI and FIS. The magnitude of increase in input cost in the former two schemes is on an average around 90 per cent as compared to about 65 per cent increase in the latter two schemes.

The net returns also increase substantially after the availability of irrigation. The pattern of net returns realised reveal that net returns are generally

higher in TW and LIS schemes as compared to TI and FIS, except FIS Shimla where net returns compare favourably with those realised in LIS. The net returns in TW and LIS scheme vary between Rs. 6231 to Rs.8910 per hectare in comparison to Rs. 4179 to Rs. 5691 realised for TI and FIS (excepting FIS, Shimla).

The table also gives the output/input ratios for all the eight project locations. In the case of output/ input ratios also the same pattern holds - the output/ input ratios are generally higher under TW and LIS as compared to TI and FIS, excluding FIS, Shimla. The returns per unit of input vary between 2.84 to 3.36 under TW and LIS as compared to 2.12 to 2.49 under TI and FIS (excluding FIS, Shimla).

It will thus be seen that gross return, net returns and output-input ratios under TW and LIS projects is generally higher than that under TI and FIS. Given that the crop yields expected after availability of irrigation, level of input use for different crops and prices prevailing for different inputs and outputs across different project locations are almost uniform, the differences in benefits of irrigation across different projects could be attributed to the differences in cropping pattern. While the area under cereal crops under the 'with project' conditions do not differ significantly across projects, the area under vegetables differ substantially. While under all the LIS and TW projects around 20 per cent of

vegetable cultivation, in TI Shimla about 20 per cent, in TI Mandi about 5 per cent, FIS Mandi about 8 per cent and FIS Shimla around 35 per cent of the area is proposed to be cultivated with vegetables.

1.3 Incidence of Capital Cost

Table 1.3.1 gives a summary of the incidence of capital cost per hectare of CCA in each of the project locations. It will be seen that the capital cost per hectare of CCA under LIS is higher than any other type of scheme being considered. The per hectare capital cost of LIS Kangra and Kullu respectively is of the order of Rs. 31640 and Rs. 35090 respectively. The cost per hectare under TW and TI is almost the same varying between Rs. 22000 and Rs. 25000 per hectare. While the per hectare cost under FIS Mandi is the lowest of all the schemes at Rs. 18120 that of FIS, Shimla compare favourably with LIS at Rs. 31290 per hectare.

We present in Table 1.3.2 the share of pumping equipment and power supply in the total capital cost at market prices. It will be seen that in TW projects at Solan and Una, the share of pumping equipment work out to about 14 per cent while that in LIS Kangra and Kullu it is 18 per cent. We also present in Table 1.3.3 abstract of capital cost of supplying power to the four projects.

TABLE: 1·3·1 INCIDENCE OF CAPITAL COST PER HECTARE

Project	Total Capital Cost (000)	CCA (Hectares)	Capital Cost/CCA (000)
TW, Solan	1230	54.00	22.78
TW, Una	1026	42.00	24.43
LIS, Kangra	3164	100.00	31.64
LIS, Kullu	3456	98.50	35.09
TI, Shimla	229	9.00	25.44
TI, Mandi	132	5.50	24.00
FIS, Mandi	1036	57.18	18.12
FIS, Shimla	3140	100.36	31.29

Table 1.3.2 : Shares of Power Supply and Pumping Equipment Costs in Total Capital Cost (At Market Prices)

(Rs' 000)

Item	TW Solan	TW Una	LIS Kangra	LIS Kullu
1. Pumping Equipment	199 (13)	140 (14)	604 (18)	640 (18)
2. Supply of Power	81 (5)	100 (10)	618 (20)	674 (20)
3. Total Capital cost	1508 (100)	1026 (100)	3163 (100)	3456 (100)

Note : Figures in Parentheses are Percentage to Total Capital Cost.

Table : 1.3.3 : Abstract of Capital Cost of Supply in Power (S.O.P.)

Unit - Rs

Item	TW Solan	TW Una	LIS Kandra	LIS Kullu
Cost of HT Line	15930	45385	93945	100000
Cost of Sub Station/ Transformer	44900	33015	279535	400000
Cost of Service Cable	4000		29680	125000
Cost of Street Light/ Telephone Line	-	-	55355	
Sub Total	64830	78400	458515	625000
Departmental Charges (@ 25 per cent)	16208	19600	114628	-
Other charges	-	425	-	-
Total	81038	98425	573143	625000

1.4 Review of IRR Estimated in Project Reports

Table 1.4.1 gives the transition coefficients assumed in the various project reports. The table also gives the computed value of IRR as per the project reports. The transition coefficients assumed for different projects differ, but in a majority of the projects the full benefits are realised in six years. In the case of TW projects at Solan and Una, against the 'zero' transition coefficient used for year 1, we expect a coefficient of 0.4 which we expect to rise to 0.6 in second year, 0.8 in third year, 0.9 in fourth year and full benefits are expected in the fifth year. On the contrary, in the case of LIS projects we expect the benefits to start a little later. In the LIS Kangra and Kullu, the project reports respectively assume a transition coefficient of 0.24 and 0.48 in the first and 0.64 and 0.68 in the second year. We, however, assume a 'zero' transition coefficient for the first year and 0.3 for the second year in both the projects. The transition coefficient assumed for third, fourth and fifth years respectively have been taken at 0.5, 0.7 and 0.9 and the full benefits are ssumed to be realised in the sixth year.

The project reports do not give figures of calculated IRR for Tank Irrigation Schemes at Shimla and Mandi. The IRR of other projects vary between 16.43 per cent for TW Una and 33.34 per cent for FIS, Shimla. The IRR

TABLE: 1.4.1 TRANSITION COEFFICIENTS AND IRR AS PER PROJECT REPORTS

Project	Transition Coefficients Year 1	2	3	4	5	6	7	IRR (%)
TW Solan	0	0.60	0.70	0.80	0.90	1.00	-	29.80
TW Una	-	0.12	0.62	0.72	0.82	0.92	1.00	16.43
LIS Kangra	0.24	0.64	0.74	0.84	1.00	1.00		20.31
LIS Kullu	0.48	0.68	0.78	0.88	0.98	1.00		22.06
TI Shimla								
TI Mandi								
FIS Mandi	0.30	0.65	0.75	0.85	0.95	1.00		25.23
FIS Shimla	0.48	0.83	0.88	0.93	0.98	1.00		33.34

project the increases (in real terms) in the cost of capital, cost of fuels and O&M. According to the Planning Commission data, the unit cost of operation in Himachal Pradesh, which was Rs. 0.59 per kwh in 1980-81, increased to Rs. 1.14 per kwh in 1987-88 an increase of 94 per cent over seven years. This increase of 94 per cent is in current prices and contains, partly, the influence of inflation. Since, on account of hydro-power, fuel costs in Himachal Pradesh do not increase, a major part of the increase may reflect real cost increases. In the absence of any information on this, we have taken two levels of shadow prices of electricity in our sensitivity analysis : (i) 33 per cent increase in constant (1988) prices as well as (ii) 100 per cent increase in constant (1988) prices. It is expected that this range will reflect the two extremes of likely price changes over time.

Shadow Price of Foreign Exchange

A number of methodologies have been proposed for estimating the shadow price of foreign exchange. These include use of economy-wise programming models, estimation of Domestic Resource Costs and average rate of tariff etc. It is outside the scope of this study to estimate a range of values for shadow price of foreign exchange. Hence, a notional figure of 25 per cent premium implying Rs. 17.5 per US $ has been used in base calculations. This is the figure which is being used by the

Planning Commission in evaluating projects. We have also used a figure of 50 per cent premium on foreign exchange (Rs. 21 for US $) in one of the sensitivity analysis.

Shadow Price for Unskilled Labour

The estimation of shadow price of unskilled labour requires detailed information on opportunity cost of labour in alternative employment, premium on savings and cost of migration etc. Such data for different project regions were not available.[1] Hence, a notional ratio of 0.4 has been applied to the estimated cost of unskilled labour at market prices to derive the estimate for wage costs at shadow prices. This ratio has been applied to the components of unskilled labour in capital costs of each project, O&M costs and unskilled hired labour component of farm level costs. The sensitivity analysis with respect to shadow wage rate has been attempted indirectly through sensitivity analysis in capital costs and net benefits. Since unskilled labour component accounts for 6 to 22 per cent of the project capital costs, it was not considered necessary to do separate sensitivity analysis with respect to shadow wage rate.

Estimation of Economic Rate of Return

The shadow prices of output and inputs (for farm

1. For a detailed methodology for calculation of shadow wage rate and estimates for another region, see Sinha and Bhatia, 1987, p. 161.

level costs) are used to estimated annual net value of benefits due to irrigation. These annual benefits, combined with transition coefficients discussed earlier, give estimated values of benefits for the first six to seven years. It is assumed that constant annual benefits will be available for the remaining period of the project life (i.e., upto 30 years). On the cost side, capital costs are incurred in the first two or three years while in four projects, pumping machinery is replaced after 15 years. Operation and Maintenance costs are treated as constant over the life of the project except in the case of electricity charges which vary with level of output in the first five years. The present values of stream of benefits and costs are calculated for at varying discount rates. In most cases, to begin with,net present value (NPV)* is calculated for 15 per cent discount rate. This rate is varied parametrically to arrive at that rate of discount at which NPV is zero. This is the estimate of Economic Rate of Return. For the sake of comparison, values of Internal Rate of Return (IRR) using market prices have also been calculated and displayed alongwith ERRS.

* Net Present Value (NPV = P(B) - P(C) - P(I)

where,

P(B) is present value of benefits
P(C) is present value of O&M costs, and
P(I) is present value of capital costs.

Shadow Price Multipliers for Major Outputs and Inputs

Table 1.5.2 brings together the estimated values of shadow price for major outputs and inputs. The shadow price multipliers (ratio of shadow price to market price) are also given. The multiplier for paddy is 1.46 while for wheat and maize, the multipliers are 1.74 and 1.77 respectively. The multipliers for fertilizers are between 1.13 and 1.27.

1.6 Sensitivity Analysis

Since crop yields, output prices and input prices cannot be forecast with accuracy, it becomes important to study the effects of variations in these parameter values. We have carried out the following Sensitivity Analysis :

i. Economic Rate of Return assuming 50 per cent premium on foreign exchange;

ii. Changes in O&M costs in particular 33 per cent and 100 per cent increase in shadow price of electricity;

iii. Changes in capital cost assuming : (a) that the supply of power will require HT line for a distance which is three times the distance taken in the project, and (b) a 25 per cent increase in total capital cost;

TABLE 1.5.2 ESTIMATES OF SHADOW PRICE AND IMPLIED MULTIPLIERS FOR MAJOR OUTPUTS AND INPUTS

(Rs. per Quintal (100 kg)

	Market Price	Shadow Price	Shadow Price Multiplier
1	2	3	3÷2
OUTPUTS			
Paddy	210	306	1.46
Wheat	200	348	1.74
Maize	157	278	1.77
Barley	168	292	1.74
Oilseed	600	1044	1.74
Pulses (Mash)	600	1044	1.74
Gram	600	1044	1.74
Berseem	15	15	1.00
Mustard	600	1044	1.74
Sugarcane	20	52	2.60
Tomato	252	252	1.00
Beans	150	150	1.00
Capsicum	197	197	1.00
Cabbage	225	225	1.00
Peas	292	292	1.00
Cauliflower	300	300	1.00
Onion	80	80	1.00
Vegetables (Ladies Finger)	100	100	1.00
Carrot	80	80	1.00
Turnip	80	80	1.00
Potato	100	100	1.00
Veg Mix	120	120	1.00

	Market Price	Shadow Price	Shadow Price Multiplier
	4	5	5 ÷ 4
INPUTS (Rs. per Kg of Nutrient)			
Nitrogenous Fertilizer	6	7.645	1.27
Phosphatic Fertilizer	6	6.8	1.13
Potassic Fertilizer	3	3.59	1.20
Electricity (Rs/Kwh)	0.55	1.14	2.07

Table 1.5.3 : A Comparison of Net Benefits, Capital Costs and O and M Costs of Eight Projects (At Shadow Prices)

Items	Units	Twin Solan	Twin Una	LIS in Kangra	LIS in Kullu	TI in Simla	TI in Mandi	FIS Simla	FIS Mandi
G C A	Ha	54	42	100	98.50	9	5.50	100.36	57.18
S C A	Ha	109	84	200	197	18	11.60	200.72	124.54
Net benefits	'000	581	54	1738	1278	60	62	928	194
Net benefits per hectare	Rs	5380	6430	8690	6487 (16494)	3330	5340	4400	1560
Capital Cost	Rs'000	1540	1007	3187	3561	225	135	3011	974
Capital Cost per hectare	Rs	14259	11984	15935	18076	12500	11638	150001	7821
O and M Cost	Rs'000	288	227	693	994	8	5.20	75	21
O and M cost per hectare	Rs	2670	2700	3470	5050	440	450	360	170
Electricity cost per hectare	Rs	2,150	2,150	2,800	4,370	NA	NA	NA	NA
Other O and M cost per hectare	Rs	520	550	670	680	NA	NA	NA	NA

NA - Not available

Notes : 1. Per ha benefits and costs have been calculated using in GCA.

2. For Kullu, figure in bracket shows the net benefit per hectare per net area than Command area.

Source : As in Section 3,4,5,6.

iv. Changes in value of output by : (a) reducing gross value of output by 25 per cent and 10 per cent, and (b) reducing the output of wheat to reflect non-availability of power or non-availability of water during November, which is the month of peak water requirements;

v. Increase in capital cost (by 25 per cent) coupled with decrease in gross value of output (by 10 per cent, 25 per cent); and

vi. Increase in gross value of output (by 10 per cent and 25 per cent) along with a 100 per cent increase in shadow price of electricity.

SECTION 2

2.1 Economic Rate of Return (ERR) for the Tubewell Project in Solan

In this section we present the results of the estimates of Economic Rate of Return (ERR), using the shadow prices discussed earlier, for the tubewell project at Dhakeri in tehsil Nalagarh of Solan district.

2.1.1 Estimates of Benefits

Table 2.2.1 presents details of Net Value of Benefits for the irrigation project which are taken as equal to the economic value of the incremental net farm income defined as With Irrigation Project (WIP) minus Without Irrigation Project (WOP). Net farm income is defined here as the difference between Gross Value of Produce (Crop output plus by product) and Farm Level Costs (excluding irrigation charges, taxes etc.). Under conditions of Without Irrigation gross value of output is estimated at Rs. 0.326 million, about 90 per cent of which is the value of crop output, using market prices. The estimated value of Farm Level Costs is Rs. 0.177 million giving an estimate of Rs. 0.149 million as the Net Value of Produce at Market Prices. The details of crop-wise area, yield, prices, input costs are given in the Appendix Tables 2.1 to 2.8. At shadow prices, gross

TABLE 2.1.1 ESTIMATES OF NET VALUE OF BENEFITS WITHOUT AND WITH IRRIGATION FOR TUBEWELL PROJECT IN SOLAN

	WITHOUT IRRIGATION(X)		WITH IRRIGATION		DIFFERENCE (1 - X)	
	At Market Prices	At Shadow Prices	At Market Prices	At Shadow Prices	At Market Prices	At Shadow Prices
A. Gross Value of Agri. Prod.						
Value of Crop Output	290	507	867	1229		
Value of By Prod.	36	36	72	72		
Sub Total	326	543	939	1301		
B. Costs of Cultivation for Farm Level Costs						
Seeds	19	19	23	23		
Human Labour	50	22	76	33		
Manures & Fertilisers	58	62	183	206		
Bullock Labour	48	48	59	59		
Inc./Pesti.	2	2	9	9		
Sub Total	177	151	350	327		
Net Value Produced (A - B)	149	392	589	974	440	582

Notes: 1. For details see Appendix Tables 2.1 to 2.8.

value of crop output is considerably higher at Rs. 0.5 million while the Farm Level Costs are lower (by about 10 per cent on account of shadow price of labour). This gives an estimate of Rs. 0.390 for the Net Value of Produce at Shadow Prices.

The gross value of agricultural output under conditions of "With Irrigation" is Rs. 1.301 million using shadow prices. The Farm Level Costs are estimated at Rs. 0.33 million giving an estimate of Net Value of Produce at Rs. 0.97 million. Thus, the estimated Net Value of Benefit is Rs. 0.581 million (Rs. 0.971 - Rs. 0.390 million).

As discussed earlier, this is taken as the estimate of the direct benefit due to or arising as a result of the proposed irrigation project. This gives a net value of benefit of Rs. 5380 per ha of gross cropped area when outputs and inputs are valued at shadow prices.

Project Capital Costs

Table 2.1.2 gives detailed estimates of various components of the project capital costs in terms of major commodities, machinery and unskilled labour. Cement and Steel, two items where shadow prices are estimated to be higher than market prices account for about one-third of the total costs. Supply of electric power (i.e. HT line and transformer) account for Rs. 81000 which is only 5 per

TABLE 2•1•2 PROJECT CAPITAL COSTS FOR TUBEWELL PROJECT IN SOLAN

	Cost at Market Prices	Multiplier for Shadow Prices	Cost at Shadow Prices
Cement	230	1•25	288
Steel	256	1•25	320
Machinery	261	1•00	261
Unskilled Labour	150	0•40	60
Admin charges	170	1•00	170
Others	441	1•00	441
Total	1508		1540

193

cent of the total cost. Pumping machinery, at Rs. 199000 accounts for 13 per cent of the total. Unskilled labour cost is about 10 per cent of the total.which reduces to around 4 per cent when shadow price of unskilled labour is used. The costs of cement and steel increase to around Rs. 0.6 million when 25 premium is used to reflect the premium on foreign exchange. Thus, on balance, the estimated project capital cost is taken as Rs. 1.545 million whc;h is equal to Rs. 14300 per ha of gross cropped area. Sensitivity analysis has been done for (i) 50 per cent premium on foreign exchange which will raise the shadow price of cement and steel and (ii) by increasing the distance (from 0.38 km to 1.0 km) for which the HT line is required. These results are given later.

Operation and Maintenance (O&M) Costs

The estimated values of different components of O&M costs are given in Table 2.1.3. At market prices, electricity accounts for about two-thirds of the O&M costs. As discussed earlier (Section 1.5), the shadow price of electricity is estimated as Rs. 1.138 per kwh giving a shadow price multiplier of 2.07 (since the market price is Rs. 0.55/kwh). Maintenance charges for civil works, rising main and pumping machinery are about 20 per cent of the total. Establishment charges are estimated at Rs. 25000 per annum. It is assumed that an average coefficient of 0.8 will reflect the share of unskilled labour

TABLE 2.1.3 OPERATING AND MAINTENANCE COSTS FOR TUBEWELL PROJECT IN SOLAN

(Rs. Thousands/Year)

	Cost at Market Prices	Shadow Price Multiplier	Cost at Shadow Prices
1. Electricity			
- Demand charges	13	-	-
- Electricity charges @ Rs.0.55/ Kwh assuming 2906 hours/year	99	-	-
	112	2.07	232
2. Maintenance Charges			
- Civil works @ 2%	5	1.00	5
- Rising main & distribution @ 3.5% on Rs.5.1 lakhs	18	1.00	18
- Pumping Machinery @ 6.5% on Rs.2 lakhs	13	1.00	13
3. Establishment Charges	25	0.80	20
	173		288

Source: Project Report

(Chowkidar, lamporder etc.) in the establishment charges. The estimated O&M costs, at shadow prices, are Rs. 288000 per annum or Rs.2667 per ha.

Estimate of ERR

Table 2.1.4 brings together the estimated values of benefits and costs for calculating ERR. At market prices, the IRR is calculated at 15.375 per cent. It may be noted that annual net benefit are distributed over the first four years according to transition coefficient discussed earlier. It is further assumed (as in the project report) that the entire pumping machinery costing Rs. 199000 (minus Rs. 20000 received as scrap value) is incurred again in the year 16. Since the life of the project is taken as 30 years, annual benefits as received earlier, continue to be available upto the year 30. We have accepted this assumption even though some other components of the project (rising main, channels etc.) may also be so damaged as to reduce project life or require major maintenance expenditures.

The present value of benefits at shadow prices is Rs. 3.227 million while the present value (PV) of O&M costs is Rs. 1.66 million. With the PV of project capital cost at Rs. 1.42 million, the Net Present Value (NPV) at 15 per cent discount rate is Rs. 0.146 million. The estimated value of ERR at shadow prices is 16.6 per cent which is higher than the estimated rate of 12 per cent

TABLE 2.1.4 CALCULATION OF BENEFIT COST RATIO FOR TUBEWELL PROJECT IN SOLAN AT MARKET PRICES (M.P) AND SHADOW PRICES (S.P)

(Rs. in thousand)

Year	Discount Factor at 15% Discount Rate	Net Benefit		O & M		Project Cost		Rate of Discount 15%					
		MP	SP	MP	SP	MP	SP	P.V. N.B. MP	P.V. N.B. SP	P.V. C&M MP	P.V. C&M SP	P.V. P.Cost MP	P.V. P.Cost SP
0	1.0	0	0	0	0	433	444	0	0	0	0	433	444
1	0.8696	176	232	106	149	1075	1096	153	202	92	130	935	953
2	0.7561	264	349	128	195			200	264	97	147		
3	0.6575	352	465	151	246			231	306	99	162		
4	0.5717	396	523	162	265			226	299	93	152		
5	0.4972	440	581	173	288			219	289	86	143		
6	0.4323	440	581	173	288			190	251	75	125		
7	0.3759	440	581	173	288			165	218	65	108		
8-15	1.6869	440	581	173	288			742	980	292	486		
16	0.1069	440	581	173	288	199-20	199-20	47	62	18	31	19	19
17 to 30	0.6133	440	581	173	288			270	356	106	177		
								2443	3227	1023	1661	1387	1416

Net Present Value at 15 per cent = 2443-1023-1387 = 33***

Net Present Value at 16 per cent = 2278-956-1377 = -55

IRR = 15.375 per cent

Net Present Value at 15 per cent = 3227-1661-1416 = 150***

Net Present Value at 17 per cent = 2813 - 1451-1399= - 37

IRR = 16.596 per cent

used as the opportunity cost of capital by the Planning Commission. This value shows that under the assumptions of output yields and prices, input prices and estimated project costs the proposed investment in a tubewell at Dhakeri Village in Solan district is economic from the viewpoint of society. The robustness of this conclusion is tested under the Sensitivity Analysis described subsequently in Section 6.

2.2 Economic Rate of Return for Tubewell Project in UNA

The results on Economic Rate of Return (ERR) for tubewell project in Una, using the shadow prices of various inputs and outputs are described below :

2.2.1 Estimation of Benefits

We present in Table 2.2.1 the details of the Net Value of Benefits for the tubewell project in Una. As discussed earlier the Net Benefits have been taken as the economic value of the incremental net farm income without and with project. The net farm income represents the gross value of output minus farm level cost, excluding irrigation charges, taxes etc. At the exist-ng level of farming conditions without irrigation, the gross value of crop output is estimated at Rs. 0.276 million at market prices. The estimated value of cost of inputs work out to Rs. 0.155 million, giving a net value of crop output

TABLE 2.2 | ESTIMATES OF NET VALUE OF BENEFITS WITHOUT AND WITH IRRIGATION FOR TUBEWELL PROJECT IN UHA DISTRICT

(Rs. in thousands)

	WITHOUT IRRIGATION (X)		WITH IRRIGATION (Y)		DIFFERENCE (Y - X)	
	At Market Price	At Shadow Price	At Market Price	At Shadow Price	At Market Price	At Shadow Price
A. Gross Value of Agri. Prod.						
Value of Crop Output	271	336				
Value of By Product	5	5				
Sub Total	276	341	782	1013		
B. Cost of Cultivation						
Seeds	23	23				
Human Labour	51	22				
Manures & Fertilisers	42	44				
Bullock Labour	40	40				
Ins./Pesticides	-	-				
Sub Total	156	127	278	260		
C. Net Value Produced (A - B)	120	214	504	753	384	539

at Rs. 0.121 million at market prices. Using the shadow prices, the gross value of output work out to Rs. 0.341 million of which the farm level costs work out to Rs. 0.128 million giving a net value of Rs. 0.213 million at shadow prices.

Under 'with project' condition, using shadow prices, the gross value of output work out to Rs. 1.013 million, the value of farm level cost at Rs. 0.260 million, giving a net value of Rs. 0.753 million. Thus the estimated net value of benefits due to or arising out of the proposed tubewell project work out to Rs. 0.540 million (0.753 - 0.213) at shadow prices. Converted into per hectare, the net value of benefits at shadow prices work out to Rs. 6435 per hectare of gross cropped area.

2.2.2 Capital Cost of Project

Table 2.2.2 gives detailed estimates of different components of capital cost, separately for major commodities, machinery and unskilled labour. Cement and steel, whose shadow prices are higher than market prices, account for about 32 of the total capital cost. Supply of Power (SOP) account for Rs. 0.1 million, just 10 per cent of the total cost and pumping machinery for 20 per cent. The cost of unskilled labour at shadow prices work out Rs. 0.06 million which is 6 per cent of the estimated total capital cost of the project. Using a premium of 25 per cent on foreign exchange, the cost of cement and steel increase to Rs. 0.325 million. Thus the estimated cost of the

TABLE 2.2.2

CAPITAL COSTS OF TUBEWELL PROJECT IN UNA DISTRICT

(Rs. Thousands)

	Cost at Market Prices	Shadow Price Multiplier	Cost at Shadow Prices
Cement	200	1.25	250
Steel	60	1.25	75
Machinery	280	1.00	280
Unskilled Labour	140	0.40	56
Others	225	1.00	225
Admin charges	121	1.00	121
	1026		1007

TABLE: 2.2.3

TIME-PATTERN OF CAPITAL COSTS AND O & M COSTS FOR TUBEWELL PROJECT AT UNA

Year	Capital Costs		O & M Costs	
	Market Prices	Shadow Prices	Market Prices	Shadow Prices
0	400	394	0	0
1	626	613	106	120
2	0	0	124	156
3	0	0	141	191
4	0	0	149	209
5	0	0	158	227
6-15	0	0	158	227
16	140-20	140-20	158	227
17-30			158	227

TABLE: 2.2.4 CALCULATION OF BENEFIT COST RATIO FOR TUBEWELL PROJECT, UHA

(Rs. in thousands)

Year	Net Benefit		O & M		Proj Cost		17% Discount Rate			26% Discount Rate		
	MP	SP	MP	SP	MP	SP	PV, NB MP	PV, O&M MP	PV, P.cost MP	PV, NB SP	PV, O&M, SP	PV, P.Cost SP
0	0	0	0	0	400	394	0	0	400	0	0	394
1	153	216	106	120	626	613	131	91	535	171	95	487
2	230	324	124	156			168	91		204	98	
3	306	432	141	191			191	88		216	95	
4	345	486	149	209			184	80		193	83	
5	383	540	158	227			175	72		170	71	
6-15	383	540	158	227			814	336		589	248	
16	383	540	158	227	140-20	140-20	31	13	10	13	6	3
17-30	383	540	158	227			162	67		49	21	
							1856	838	945	1605	717	884

MP: 1856-838-945 = 73 17%

1546-705-928 = -87 20%

IRR = 18.37

SP: 2180-952-914 = 314 20%

1765-784-896 = 85 24%

1682-750-891 = 41 25%

1605-717-884 = 4 26%

SECTION 3

3.1 Economic Rate of Return (ERR) for the Lift Irrigation Scheme in Kangra District

In this section we present the results of the estimates of Economic Rate of Return (ERR), using the shadow price, discussed earlier, for the tubewell project at Bhaura in tehsil Palampur of Kangra district.

3.1.1 Estimates of Benefits

Table 3.1.1 presents details of Net Value of Benefits for the irrigation project which are taken as equal to the economic value of the incremental net farm income defined as With Irrigation Project (WIP) minus Without Irrigation Project (WOP). Net farm income is defined here as the difference between Gross Value of Produce (crop output plus by product) and Farm Level Costs (excluding irrigation charges, taxes etc.). Under conditions of Without Irrigation gross value of output is estimated at Rs. 0.620 million, about 88 per cent of which is the value of crop output using market prices. The estimated value of Farm Level Costs are Rs. 0.397 million, giving an estimate of Rs. 0.223 million as the annual Net Value of Produce at Market Prices. The details of crop-wise area, yield, prices, input costs are given in the Appendix Tables 3.1 to 3.4.

At shadow prices, gross value of crop output is considerably higher at Rs. 0.98 million while the Farm Level costs are the same as under market prices because an increase in fertiliser costs is nullified by a decrease in the cost of unskilled labour. This gives an estimate of Rs. 0.583 million for the Net Value of Produce at Shadow Prices.

The gross value of agricultural output under conditions of "With Irrigation" is Rs. 2.96 million using Shadow Prices. The Farm Level Costs are estimated at Rs. 0.64 million giving an estimate of Net Value of Produce at Rs. 2.32 million. Thus, the estimated Net Value of Benefit is Rs. 1.74 million (Rs. 2.32 million minus Rs. 0.58 million). As discussed earlier, this is taken as the estimate of the direct benefit due to or arising is a result of the proposed irrigation project. This gives a net value of benefit of Rs. 8700 per hectare of gross cropped area. Outputs and inputs are valued at shadow prices. This level of net value of benefit is higher than in other project (.e.g. tubewells in Solan and Una) because almost two-thirds of the crop area here is devoted to paddy and wheat where net value of benefit is higher than in Maize.

3.1.2 Project Capital Costs

Table 3.1.2 gives detailed estimates of various components of the project capital costs (market prices)

TABLE 3.1.2

CAPITAL COSTS OF LIFT IRRIGATION SCHEME IN KANERA DISTRICT

(Rs.'000)

	Cost at Market Price (MP)	Shadow Price Multiplier	Cost at Shadow Price (SP)
Cement	180	1.25	225
Steel	347	1.25	225
Machinery	884	1.00	884
Unskilled Labour	184	0.40	76
Others	994	1.00	994
Admin Charges	574	1.00	574
Total	3163		3187

TABLE: 3.1.4 CALCULATION OF BENEFIT COST RATIO FOR LIFT IRRIGATION SCHEME IN KANGRA

Year	Net Benefit		O&M		P.Cost		15% Discount Rate						25% Discount Rate					
							P.V. N.B.		P.V. O&M		P.V. P.Cost		P.V. N.B.		P.V. O&M		PV. P.Cost	
	MP	SP	MP	SP	MP	SP	MP	SP	MP	SP	MP	SP	MP	SP	MP	SP	MP	SP
0	0	0	0	0	633	639	0	0	0	0	633	639	0	0	0	0	633	639
1	0	0	0	0	1581	1598	0	0	0	0	1375	1383	0	0	0	0	1265	1273
2	385	521	207	288	949	957	291	394	157	218	718	724	246	333	132	184	607	612
3	642	869	263	404			422	571	173	266			329	445	135	207		
4	899	1217	318	520			514	696	182	297			368	498	130	213		
5	1156	1564	374	635			575	778	186	316			379	512	123	208		
6	1284	1738	402	693			555	751	174	300			337	456	105	182		
7 to 15	1284	1738	402	693			2649	3585	829	1430			1166	1578	365	629		
16	1284	1738	402	693	504	504	137	186	43	74	61	61	36	49	11	20	16	16
17-30	1284	1738	402	693			787	1066	247	425			138	187	43	75		
							5930	8027	1991	3326	2787	2707	2999	4058	1044	1718	2521	2543

MP: 4087-1399-2640 = 48 at 20% discount rate

3990-1238-2591 = -100 21%

IRR = 20.324

SP: 8027-3326-2707 = 189***

4058-1728-2540 = - 200 At 25% Discount Rate.

4568-1924-2590 = 54 At 23% Discount Rate.

IRR = 23.42

TABLE 3.1.3

YEARWISE BREAK-UP OF CAPITAL COST AND O & M COST FOR LIS IN KANGRA DISTRICT

Year	Year-wise Break-up of Project Outlay (M.P.)	At Shadow Price	O & M (M.P.)	O & M (S.P.)
0	633	639	0	0
1	1581	1591	0	0
2	949	957	207	268
3			263	404
4			318	520
5			374	635
6			402	693
7-15			402	693
16	604-30	604-30	402	693
17-30			402	693

TABLE: 3.2.1 ESTIMATES OF NET VALUE OF BENEFITS WITHOUT AND WITH IRRIGATION FOR LIFT IRRIATION SCHEME IN KULLU DISTRICT

(Rs. in Thousands)

	WITHOUT IRRIGATION (X)		WITH IRRIGATION (Y)		DIFFERENCE (Y - X)	
	At Market Price	At Shadow Price	At Market Price	At Shadow Price	At Market Price	At Shadow Price
A. Gross value of Agri. Prod.						
Value of Crop Output	286	475	747	1095		
Value of By Product	37	37	84	84		
Sub Total	323	512	831	1179		
B. Costs of Cultivation						
Seeds	61	61				
Human Labour	61	24				
Manures & Fertilizer	48	50				
Bullock Labour	53	53				
Ins./Pesticides	1	1				
Sub Total	184	189	341	314		
C. Net Value Produced from crops (A - B)	139	323	490	865	351	544
D. Net Value of Produce from orchards	742	742	1476	1476	734	734
E. Grand Total	881	1065	1966	2341	1085	1276

of Rs. 1.545 million to farmers. IRR works out to 22.06 per cent of the total net benefit Rs. 0.8 million (52 per cent) would come from crop production and Rs. 0.734 million from orchards. The net benefits from orchard are expected to result from doubling of net returns per gross hectare (from Rs. 16674 to Rs. 33168) . In the case of crop production 91 per cent of the net benefit would come from the doubling of yield of vegetables and also the increase in gross area under vegetables from existing 6 hectares to 53 hectares. The vegetables would occupy 49 per cent of gross cropped area. Crop intensity would remain unchanged at the existing level of 200 per cent.

The net returns to farmers given in the project report have been estimated without considering the cost of irrigation as per gross hectare annualised. The cost of irrigation roughly work out to Rs. 5483. The annual cost of electricity alone comes to Rs. 212 per gross cropped hectare. If the irrigation cost is to be met by farmers, net benefit to farmers get reduced to Rs. 2359 per gross hectare. The realisation of irrigation cost of this order from farmers would not be an easy task. Besides, as indicated earlier, the actual increases in area under vegetables and crop yield would be much lower than the estimates given in the project report.

3.2.2 Estimates of Benefits

Table 3.2.1 presents details of net value of

Rs. 1.178 million with irrigation (i.e. by 130 per cent) while net returns go up from Rs. 0.32 million to Rs. 0.864 million. Net benefits from crop production work out to Rs. 0.54 million as against Rs. 0.35 million at market prices. The total net benefits from the project including Rs. 0.734 million from orchard amount to Rs. 1.239 million. Here again orchard accounts for the bulk (59 per cent) of total net benefits.

3.2.3 Estimates of Project Costs

Tables 3.2.2 and 3.2.3 respectively give detailed estimates of various components of capital and O&M costs of the project. The cost of electric power, steel and machinery account for 19.5 per cent, 19.8 per cent and 20 per cent of the total capital costs of Rs. 34.56 lakhs at market prices. As is to be expected, the cost of cement, steel and machinery are higher at shadow prices. However, because of lower shadow price of unskilled labour, the total capital cost at shadow prices is only marginally higher (3 per cent) as compared with capital cost at market prices. The capital cost per gross hectare work out to Rs. 17543.

Annual O&M costs at market prices amount to Rs. 0.56 million (Rs. 2842 per gross hectare). Electricity accounts for 74 per cent of total O&M costs. At shadow prices O&M costs go upto Rs. 0.994 million because the shadow price of electricity is assumed to be 207 per

benefits of the project estimated on the basis of modified crop pattern and crop yields. For reasons mentioned earlier, gross area under vegetables would increase by only 200 per cent as against 783 per cent assumed in the project report. Likewise the increase in vegetable yield would be somewhat lower (100 per cent as against 140 per cent estimated in the project report). In the absence of data on inputs and output of orchard, the net returns assumed in the project report have been kept unchanged. However, the doubling of net returns from orchard assumed in the project report is not likely to materialise.

At market prices annual crop output without irrigation works out to Rs. 0.322 million while net returns amount to Rs. 0.138 million. The corresponding values for benefits with irrigation based on modified crop pattern and yields work out to Rs. 0.83 million and Rs. 0.489 million, respectively. Net benefit from crop production come to Rs. 3,51 lakh as against Rs. 8.11 lakhs estimated in the project report. If we add net benefit of Rs. 7.3 lakhs from orchard, the total annual net benefit of the project works out to Rs. 1.084 million (Rs. 5507 per gross hectare) orchard accounts for 68 per cent of total net benefit. The net benefit would be lower if the assumption regarding the doubling of net returns from orchard does not materialise.

At shadow prices, the gross value of crop output increases from Rs. 0.512 million without irrigation to

TABLE 3.2.4 ESTIMATION OF ERR FOR LIS IN KULLU AT MARKET PRICES (MP) AND SHADOW PRICES (SP)

Year	Net Value of Benefits			Net Benefit		O &M		Project cost		6% Discount Rate			10% Discount			12% Discount Rate		
	From Orchard	From Crop Output								PV, N.B	PV, C&M	PV C.Cost	PV N.B	PV, C&M	PV, C. Cost	PV, NB	PV, C&M	PV, Capital cost
		MP	SP	MP	SP	MP	SP	MP	SP	SP	SP	SP	MP	MP	MP	MP	MP	MP
0	8	0	0	8	8	0	0	691	714	8	0	714	8	0	691	8	0	691
1	100	0	0	100	100	0	0	1728	1780	94	0	1679	91	0	1571	89	0	1543
2	110	105	163	215	273	269	391	1037	1067	243	348	954	178	222	857	171	214	827
3	375	176	273	551	648	352	564			544	474		414	264		392	251	
4	558	246	381	804	939	435	736			744	583		549	297		511	276	
5	734	316	490	1050	1224	518	908			915	679		652	322		596	294	
6-15	734	351	544	1085	1278	560	994			7029	5467		4140	2137		3479	1795	
16	734	351	544	1085	1278	560	994	640	640	503	391	227	236	122	125	177	91	94
17-30	734	351	544	1085	1278	560	994			4676	3637		1732	894		1173	605	
										14756	11579	3570	8000	4258	3244	6596	3526	3155

MARKET PRICES

NPV at 10% : 8000-4258-3244 = 498

NPV at 12% : 6596-3526-3155 = - 85

IRR = 11.71

SHADOW PRICES

NPV at 6% : 14756-11579-3570 = - 403

NPV at 5% : 16755-13135-3651 = - 31

cent higher than its market price. This gives the O&M costs at Rs. 5045 per gross cropped hectare.

3.2.4 Estimates of ERR

'able 3.2.4 brings together estimated value of benefits and costs for estimation of IRR. The estimates have been worked out according to the methodology described earlier. At market prices the IRR is estimated at 11.7 per cent. The ERR using shadow prices of outputs and inputs is 4.9 per cent. This value of ERR is lower than the estimated opportunity cost of capital at 12 per cent. This is partly because (a) the area under vegetables assumed in our analysis is much lower than that assumed in the project report and (b) the area under food crops where shadow price is much higher than market prices, (c) the cost of electricity in Kullu is Rs. 5045 per ha compared with Rs. 4420/ha for another LIS project in Kangra district, and (d) capital cost per ha is Rs. 18126 compared with Rs. 15955/ha for the other LIS project.

SECTION 4

4.1 Water Storage Tank Irrigation Project, Village Churla/Bamto (Distrct Shimla)

This project involves construction of a storage tank and water distribution system for utilising water from a nallha for irrigating 6 and 8 hectares respectively in Kharif and Rabi out of the 9 net sown hectares in the village. The capital cost of the project is estimated to be Rs. 2.29 lakh and annual O&M expenses come to Rs. 6795. Capital and O&M cost per hectare work out to Rs. 12711 and Rs. 727 respectively.

According to the project report the project gives a benefit cost ratio of 1.49 : 1 (The report does give estimates of IRR). The total net benefits accruing to farmers work out to Rs. 65445 (Rs. 3636 per GCH). The gross value of crops output would go up by 100 per cent while net returns would increase by 176 per cent. These benefits would be due to considerable increase in crop yields. Significantly, the project report envisages relatively small changes in crop pattern. In particular, area under vegetables is kept unchanged at the existing level of 4 hectares (22 per cent of GCA). However, additional yield from vegetables (114 per cent in Kharif and 140 per cent in Rabi) gives additional net returns of Rs. 46845 which account for 72 per cent of total net benefit of Rs. 65445 from the project.

The cost of irrigation per GCH work out to Rs. 2506. If irrigation cost is met by farmers, net benefits get reduced to Rs. 1130 per gross cropped hectare.

4.1.1 Estimates of Net Benefits

Table 4.1.1 presents estimated net values of benefits from the project on the basis of modified yield of vegetables. At market prices, gross value of output come to Rs. 83,000 without project and Rs. 1,48,000 with project, showing an increase of 78 per cent. The corresponding values for net returns work out to Rs. 35,000 to Rs. 82,000 (i.e., increase of 134 per cent). Net benefits from the project come to Rs. 47,000 (Rs. 2611 per gross hectare). Thus net benefits are about 28 per cent lower as compared with project report estimates.

At shadow prices, gross value of crop output increases from Rs. 1,07,000 to Rs. 1,87,000 (+75 per cent) and net returns from Rs. 65,000 to Rs. 1,25,000 (+92 per cent). Net benefits from the project work out to Rs. 60,000 (Rs. 3333 per gross hectare). Here again net benefit at shadow prices are more than net benefits at market prices.

4.2.1 Estimates of Project Costs

The estimates of project costs are presented in

The cost of irrigation per GCH work out to Rs. 2506. If irrigation cost is met by farmers, net benefits get reduced to Rs. 1130 per gross cropped hectare.

4.1.1 Estimates of Net Benefits

Table 4.1.1 presents estimated net values of benefits from the project on the basis of modified yield of vegetables. At market prices, gross value of output come to Rs. 83,000 without project and Rs. 1,48,000 with project, showing an increase of 78 per cent. The corresponding values for net returns work out to Rs. 35,000 to Rs. 82,000 (i.e., increase of 134 per cent). Net benefits from the project come to Rs. 47,000 (Rs. 2611 per gross hectare). Thus net benefits are about 28 per cent lower as compared with project report estimates.

At shadow prices, gross value of crop output increases from Rs. 1,07,000 to Rs. 1,87,000 (+75 per cent) and net returns from Rs. 65,000 to Rs. 1,25,000 (+92 per cent). Net benefits from the project work out to Rs. 60,000 (Rs. 3333 per gross hectare). Here again net benefit at shadow prices are more than net benefits at market prices.

4.2.1 Estimates of Project Costs

The estimates of project costs are presented in

TABLE 4.1.1 ESTIMATES OF NET VALUE OF BENEFITS WITHOUT AND WITH IRRIGATION FOR TANK IRRIGATION SCHEME - SITMLA

	Without Irrigation		With Irrigation		With - Without	
	At Market Prices	At Shadow Prices	At Market Prices	At Shadow Prices	At Market Prices	At Shadow Prices
A. Gross Value of Agri. Production						
Value of Crop Output	77	101	140	179		
Value of By Prod.	6	6	8	8		
Sub Total	83	107	148	187		
B. Costs of Cultivation or Farm Level Costs						
Seeds	12	12	14	14		
Human Labour	12	5	14	6		
Manures & Fertilizers	13	14	27	31		
Bullock Labour	10	10	10	10		
Ins./Pesti.	1	1	1	1		
Sub Total	48	42	66	62		
Net Value Produced (A-B)	35	65	82	125	47	60

Tables 4.1.2 and 4.1.3. It may be noted that at market prices, steel, cement and machinery together account for 52 per cent of total capital costs. Their share goes up at shadow prices because of their higher cost at shadow prices and lower shadow prices of unskilled labour on balance capital costs are slightly lower at shadow prices.

O&M costs are Rs. 14,000 at market prices and Rs. 8000 at shadow prices.

4.3.1 Estimates of ERR

Table 4.1.4 gives estimated values of benefits, costs and IRR. At market prices, IRR is estimated at 13.5 per cent while at shadow prices IRR comes to 21 per cent. The IRR at shadow prices is much higher than the estimated opportunity cost of capital, used by the Planning Commission. Thus, the proposed investment on the project is economic on social considerations, provided that the costs of irrigation are largely met by farmers.

4.2 Tank Irrigation Project, Village Ropan-Badu (District Mandi)

This project involves the construction of a small tank and water distribution system for utilisation of water from a perrenial nallah for irrigating 4.6 hectares in Kharif and 5.20 hectares in Rabi, out of 5.5 hectares of net sown area in the village. The total cost of the

TABLE 4.1.2 PROJECT CAPITAL COST FOR TANK IRRIGATION SCHEME - SHIMLA

	Cost at Market Price	Shadow Price multiplier	Cost at Shadow Price
Cement	30	1.25	38
Steel	70	1.25	88
Machinery	20	1.00	20
Unskilled Labour	50	0.40	20
Admin charges	40	1.00	40
Others	19	1.00	19
TOTAL	229		225

TABLE 4.1.3 PROJECT CAPITAL COST FOR TANK IRRIGATION SCHEME - SHILA

	C & M		Year-wise breakup of Project Outlay	
	IP	CP	IP	SP
0	0	0	100	99
1	6	4	129	126
2	10	6	0	0
3	13	7	0	0
4	14	8	0	0
5 to 40	14	8	0	0

project is relatively small, namely 1.32 lakh of capital expenditure and Rs. 9160 of annual O&M expenses. However, capital cost per gross cropped hectare (GCH) is quite substantial (Rs. 1379).

The project report envisages considerable increase in per GCH gross output (158 per cent), net returns (234 per cent), and total net benefits (Rs. 3100) after the introduction of irrigation. The total net benefit is estimated to be Rs. 35969. The benefit cost ratio works out to 1.5:1 (The project report does not give estimates of IRR). The net benefit of Rs. 35969 is expected to result from the shifts in crop pattern (specially the introduction of vegetables on 1.2 hectares and considerable increases in crop yield assumed in the report. About 39 per cent of net benefits would accrue from vegetables which give a very high net return per hectare (Rs. 11588) to the farmer. If the cost of irrigation is to be met by farmers, the net benefits get reduced to Rs. 717 per gross cropped hectare.

4.2.1 Estimates of Benefits

Table 4.2.1 presents details of net value of benefits of the project on the basis of modified yield of vegetables (crop pattern suggested in the project report is taken to be realistic). At market prices, annual gross crop output without and with irrigation respectively work

WITH IRRIGATION SCHEME FOR TANK IRRIGATION SCHEME - HANDI

	Without Irrigation		WITH IRRIGATION		WITH-WITHOUT	
	At Market Prices	At Shadow Prices	At Market Prices	At Shadow Prices	At Market Prices	At Shadow Prices
A. Gross Value of Agri. Prod:						
Value of Crop Output	31	51				
Value of By Product	5	5				
Sub Total	36	56	95	134		
B. Costs of Cultivation or Farm Level Costs						
Human Labour	7	4				
Seeds	2	2				
Manures & Fertilizers	7	8				
Bullock Labour	6	6				
Ins./Pesti.		-				
Sub-Total	22	20	39	36		
Net Value Produced (A-B)	14	36	56	98	42	62

out to Rs. 35900 and Rs. 94700. The annual net benefit from the project comes to Rs. 42000 (Rs. 3600 per gross hectare). At shadow prices, the gross crop output increases by 139 per cent while net returns go up by 172 per cent. The net benefit from the project comes to Rs. 62000 (Rs. 5345 per gross hectare) which is 48 per cent more as compared with net benefit at market prices.

4.2.2 Estimates of Project Costs

Tables 4.2.2 and 4.2.3 respectively give estimates of various components of project costs. Cement and steel account for about 45 per cent of the project cost. Machinery at Rs. 20000 accounts for about 7.5 per cent of the total. The share of unskilled labour in the total project cost is about 15 per cent which gets reduced to about 6.6 per cent when shadow price of labour is used. The share of cement and steel increases to 55 per cent when 25 per cent premium on foreign exchange is used.

The estimated values of different components of O&M costs are given in Table 4.2.3. At market prices, maintenance charges on account of labour account for nearly 76 per cent of the total maintenance cost.

4.2.3 Estimates of ERR

Table 4.2.4 brings together the estimated values of benefits and costs for calculating ERR. At market prices

TABLE 4.2.2 PROJECT CAPITAL COSTS FOR TANK IRRIGATION SCHEME - MADI

	Cost at Market Prices	Multiplier for Shadow Prices	Cost at Shadow Prices
Cement	40	1.25	50
Steel	20	1.25	25
Machinery	10	1.00	10
Labour	20	0.40	8
Admin charges	20	1.00	20
Others	22	1.00	22
TOTAL	132		135

TABLE 4.2.3 TIME PATTERN OF CAPITAL COST AND O & M COST FOR TAWA IRRIGATION SCHEME- HARDI

	Yearwise Breakup of Project Outlay		O & M	
	M.P.	S.P.	M.P.	S.P.
0	32	33	0	0
1	100	102	3	2
2	0	0	5	3
3	0	0	7	4
4	0	0	9.2	5.2
5-40	0	0	9.2	5.2

TABLE 4.2.4 CALCULATION OF BENEFIT COST RATIO FOR TANK IRRIGATION, HAITI

	B.B.		O & M		Project Cost		23% B.B.	23% O&M	23% Project Cost	30% B.B.	30% O&M	30% Project Cost
	IP	SP	IP	SP	IP	SP	IP	SP	IP	SP	SP	SP
0	0	0	0	0	32	33	0	0	32	0	0	33
1	14	20	3	2	100	102	11	2	81	15	1	78
2	22	33	5	3	0	0	15	3		20	2	
3	32	48	7	4	0	0	17	4		22	2	
4	42	62	9.2	5.2	0	0	18	4		22	2	
5-10	42	62	9.2	5.2	0	0	80	18		72	6	
							141	31	113	151	13	111

IP: 141-31-113 = - 3 -25%

IRR = 22.9%

SP: 151-13-112 = 26 30%

IRR = 31%

SECTION 5

5.1 Flow Irrigation Project, Sundernagar (District Mandi)

Project Profile

Water from a perrenial nallah is to be utilised to irrigate 47.18 hectares (both in Kharif and Rabi) out of 57.18 net sown hectares in the village. The irrigation intensity would be 183 per cent. According to the project report, the net benefit from the project would be about Rs. 0.378 million. IRR is estimated as 25.23 per cent. Here again, bulk (68 per cent) of net benefits are due to increase in area from 1 hectare to 30 hectare and yield of vegetables (including potatoe) assumed in the project report. Net benefit per gross hectare come to Rs. 3037. If cost of irrigation (viz., Rs. 1425) is met by farmers, net benefit would be 47 per cent lower (Rs. 1612 per gross hectare).

5.1.1 Estimates of Benefits

Table 5.1.1 presents details about net value of benefits of the estimated on the basis of modified crop pattern and crop yield. At market prices, the gross value of crop output and net returns increase from Rs. 0.319 million to Rs. 0.699 million and from Rs. 0.108 million to Rs. 0.298 million respectively. The net returns per

the IRR comes to 22.9 per cent. The present value of benefits at shadow prices work out to Rs. 0.151 million while the present value of O&M costs if Rs. 0.013 million. With the present value of capital cost at Rs. 0.112 million, the NPV at 30 per cent discount rate work out to Rs. 0.026 million. The estimated value of ERR at shadow prices work out at 31 per cent which is higher than the opportunity cost of capital which is taken as 12 per cent.

TABLE 5.1.2 PROJECT CRITICAL COST FOR FLOW IRRIGATION SCHEME - HARDI

	Cost at Market Price	Shadow Price Multiplier	Cost at Shadow Price
Cement	150	1.25	188
Steel	90	1.25	113
Machinery	125	1.00	125
Unskilled Labour	205	0.40	82
Admin charges	135	1.00	135
Others	331	1.00	331
	1036		974

TABLE 5.1.3 PROJECT CAPITAL COST FOR FLOW IRRIGATION SCHEME - MANDI

	Yearwise Breakup of Project Outlay		O & M	
	MP	SP	MP	SP
0	450	426	0	0
1	586	548	0	0
2	0	0	13	8
3	0	0	19	12
4	0	0	26	17
5	0	0	29	19
6 to 50	0	0	32.5	21

TABLE 5.1.4 BENEFIT COST RATIO FOR FLOW IRRIGATION SCHEME - HAITI

	Net Benefit		O&M		Project Cost		13% Discount Rate						15% Discount Rate					
							Net Benefit		O & M		Project Cost		Net Benefit		O & M		Project Cost	
	MP	SP	MP	SP	MP	SP	MP	SP	MP	SP	MP	SP	MP	SP	MP	SP	MP	SP
0	0	0	0	0	450	426	0	0	0	0	450	426	0	0	0	0	450	426
1	0	0	0	0	586	548	0	0	0	0	519	485	0	0	0	0	510	477
2	76	78	13	8	0	0	59	61	10	6			57	59	10	6		
3	114	116	19	12	0	0	79	80	13	8			75	76	12	8		
4	152	155	26	17	0	0	93	95	16	10			87	89	15	10		
5	171	175	29	19	0	0	93	95	16	10			85	87	14	9		
6 to 50	190	194	32.5	21	0	0	910	929	156	101			629	642	108	69		
							1234	1260	211	135	969	911	933	953	159	102	960	903

MP: 1234-211-969 = 54 13%

933-159-960 = -186 15%

IRR = 13.45

SP: 1260-135-911 = 208 13%

953-102-903 = -54 15%

IRR = 14.56

cent used as the opportunity cost of capital by the Planning Commission.

5.2 Flow Irrigation Project, Jond Bhajanu (Shimla District)

The project involves utilisation of water from Sarali Nallah for irrigating 90.3 hectare out of 100.36 hectares of net sown hectares in the village. The irrigation intensity would be 180 per cent.

According to the project report, the annual net benefits from the project would be Rs. 1.31 million. At market prices, IRR is estimated at 33.34 per cent. This substantial benefit would mainly come from 155 per cent increase in area and substantial increase in yield of vegetables. Altogether vegetables account for 77 per cent of net benefits while another 15 per cent would come from potatoes. Vegetables would provide 74 per cent of the additional gross value of output after introduction of irrigation. The net benefit per gross hectare works out to Rs. 6526. If the cost of irrigation is to be met by farmers, net benefits would decline to Rs. 3824 per gross hectare.

5.2.1 Estimates of Beneifts

The estimated benefits of the project based on realistic increase in area and yield of vegetables, are

presented in Table 5.2.1 (area under vegetables is assumed to be 49.72 hectares which is 29 per cent less than the area assumed in the project report). At market prices the gross value of crop output and net returns would increase by 106 per cent and 154 per cent respectively. The net benefit amounts to Rs. 0.83 million (Rs. 4153 per gross hectare) as against Rs. 1.31 million as shown in the project report).

At shadow prices, gross value of crop output and net returns respectively increase from Rs. 1.39 to Rs. 2.55 million (+ 83 per cent) and from Rs. 0.99 to Rs. 1.92 million (+ 93 per cent). The net benefit from the project work out to Rs. 0.93 million which is 12 per cent more as compared with net benefits at market prices.

5.2.2 Estimates of Project Costs

The estimates of capital and O&M costs are presented in Tables 5.2.2 and 5.2.3 respectively. The capital costs amount to Rs. 3.14 million at market prices and Rs. 3.02 million at shadow prices (Rs. 15622 and Rs. 15050 per gross hectares respectively). The annual O&M costs are Rs. 0.103 million and Rs. 0.75 million at market and shadow prices respectively. The cost of unskilled labour accounts for 48 per cent of O&M cost at market prices and 27 per cent at shadow prices. O&M cost per gross hectare come to Rs. 512 at market prices and Rs. 373 at shadow prices.

TABLE 5.2.1 ESTIMATES OF NET VALUE OF BENEFITS WITHOUT AND WITH IRRIGATION FOR FLOW IRRIGATION SCHEME - SHIMLA

	Without I					
	At Market Prices					
A. Gross Value of Agri. Production:						
Value of Crop Output	955	1347				
Value of By Product	49	49				
Sub Total	1004	1396	2078	2554		
B. Costs of Cultivation or Farm Level Costs						
Seeds	55	55	64	64		
Human Labour	164	66	187	75		
Manures & Fertilizers	97	127	289	319		
Bullock Labour	145	145	156	156		
Ins./Pesti.	3	3	11	11		
Sub Total	464	396	707	625		
Net Value Produced (A-B)	540	1000	1371	1929	831	919

TABLE 5.2.2 PROJECT CAPITAL COSTS FOR FLOW IRRIGATION SCHEME - SHIMLA

	Cost at Market Prices	Multiplier for shadow price	Cost at Shadow prices
Cement	203	1.25	254
Steel	300	1.25	375
Machinery	260	1.00	260
Unskilled Labour	425	0.40	170
Admin. charges	410	1.00	410
Others (Incl. Pipes)	1542	1.00	1542
Total	3140		3011

TABLE 5.2.3 TIME PATTERN OF CAPITAL COST AND O & M COSTS FOR FLOW IRRIGATION SCHEME - JHELA

	Yearwise Breakup of Project Outlay		O & M	
	M.P.	S.P.	M.P.	S.P.
0	1019	977	0	0
1	1021	1557	30	22
2	500	477	51	37
3	0	0	70	51
4	0	0	80	58
5	0	0	90	66
6	0	0	103	75
7 to 30	0	0	103	75

5.2.4 Estimates of ERR

Table 5.2.4 gives estimated values of benefits, costs and IRR. It may be noted that IRR at market prices comes to 20 per cent while at shadow prices ERR is 23 per cent. Although estimated ERR is much lower than IRR given in the project report, it is considerably higher as compared with the estimated opportunity cost of capital used by the Planning Commission. Here again, the estimated benefits from the project would be realised only if the expected increase in area and yield of vegetables materialises.

TABLE 5.2.4 CALCULATION OF BENEFIT COST RATIO FOR FLOW IRRIGATION SCHEME - SIMLA

	Net Benefits		O & M Costs		Project Costs		21% Discount Rate					
							Net Benefits		O & M Costs		Project Cost	
	MP	SP	MP	SP	MP	SP	MP	SP	MP	SP	MP	SP
0	0	0	0	0	1019	977	0	0	0	0	1019	977
1	249	278	30	22	1621	1559	206	230	25	18	1340	1287
2	416	464	51	37	500	477	284	317	35	25	342	326
3	582	650	70	51	0	0	329	367	40	29		
4	665	742	80	58	0	0	310	346	37	27		
5	748	835	90	66	0	0	288	322	35	25		
6	831	928	103	75	0	0	265	296	33	24		
7-50	831	928	103	75	0	0	1261	1408	156	114		
							2943	3286	361	262	2701	2590

MP: 2943-361-2701 = -119 21%

IRR 20.1

SP: 3286-262-2602 = 422 21%

ERR 24.2

SECTION 6

Table 6.1 present the result of various sensitivity analysis carried out in the study.

For the tubewell project in Solan, the ERR is quite robust with respect to changes in cost parameters. When 33 per cent increase in shadow price of electricity is taken the ERR is 14.8 per cent compared with the base case of 16.6 per cent. When higher capital costs of power supply are considered (to reflect three times the distance i.e., 1.0 km of HT line), the ERR is 16 per cent. Even when a 25 per cent increase in Project Capital Cost is taken, the ERR is 13.7 per cent i.e. higher than the opportunity cost of capital (12 per cent). The use of 50 per cent premium on foreign exchange (instead of 25 per cent) increases the ERR to 17.3 per cent.

However, as expected, the ERR is very sensitive to reduction in gross value of output (GVO). A 25 per cent reduction in GVO brings down the ERR from 16.6 per cent to 4.4 per cent. A reduction of 25 per cent in GVO coupled with an increase of 25 per cent Project Capital Cost brings the ERR down to 2.47 per cent. However, when 25 per cent reduction in wheat output is taken (to reflect shortage of power or water in the peak month of November).

Similar results are seen for the tubewell project in Una where the ERR continues to be higher than 20 per cent except when the GVO is reduced by 25 per cent

(ERR is 12 per cent) and when GVO is reduced by 25 per cent coupled with 25 per cent increase in Capital Cost (ERR is 9.5 per cent).

The Lift Irrigation Scheme at Kangra also has fairly high ERR (around 20 per cent) for cases where capital costs and O&M costs are increased. Here, ERR at 13.4 per cent is higher than 12 per cent even when 25 per cent reduction in GVO is considered. It is 10.4 per cent only when 25 per cent reduction in GVO is coupled with 25 per cent increase in capital cost.

The LIS in Kullu continues to show low ERR as anticipated. An increase of 33 per ent in shadow price of electricity reduces the ERR to less than 2 per cent. (The Net Present Value at 2 per cent discount rate is Rs. -4.0 million). The increase in Project Capital Cost by 25 per cent results in the ERR coming down to 4.5 per cent. Similarly, in Kullu ERR is less than 2 per ent (NPV is Rs. -5.59 million at 2 per cent discount rate) when 25 per cent reduction in GVO is considered.

An increase in GVO by 10 per cent increase the ERR, as expected. Even under this assumption, the ERR for Lift Irrigation Scheme at Kullu is only 7 per cent (i.e. less than 12 per cent taken as the opportunity cost of capital).

An increase in shadow price of electricity by 100 per cent affects the ERR significantly in the case

of LIS at Kullu and Tubewell at Solan. The ERR for tubewell at Solan reduces significantly (is less than 2 per cent), NPV is Rs. -0.435 million from the base case of 16.63 per cent when a 100 per cent increase in shadow price of electricity is taken.

Thus the results of sensitivity analysis show that, under the assumptions used in this study the Tubewell Project in Una and LIS in Kangra seem to be profitable from the viewpoint of the economy. For LIS at Kullu and Tubewell in Solan, there is need for further analyses specially with respect to level of benefits and shadow price of power.

As given in Table 6.2 in the Tank Irrigation Scheme, Mandi, a 25 per cent increase in capital cost reduces the ERR to 30 per cent, while a 25 per cent reduction in GVO brings it further down to 25 per cent. A 25 per cent increase in capital cost accompanied by a 25 per cent reduction in GVO brings down the ERR to 20.4 per cent.

The ERR for Tank Irrigation Scheme, Shimla decreases to 17.6 per cent with a 25 per cent increase in GVO. The combined effect of increased capital cost and reduction in GVO further lowers the ERR to 10.8 per cent.

The sensitivity analysis for Flow Irrigation Scheme, Mandi reveals that ERR declines to 12 per cent

when the capital cost is raised by 25 per cent and to 9.8 per cent when the GVO is reduced by similar percentage. The joint effect of the shift in the two parameters results in a further lowering of ERR to 7.9 per cent.

In TIS, Shimla, a 25 per cent increase in capital cost reduces the ERR to 19.7 per cent, while a 25 per cent reduction in GVO brings it down to 16.5 per cent. A simultaneous change of 25 per cent increase in capital cost and a 25 per cent reduction in value of output brings down the ERR to 13.8 per cent. Thus, we see that under most of the cases where benefits are lower or capital costs are higher, the ERR is higher than 12 per cent which is taken as the opportunity cost of capital. These results show that the economic profitability of these projects is rather robust in the context of possible changes in crop yields, prices or project costs.

APPENDIX

CROPPING PATTERN AS USED IN THIS REPORT (%)

Crop	LIS		TW		TI		FIS	
	Kangra	Kullu	Solan	Una	Shimla	Mandi	Mandi	Shimla
Paddy	32.50	10.15		6.26		25.00	9.64	9.97
Maize (Irr)	10.00	8.12	35.96	17.86	22.22	9.49	24.23	7.47
Maize (RF)				2.38		7.76		
Wheat (Irr)	30.00	17.77	36.15	21.43	22.22	34.48	23.44	25.91
Wheat (RF)					5.56	7.76		
Barley		2.54						
Barley (RF)								2.49
Mash (Irr)								2.49
Mash (RF)	2.50						8.03	
Gram (Irr)			3.01	3.57				
Gram (RF)							8.03	
Rajmah (RF)								
Unspecified Pulses (Kharif) (Irr)		5.08		5.36				2.49
Unspecified Pulses (Kharif) (RF)			4.52	2.98				
Unspecified Pulses (Rabi)		2.02						
Sarson (Irr)				1.78	11.11			7.97
Sarson (RF)	7.50		2.41					
Toria				3.57			8.17	
Lentil (RF)								2.49
Unspecified Oilseeds (Kharif)			4.52					
Unspecified Oilseeds (Rabi)								
Sugarcane				7.14				
Orchard		45.18						
Potato (Irr)				5.36			8.03	14.95
Potato (RF)					16.66			
Beans	2.50							
Capsicum	1.25							
Cauliflower	2.50		4.62	4.46				
Cabbage	2.50							
Onion			1.33				4.01	2.49
Ladies Finger						5.17		
Peas (Irr)	5.00			5.36	11.11			19.79
Peas (RF)						5.17		
Turnip (Irr)			1.03					
Turnip (RF)				2.38				

(Contd.)

TABLE: (Contd.)

Crop	LIS		TW		TI		FIS	
	Kangra	Kullu	Solan	Una	Shimla	Mandi	Mandi	Shimla
Tomato	1.25		2.01	2.68	5.56			2.49
Carrot (Irr)			2.78					
Carrot (RF)				1.19				
Raddish (RF)				1.78				
Unspecified Vegetables (Kharif)		4.06	1.66		5.56		4.01	
Unspecified Vegetables (Rabi)		5.08						
Fodder (Kharif)				1.78				
Fodder (Rabi)	2.50			2.68		5.17	2.41	
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
GCA (Ha)	200.00	197.00	108.00	84.00	18.00	11.60	124.54	200.72

APPENDIX TABLE: 1.2; DETAILS ABOUT AREA & YIELD

LIS, BHAURA, KANGRA

Units Area - Hectares
Yield - Qtl/hec.

Crop	Area			Yield (Main Product)			
	Existing	With Project (A)	With Project (B)	Existing	Maximum Realised	With Project (A)	With Project (B)
Paddy	20	60	66	18	19.89	50	40
Maize	75	15	20	18	17.23	30	30
Wheat	90	60	60	12	9.07	30	30
Mash (RF)	5	5	5	5	2.50	5.50	5.50
Sarson (RF)	10	15	15	4	N.A.	4.50	4.50
Tomato	-	5	2.50	-	81.00	200	160
Beans	-	10	5.00	-	N.A.	150	150
Capsicum	-	5	2.50	-	68.00	120	100
Cauliflower	-	5	5	-	73.00	200	140
Cabbage	-	5	5	-	N.A.	200	140
Peas	-	10	10	-	18.00	120	55
Berseem	-	5	5	-	N.A.	400	400
CCA	100	100	100				
GCA	200	200	200				
Cropping Intensity (%)	200	200	200				
Irrigation Intensity (%)		180	180				

NOTES: (A) - As per Project Report

(B) - As used in this Report.

APPENDIX TABLE: 1.5 DETAILS ABOUT AREA & YIELD

LIS, NEOLI THERMAN, KULLU

Units Area - Hectares
Yield - Qtl/hec.

Crop	Area			Yield (Main Product)			
	Existing	With Project (A)	(B)	Existing	Maximum Realised	With Project (A)	(B)
Paddy	-	10.00	20.00	-	20.08	50	40
Maize	40	5.00	16.00	16	21.63	30	30
Wheat	35	20.00	35.00	12	15.47	30	30
Barley	15	5.00	5.00	13	15.82	27	27
Pulses (Kharif)	10	10.00	10.00	5	2.50	8	6
Pulses (Rabi)	2	5.00	4.00	4	3.75	8	8
Vegetables (Kharif)	4	29.00	8.00	50	-	150	100
Vegetables (Rabi)	2	24.00	10.00	40	-	150	100
Orchard	44.50	44.50	44.50				
CCA	98.50	98.50	98.50				
GCA	197.00	197.00	197.00				
Cropping Intensity (%)	200	200	200				
Irrigation Intensity (%)		200	200				

NOTES (A) - As per Project Report (B) - As used in this Report.

TW, DHAKERI, SOLAN

Units Area - Hectares
Yield - Qtl/Hec.

Crop	Area			Yield (Main Product)			
	Existing	With Project (A)	With Project (B)	Existing	Maximum Realised	With Project (A)	With Project (B)
Maize	29.28	29.28	38.84	18	21.78	30	30
Wheat	39.04	39.04	39.04	15	7.13	30	30
Pulses (Kharif) (RF)	14.96	4.88	4.88	5	4.43	5.50	5.50
Gram	3.25	3.25	3.25	6	4.05	10	8
Oilseeds (Kharif)	4.88	4.88	4.88	4	-	12	8
Sarson (RF)	9.11	2.60	2.60	4	-	4.50	4.50
Tomato	-	6.00	2.17	-	81	200	160
Onion	-	4.00	1.44	-	-	200	140
Cauliflower	-	5.00	5.00	-	73	200	140
Turnip	-	1.11	1.11	-	-	250	125
Carrot	-	3.00	3.00	-	-	200	140
Mix Vegetable (Kharif)	-	4.96	1.79	-	-	150	100
Fallow (Kharif)	4.88	-	-	-			
Fallow (Rabi)	2.60	-	-	-			
CCA	54.00	54.00	54				
GCA	100.52	108.00	108.00				
Cropping Intensity (%)	186	200	200				
Irrigation Intensity (%)		186	186				

APPENDIX TABLE: \.6 DETAILS ABOUT AREA & YIELD

TI, GURLA, SHIMLA

Units Area - Hectares
Yield - Qtl/Hec.

Crop	AREA			Yield (Main Product)			
	Existing	With Project (A)	With Project (B)	Existing	Maximum Realised	With Project (A)	With Project (B)
Maize	5	4	4	16	17.15	25	25
Wheat (Irr)		4	4	-	18.70	30	30
Wheat (RF)	7	1	1	14		15	13
Sarson		2	2		-	8	8
Vegetable (Kharif)	2	1	1	70	-	150	100
Potato (RF)	2	3	3	80	35.04	90	90
Vegetable (Rabi)	2	-	-	50	-	-	-
Peas	-	2	2	-	18	120	55
Tomato	-	1	1	-	81	150	150
CCA	9	9	9				
GCA	18	18	18				
Cropping Intensity (%)	200	200	200				
Irrigation Intensity (%)		156	156				

APPENDIX TABLE: 1.7 DETAILS ABOUT AREA & YIELD

TI, ROPA BUDA, MANDI

Units Area - Hectares
Yield - Qtl/Hec.

Crop	Area			Yield (main Product)			
	Existing	With Project (A)	With Project (B)	Existing	Maximum Realised	With Project (A)	With Project (B)
Paddy	1.70	2.90	2.90	18	24.69	50	50
Maize (Irr)		1.10	1.10	X	19.50	30	30
Maize (RF)	3.80	0.90	0.90	18	X	19	19
Wheat (Irr)		4.00	4.00	X		30	30
Wheat (RF)	5.50	0.90	0.90	X		13	13
Bhindi		0.60	0.60	12	12	150	100
Peas (RF)		0.60	0.60	X	N.A.	100	55
Berseem	-	0.60	0.60		18	400	400
CCA	5.50	5.50	5.50				
GCA	11.00	11.60	11.60				
Cropping Intensity (%)	200	211	211				
Irrigation Intensity (%)		167	167				

APPENDIX TABLE: 1.8 DETAILS ABOUT AREA & YIELD

FIS, BARI KULHARA, MANDI

Units Area - Hectares
Yield - Qtl/Hec.

Crop	Area			Yield (Main Product)			
	Existing	With Project (A)	With Project (B)	Existing	Maximum Realised	With Project (A)	With Project (B)
Paddy	24.18	12.00	12.00	18	24.69	50	50
Maize	33.00	30.18	30.18	18	19.50	30	30
Wheat	50.00	10.18	29.18	12	12	30	30
Mash (RF)		10.00	10		3.74	5	5
Gram (RF)		10.00	10		5.34	5	5
Toria		10.18	10.18			8	6
Mix Vegetable (Kharif)		5.00	5.00			150	100
Potato	1.00	20.00	10	100		150	150
Onion		5.00	5			200	140
Berseem	3.00	12.00	3	250		400	400
Fallow (Rabi)	3.18						
CCA	57.18	57.18	57.18				
GCA	114.36	124.54	124.54				
Cropping Intensity (%)	200	218	218				
Irrigation Intensity (%)		183	183				

APPENDIX TABLE: 1.9 DETAILS ABOUT AREA & YIELD

FIS, NANDPUR, SHIMLA

Units Area - Hectares
Yield - Qtl/hec.

Crop	AREA			Yield (Main Product)			
	Existing	With Project (A)	With Project (B)	Existing	Maximum Realised	With Project (A)	With Project (B)
Paddy	15	15	20	18	24.69	35	35
Maize	24	10	15	20	17.15	30	30
Wheat	37	40	50	16	8.70	30	30
Barley (RF)	15	5	5	16	11.02	18	18
Mash (RF)	10	5	5	6	3.23	7	7
Rajmah (RF)	10	5	5	6		7	7
Lentil (RF)	10	5	5	4		5	5
Sarson	26	16	16	4		8	8
Potato	26	30	30	60		150	150
Cabbage	1	5	5	55		100	100
Tomato	1.20	10	5	70	81	260	160
Peas (Kharif)	13.16	20.36	15.36	45	18	130	55
Peas (Rabi)	12.36	34.36	24.36	50	18	80	55
CCA	100.36	100.36	100.36				
GCA	200.72	200.72	200.72				
Cropping Intensity (%)	200	200	200				
Irrigation Intensity (%)		180	180				

APPENDIX TABLE: 1.15 OUTPUT PRICES OF IMPORTANT CROPS AS PER PROJECT REPORTS (Rs/Qtl)

Crop	TI		LIS		TI		FIS	
	Solan	Una	Kangra	Kullu	Shimla	Mandi	Mandi	Shimla
Paddy	150	150	150	160		150	150	200
Maize	180	180	180	180		180	180	180
Wheat	200	200	200	200	200	200	200	200
Barley				160				175
Mash			600	600			600	600
Gram	450	450					450	
Sarson	600	600	600		600			600
Sugarcane							100	100
Potato								
Tomato	200		200		200	200		200
Beans			150					
Capsicum								
Cauliflower	200		200		200	200		
Ladies Finger						100		
Onion	80						80	
Peas		150	150		150	150		150
Cabbage						100		
Fodder		15	15				15	

APPENDIX TABLE 2.1 TOTAL FARM LEVEL COSTS FOR TUBEWELL IRRIGATION PROJECT IN SOLAN AT MARKET PRICES

WITHOUT IRRIGATION

(Rs.)

	Seed	Compost	Fertilizer N.	Fertilizer P.	Fertilizer K.	N.P.K	Human Labour	Bullock Labour	Insecticide	Total	& NPK Compost
Kharif											
Maize	1757	14640	10541	7027	-	17568	19325	15811	-	69101	32208
Til	244	488	-	-	-	-	1464	1757	-	3953	488
Mash	3590	-	898	1795	898	3591	4488	5386	1496	18551	3591
Rabi											
Wheat	11712	19520	-	-	-	-	21082	21082	-	73396	19520
Gram	975	813	-	-	-	-	975	1170	163	4096	813
Sarson	729	1367	-	-	-	-	2732	3280	-	8108	1367
Total	19007	36828	11439	8822	898	21159	50066	48486	1659	177205	57987

APPENDIX TABLE: 2.2 TOTAL FARM LEVEL COSTS FOR TUBEWELL PROJECT IN SOLAN WITH IRRIGATION AT MARKET PRICES

WITH IRRIGATION (In Rupees)

	Seed	Compost	Fertilizers N	P	K	NPK	Human Labour	Bullock Labour	Ins./ Pesti.	Total	NPK + Compost
Kharif											
Maize	2330	19420	27965	13982	4661	46608	32626	23304	1942	126230	66028
Oilseeds	3294	-	586	1757	586	2929	1757	1757	244	9981	2929
Tomato	271	2713	781	391	195	1367	2604	1302	434	8691	4080
Onion	634	1440	778	518	130	1426	1210	864	144	5718	2866
Veg. Mix	179	1790	644	322	161	1127	1718	1074	269	6157	2917
Pulses	1171	-	293	878	146	1317	1464	1757	488	6197	1317
Rabi											
Wheat	11712	39040	28109	14054	3514	45677	23424	21082	3904	144839	84717
Gram	975	-	390	780	195	1365	1170	1170	325	5005	1365
Sarson	208	650	-	-	-	-	780	936	-	2574	650
Cauliflower	1315	5000	4500	1800	450	6750	6000	3000	1000	23065	11750
Turnip	167	555	333	266	133	732	799	666	111	3030	1287
Carrot	945	1500	900	720	360	1980	2160	1200	300	8685	3480
Grand Total	23201	72108	65279	35468	10531	111278	75712	58712	9161	350172	183386

APPENDIX TABLE 2.3 FARM LEVEL COSTS (AT MARKET PRICES) FOR TUBEWELL PROJECT IN SOLAN

(Rs./Hectare)

		Seed	Compost	Fertilizer N.	Fertilizer P.	Fertilizer K.	Fertilizer NPK	Hired Labour	Bullock Labour	Insecticide	Total
Kharif											
Maize I	WT	60	500	360	240	-	600	660	540	-	2360
I	W	60	500	720	360	120	1200	840	600	50	3250
Til	WT	50	100	-	-	-	-	300	360	-	810
Mash	WT	240	-	60	120	60	240	300	360	100	1240
Oilseeds	W	675	-	120	360	120	600	360	360	50	2045
Tomato	W	125	1250	360	180	90	630	1200	600	200	4005
Onion	W	440	1000	540	360	90	990	840	600	100	3970
Other Mixed	W	100	1000	360	180	90	630	960	600	150	3440
Pulses(R.F)	W	240	-	60	180	30	270	300	360	100	1270
Rabi											
Wheat I	WT	300	500	-	-	-	-	540	540	-	1880
I	W	300	1000	720	360	90	1170	600	540	100	3710
Gram I	WT	300	250	-	-	-	-	300	360	50	1260
I	W	300	-	120	240	60	420	360	360	100	1540
Sarson I	WT	80	150	-	-	-	-	300	360	-	890
I	W	80	250	-	-	-	-	300	360	-	990
Cauliflower	W	263	1000	900	360	90	1350	1200	600	200	4613
Tarrip	W	150	500	300	240	120	660	720	600	100	2730
Carrot	W	315	500	300	240	120	660	720	600	100	2895

WT: Without Irrigation W: With Irrigation

APPENDIX TABLE: 2.4 TOTAL FARM LEVEL COSTS FOR TUBEWELL PROJECT IN SOLAN WITHOUT IRRIGATION AT SHADOW PRICES

WITHOUT IRRIGATION

(in Rupees)

	Seed	Compost	Fertilizers N	P	K	N.P.K.	Human Labour	Bullock Labour	Insecti-cide	Total	NPK + Compost
Maize	1757	14640	13431	7495	-	20926	7730	15811	-	61520	35566
Til	244	488	-	-	-	-	586	1757	-	3124	488
Mash	3590	-	1144	1915	1075	4134	2154	5386	1496	16554	4134
Wheat	11712	19520	-	-	-	-	8432	21082	-	61464	19520
Gram	975	813	-	-	-	-	468	1170	163	3544	813
Sarson	729	1367	-	-	-	-	1312	3280	-	6562	1367
Total	19007	36828	14575	9410	1075	25060	20682	48486	1659	152768	61888

APPENDIX TABLE: 2.5 TOTAL FARM LEVEL COSTS FOR TUBEWELL PROJECT IN SOLAN WITH IRRIGATION AT SHADOW PRICES

WITH IRRIGATION (In Rupees)

	Seed	Compost	Fertilizers N	P	K	NPK	Human Labour	Bullock Labour	Ins./ Pesti.	Total	NPK + Compost
Kharif											
Maize	2330	19420	35631	14914	5578	56123	13050	23304	1942	117279	75543
Oilseeds	3294	-	747	1874	701	3322	703	1757	244	9380	3322
Tomato	271	2713	995	417	233	1645	1042	1302	434	7495	4358
Onion	634	1440	991	553	156	1700	484	864	144	5307	3140
Veg Mix	179	1790	821	343	193	1357	687	1074	269	5415	3147
Pulses	1171	-	373	937	175	1485	586	1757	488	5536	1485
Rabi											
Wheat	11712	39040	35816	14990	4204	55010	19730	21082	3904	140913	94050
Gram	975	-	497	832	233	1562	468	1170	325	4540	1562
Sarson	208	650	-	-	-	-	312	936	-	2133	650
Cauliflower	1315	5000	5734	1920	539	8193	2400	3000	1000	21112	13193
Turnip	167	555	424	284	159	867	320	666	111	2713	1422
Carrot	945	1500	1147	768	431	2346	864	1800	300	7828	3846
Grand Total	23201	72108	83176	37832	12602	133610	30646	58712	9161	329651	205718

		Seed	Compost	Fertilizer N	Fertilizer P	Fertilizer K	NPK	Human Labour	Bullock Labour	Insecticide	Total
Kharif											
Maize ½	WT	60	500	459	256	–	715	286	540	–	2101
½	W	60	500	917	384	144	1445	365	600	50	3020
Til	WT	50	100	–	–	–	–	130	360	–	640
Mash	WT	240	–	76	128	72	276	130	360	100	1106
Oilseed	W	675	–	153	384	144	681	156	360	50	1922
Tomato	W	125	1250	459	192	108	759	521	600	200	3455
Onion	W	440	1000	688	384	108	1180	365	600	100	3685
Other Mixed	W	100	1000	459	192	108	759	417	600	150	3026
Pulses(RF)	W	240	–	76	192	36	304	130	360	100	1134
Rabi											
Wheat ½	WT	300	500	–	–	–	–	234	540	–	1574
½	W	300	1000	917	384	108	1409	260	540	100	3609
Gram ½	WT	300	250	–	–	–	–	130	360	50	1090
½	W	300	–	153	256	72	481	156	360	100	1397
Sarson ½	WT	80	150	–	–	–	–	130	360	–	720
½	W	80	250	–	–	–	–	130	360	–	820
Cauliflower	W	263	1000	1147	384	108	1639	521	600	200	4223
Turnip	W	150	500	382	256	144	782	312	600	100	2444
Carrot	W	315	500	382	256	144	782	312	600	100	2609

APPENDIX TABLE: 2.7 ESTIMATION OF BENEFITS (WITHOUT IRRIGATION) FOR TUBEWELL PROJECT IN SOLAN AT MARKET & SHADOW PRICES

CROPS	MAIN PRODUCT							BY PRODUCT		
	Crop Area (Hec)	Yield (Qtl/H.)	Total Amount (Qtls)	Market Prices (Rs./Qtls)	Shadow Prices (Rs./Qtls)	Total Value (Rs.'000) At Market Price	Total Value (Rs.'000) At Shadow Prices	Qtls/ Hec.	Rate Rs./H	Total Value (Rs.'000)
Kharif										
Maize	29.28	18	527.04	157	278	82.75	146.52	18	270	8.0
Til	4.88	4	19.52	600	1044	11.71	20.38	-	-	-
Mash	14.96	5	74.80	600	1044	44.88	78.09	5	75	1.0
Total	49.12									9.0
Rabi										
Wheat	39.04	15	585.60	200	348	117.12	203.79	22	660	26.0
Gram	3.25	6	19.50	600	1044	11.70	20.36	6	150	0.5
Sarson	9.11	4	36.44	600	1044	21.86	38.04	4	60	0.5
Total	51.40									27.0
GRAND TOTAL	100.52					290	507			36.0

APPENDIX TABLE: 2.8 ESTIMATION OF BENEFITS (WITH IRRIGATION) FOR TUBEWELL PROJECT IN SOLAN

CROP	MAIN- PRODUCT							BY- PRODUCT		
	Crop Area (H.)	Yield (Qtl/H)	Total Amount (Qtl)	Market Price (Rs./Qtl)	Value at Market Price (Rs.'000)	Shadow Price (Rs.)	Value at Shadow Price (Rs.'000)	Market Price (Rs./Qtl)	Yield Qty (Qtls/ H.)	Value of By Product (Rs.'000)
Kharif										
Maize	38.84	30	1165	157	183	278	324	15	30	17.4
Oilseeds	4.88	8	39	600	23	1044	41	15	8	0.5
Tomato	2.17	160	347	252	87	252	87	-	-	-
Onion	1.44	140	202	80	16	80	16	-	-	-
Pulses	4.88	5.5	27	600	16	1044	28	15	5.5	0.4
Mix. Veg.	1.79	140	251	120	30	120	30	-	-	-
Total	54.00									
Rabi										
Wheat	39.04	30	1171	200	234	348	408	30	45	53.0
Gram	3.25	8	26	600	16	1044	27	25	8	0.5
Mustard	2.60	4.5	12	600	7	1044	13	15	4.5	0.2
Cauliflower	5.00	140	700	300	210	300	210	-	-	-
Turnip	1.11	125	139	80	11	80	11	-	-	-
Carrot	3.00	140	420	80	34	80	34	-	-	-
Total	54.00									
GRAND TOTAL ('000 Rs.)					867		1229			72

Appendix Table 3.1

LIS, PALAMPUR, DISTT. KANGRA

FARM LEVEL COST AT "MARKET PRICES" AND SHADOW PRICES (SP)

WITHOUT IRRIGATION

Area	FERTILIZER (Rs.)										
	Seed	Compost	N.	P.	K.	N.P.K.	Human Labour	Bullock Labour	Ins./ Pesti	Total	NPK + Compost
Kharif											
Maize	4500	18750	45000	9000	2250	56250	54000	40500	3750	177750	
Paddy	2400	5000	4800	2400	600	7800	16800	10800	1000	43800	
Mash	1200	750	-	-	-	-	1500	1800	500	5750	
Rabi											
Wheat	27000	45000	-	-	-	-	48600	40500	-	161100	
Sarson	800	1000	-	-	-	-	3000	3600	-	8400	
Total MP	35900	70500	93000	11400	2850	64050	123900	97200	5250	396800	134550
Total SP	35900	70500	118497	12160	3410	134067	53773	97200	5250	396690	205567

LIS, PALAMPUR, DISTT. KANGRA

Crop	WITHOUT IRRIGATION							BY PRODUCT		
	Crop Area (Hect)	Yield (Qtl/H.)	Total Amount (Qtls)	Market Price (Rs./Qtl)	Value at Market Price Rs.('000)	Shadow Prices (Rs./Qtls)	Value at Shadow Price (Rs.'000)	Qtls/ H.	Amount Rs./H.	Total Amount (Rs.)
Kharif										
Maize	75	18	1350	157	211.90	278.00	375.30			270x75
Paddy	20	18	360	210	75.60	306.00	110.20			405x20
Mash	5	5	25	600	15.00	1044.00	26.10			75x5
Rabi										
Wheat	90	12	1080	200	216.00	348.00	375.84			540x90
Sarson	10	4	40	600	24.00	348.00	13.90			60x10
					542.50		901.30			77,925

Appendix Table 3.3

LIS, PALAMPUR, DISTT. KANGRA

TOTAL FARM LEVEL COST AT " MARKET PRICES AND SHADOW PRICES (SP)

WITH IRRIGATION

(Rs.)

Area	Seed	FERTILISER Compost	N.	P.	K.	N.P.K.	Human Labour	Bullock Labour	Ins./ pesti	TOTAL	NPK + Compos
Kharif											
Maize	1200	10000	14400	7200	2400	24000	16800	12000	1000	65000	
Paddy	7800	32500	35100	15600	7800	58500	85800	58500	6500	249600	
Tomato	313	3125	900	450	225	1575	3000	1500	500	10013	
Beans	6875	6250	1500	3000	750	5250	4200	3000	1000	26075	
Capsicum	1250	3125	1500	1125	375	3000	2400	1500	375	11650	
Mash (RF)	1200	1500	-	-	-	-	1500	1800	500	6500	
Rabi											
Wheat	18000	60000	43200	21600	5400	70200	36000	32400	6000	222600	
Barseem	1250	5000	1500	1800	-	3300	3000	1500	250	14300	
Cauliflower	1050	5000	4500	1800	450	6750	6000	3000	1250	23050	
Cabbage	280	6250	1800	1800	450	4050	4800	3000	1250	19630	
Peas	6000	10000	3000	3600	1800	8400	8400	6000	2000	40800	
Sarson (RF)	1200	3750	-	-	-	-	4500	5400	-	14850	
Total MP	45918	146500	107400	57975	19650	185025	176400	129600	20625	704068	331525
Total SP	45918	146500	136845	61840	23514	222199	76558	129600	20625	641400	368699

Appendix Table 3.4

LIS, PALAMPUR, DISTT. KANGRA

Crop	WITH IRRIGATION							BY PRODUCT		
	Crop Area (Hect.)	Yield (Qtl/H)	Market Price (Rs./Qtl)	Total Amount (Qtl)	Shadow Prices (Rs./Qtl)	Value Rs.('000) at MP	Value Rs.('000) at SP	Qtls/H	Rs./H	Total Amount (Rs.)
	6							8		
Kharif										
Maize	20	30	157	600	278	94.20	166.80			450x20
Paddy	65	40	210	2700	306	567.00	826.20			1125x65
Tomato	2.5	160	252	400	252	100.80	100.80			-
Beans	5	150	150	750	150	112.50	112.50			-
Capsicum	2.5	100	197	250	197	49.25	49.25			-
Mash (RF)	5	5.5	600	27.5	1044	165.00	287.10			83x5
Rabi										
Wheat	60	30	200	1800	348	360.00	626.40			1350x60
Barseem	5	400	15	2000	15	30.00	30.00			-
Cauliflower	5	140	300	700	300	210.00	210.00			-
Cabbage	5	140	225	700	225	157.50	157.50			-
Peas	10	55	292	550	292	160.60	160.60			-
Sarson (R.F)	15	4.5	600	67.5	1044	40.50	70.47			68x15
						2047.00	2798.00			1,63,880