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RELATIVE PROFITABILITY OF HYV BORO UNDER DIFFERENT SYSTEMS OF TUBEWELL IRRIGATION IN AN AREA OF BANGLADESH*

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ABSTRACT

The present study investigated into the relative profitability and problems of Deep Tube-wells, Shallow Tube-wells and Hand Tube-wells with respect to HYV of boro. It was found that from both private and social point of views, DTW was the most profitable and then came STW and HTW in order, However, when the opportunity cost of labour for operating HTW was considered as zero, the social benefit accrued to the use of HTW was found to be the highest. When full operating cost of labour for HTW was considered, the net return to HTW was found to be negative. The HTW projects were dominated by small/marginal farmers; the STWs were dominated by rich farmers; whereas, the DTWs were used by almost all the categories of farmers: large, medium, and small, Sensitive factors such as yield, price and acreage coverage were tested against the findings. It was observed that acceptability of the project to a cost-benefit ratio of one or I. R. R of 15% would not change until there was a drastic change in those factors. The study identified certain basic problems of the irrigation facilities and came to the conclusion that for the optimal use of the facilities, these problems needed urgent solution.

I. INTRODUCTION

Bangladesh agriculture is beseized by the twin problems of drought during the rabi season and floods during the early and late monsoon. Since long past it has been realized that rabi season is a safer season and if irrigation water can be made available, Bangladesh can meet her food deficit.

Bangladesh has introducd artificial irrigation practices since 1950. Power pumps are being utilized where surface water is available and where it is not availale, different capacity tube-wells have been installed. During the 1974-75 season, the irrigated aereaQes were as shown below (Lawrence, 1976, P,5) :

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	(Million acres)
Low Lift Pumps	1.1296
Deep Tube wells	.118
Shallow Tube-wells	.023
Various surface and traditional methods	1.000

The surface water irrigation by power pumps started in 1950 with initially 5 pumps in operation. There has been progressive increase in the use of the power-pumps throughout the country with a sharp rise during the last few years, resulting in a total of 35,000 pumps fielded upto the year 1973-74. The DTW irrigation scheme was taken in hand in the year 1967-68 and by 1973-74, BADC had installed about 3,300 deep and 3,750 shallow tube-wells in different parts of the country (Biswas, 1975, P.8). The HTW irrigation was first introduced in the year 1971 and it increased progressively over the the successive years as shown below (Lawrence, 1976, P.4) :

Years	New HTWs	Cumulative Nos.
1971	—	2,000
1972	6,000	8,000
1973	1,0 0	9,000
1974	6,000	15,000
1975	15,000	30,000
1976	10,000	40,000

Assuming a command area of .50 acre per HTW, it would appear that about 20,000 acres of land would have been irrigated by this method in the year 1976.

At present the BADC arbitrarily assumes about 60 acres of command area (during winter season) for most of the power pumps and for almost all the DTWs having 2-cusec capacity. Irrigation efficiency based on the above assumption has not been improved over the past years though the number of power pumps or deep tube-wells has appreciably increased. For the DTW programme the irrigation efficiency (in terms of command area) was higher in the year 1968-69. At the Second year of implementation of the DTW programme, the efficiency was 67 per cent. But unfortunately it decreased gradually to a level of 44.4 per cent in 1972 (Biswas, 1975, P. 8). It may therefore be observed that in general, the existing capacity utilization of the irrigation facilities in the country is extremely poor.

The DTW and the STW are capital intesive projects while the HTW is labour intensive. HTW projects are much smaller than DTW and STW ones. However, each system has its relative merits and demerits. But precise information has not yet been made available as to the nature and extent of success or failure of different technologies of tube-well irrigation.

Therefore, the present study has been designed with the following objectives :

1. To determine the relative profitability of DTW, STW and HTW projects with respect to the HYV of Boro.
2. To determine the benefits accrued to the individual and the society due to the investment on DTW, STW and HTW irrigation.
3. To study the effects of sensitive factors on the findings.
4. To identify the problems associated with DTW, STW and HTW irrigation.

II. METHODOLOGY

For the present study 3 DTW, 3 STW and 24 HTW projects were selected from Jamalpur and Sharishabari Thanas of Mymensingh district. The selection of the DTWs and the STWs involved the following procedure :

A list of all the irrigation units according to categories and command areas was prepared with the help of the field officers. They were then stratified according to the actual acreages irrigated. There were 3 strata : Best, Average and Poor. The principle of selection was to select randomly one irrigation unit from each stratum ; thus 3 DTWs and 3 STWs were selected having the following actual acreages covered :

Type	Best (acres)	Average (acres)	Poor (acres)
DTW	70	45	20
STW	6.5	5	2

As regards the HTWs no such stratification was done and 24 HTWs were selected randomly from Sharishabari Thana which had about 3 thousand such small irrigation schemes.

Twenty seven farmers from the DTWs, five farmers from the STWs and 24 farmers from the HTW projects were selected randomly. The actual average acreage per DTW, STW and HTW were calculated as 45, 4.5 and .60 acres respectively. The period of investigation covered a complete boro season (January to May) of 1975.

The analytical techniques used were :

1. Enterprise costing and
2. Discounted measures of project worth (used in ex-post sense) for economic and financial analyses.

Procedure for the Evaluation of cost items for Economic and Financial Analyses

For analytical advantage the cost items were classified under the following 3 heads :

(a) Investment cost

(b) Operation and Maintenance (O & M) cost and

(c) Production cost

(a) Investment cost

In the case of financial analysis, market value (project value or P. V.) of every item of investment cost was considered, but for economic analysis, shadow price (accounting price or A. V.) of these items was taken into consideration. For economic analysis C.I.F cost of imported materials and equipments was considered as accounting value. Here C.I.F. cost refers to marginal import cost (MIC) which excludes import duty and sales tax on imports. In the case of the investment costs of the DTW and the STW, duty on imported materials was excluded in economic analysis, but in the case of the HTW the duty could not be traced out from the available data. Accounting price of the other items was calculated by using Planning Commission conversion factors (Appendix I). The market value of an input multiplied by the conversion factor represented the value of the input at accounting price.

(b) Operation and Maintenance (O&M) cost

For financial analysis market price of operation and maintenance items was taken into consideration. Repairing cost for the DTW & the STW was assumed at 1[illegible]% of the cost of engine For economic analysis accounting price of fuel and lubricant , repairs and carriage of fuel and lubricants was calculated by using Planning Commission conversion factors (Appendix 1). Conversion factors for miscellaneous expenditure was not available, so it was kept the same for both the economic and the financial analyses. Cost of family labour in preparing sheds for the STW and the HTW was excluded in both the economic and the financial analyses, because the opportunity cost of family labour was considered to be zero.

For financial analysis only the cost of hired labour for operating the HTW was considered because the analysis was performed from the view point of the farm family whose equity was assumed to be receiving the return.

The HTW was completely operated by human labour. Shadow pricing of labour is very difficutl in an economy where there exists seasonal or disguised unemployment. In this situation shadow pricing of labour depends upon the scarcity of labour in the economy (Gittinger 1972, p, 42). So the full cost of labour should not be taken into consideration in economic analysis ; only that portion of labour which is considered scarce should be taken into consideration. It was not exactly known how many mandays were scarce in Boro season in the project area. There is much controversy among the economists about the exact unemployment situation in the Boro season. Therefore, for the economic analysis shadow price for agricultural labour was calculated on different assumptions.

At first, it was assumed that there was a scarcity of 50 percent of the total labour force during the winter season. In this case, cost of only 50 percent labour was taken into cosideration. Secondly, it was assumed that there was a scarcity of only 25 percent of the total labour force during winter season. In this case, cost of 25 percent labour was taken into consideration. Thirdly, it was assumed that there was no scarcity of labour in the winter season ; therefore, the opportunity cost of labour in winter season without irrigation project was zero or close to zero. In this case shadow price for agricultural labour was considered to be zero.

(c) Production Cost

In financial analysis the cost of hired labour was considered. But in economic analysis the same concept of valuation for labour was applied as in the case of shadow pricing of labour for operating the HTW.

During the Boro season, the wage rate of labour was Tk. 10.00 due to high prices of rice and other commodities at that time. The wage rate of lobour in the Aus season was Tk. 8.00 due to a fall in the price level.

During the Aus season the opportunity cost of labour is not thought to be zero because the labourers during this season find employment and there is an active labour market. Therefore, in this case the full cost of labour was taken into consideration in economic analysis.

The full cost of animal labour was considered in economic analysis because it was relatively a scarce resource. In financial analysis, the full cost was taken into consideration becuse animal labour involved the maintenance expenditure and the farmers could rent it out if they liked, therefore, opportunity cost was involved.

The full costs of seedlings and manures were considered in both the economic and financial analyses on the basis of their opportunity costs. In the case of insecticide, market price was considered in both the analyses. For fertilizer maket price was considered in fiinancial analysis, however, in economic analysis, Government subsidy was added to the control price. The subsidy per seer on Urea, T.S.P. & M. P. was Tk. 0.90, Tk. 3.13 & Tk. 2.00 respectively.

(d) Cost of Land Use

Land was valued at an estimate of the net value of production foregone or the opportunity cost which entered each year as a cost to the project.

The farmers under the projects grew IR-8 which required a period of about 5 months in the Boro season. The farmers usually cannot grow local Aus (Broadcast) after harvesting Boro crop of IR-8 variety because the sowing would be very late and consequently the yield would be very poor. For this reason the net value of production foregone for the local Aus was considered as the net benefit without project and this was considered as a cost of the project for both the economic and the financial analyses.

Valuation of Output

The price of paddy during the period of collection of data (just after harvesting) was Tk. 115.00 per maund which was taken into consideration for financial analysis. For econmic analysis, the accounting price (shadow price) for paddy was taken at interational price using the official rate of exchange for the Bangladesh currency at US $=Tk. 14.50. The authors were convinced that the true price of Bangladesh currency was not this at the time of analysis but fiinding the true price was beyond the scope of this study.

Using the C.I.F. price of rice at US $ 235 per ton (as per Janata Bank letter of Credit), the C.I.F. price of rice per maund was calculated as Tk. 127.00. Trade and transport cost per maund of rice was assumd to be 5 percent of the price of rice (Tk. 6.35) in each case. The accounting transtort and trade cost (ATC) between the port and the the project area was then calculated as Tk. 7·00 approximately (using conversion factor .6 for transport and .55 for trade to get $6.35 \times .6 + 6.35 \times .55 = 7.30$). The accounting price of rice was then $C.I.F + ATC = 127 + 7 =$ Tk. 134.00 per maund. The price of paddy was found to be Tk. 87.00 using the paddy-rice conversion ratio.

According to the prevailing market rate at that time the price of straw for IR-8 was Tk. 4.00 per maund and it was Tk. 6.00 per maund for Aus. The market price of straw was usedin both the economic and the financial analyses.

Assumptions

1. The salvage value of pipes, strainer, bail plug, reducing socket and pump house of the DTW was assumed to be 30 percent of the initial cost. In the case of the STW, the salvage value on the cost of pipes and strainer was assumed to be 50 percent. In the case of the HTW the salvage value on pump and pipe was assumed to be 30 percent of the initial cost.

2· The life of the DTW project was assumed to be 20 years and in the case of the STW and the HTW these were assumed to be 10 years.

III. DATA AND DISCUSSION

The enterprise costing analysis was performed keeping in mind various issues and situations that were involved with these tube-well systems. The analysis covered almost all the possible situations and was made as realistic as passible. For the DTW two sets of analyses were presented :

a) Considering the rental system ; and

b) Considering the capital cost.

Since the STWs are no longer under the rental system, its analysis was performed considering the capital cost only.

For the HTW 3 variations were taken into account in the analysis :

a) Considering hired labour only (for the operation of the HTW)

b) Considering the operation of the HTW by labour exclusively whose opportunity cost was assumed to be zero.

c) Considering the full cost of labour (hired or family).

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b) Considering the operation of the HTW by labour exclusively whose opportunity cost was assumed to be zero.

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Evaluation of Some Irrigation Costs

Depreciation on Capital Cost

Depreciation on tube-well materials in the case of the DTW included depreciation on Bail plug (GI), Blind Pipes, Screen (GI), Housing Pipe and Reducing socket. In the case of STW, the cost of materials referred to cost of pump head, pipe and Screen. In the case of HTW it referred to cost of pump and pipes. Depreciation of the tube-well materials was calculated on the basis of expected lives of different items and their salvage values at the end of the project lives.

Installation and Other Initial Costs

Annual average of the installation and other associated initial costs (i. e. boring, site development etc.) of the DTW and STW projects were taken into consideration on the basis of expected lives of the projects.

Interest on Capital Cost

Annual average of the interest on the basis of the respective life of different capital items was calculated at the rate of 7% per annum. The annual average of interest was taken into consideration because the total amount of interest for the entire period of depreciation would depend upon the declining balance procedure.

Cos of Labour for Operating the HTWs

Labour for operating the HTW was calculated on hourly basis. On average, a HTW was operated for 14 hours out of 24 hours in the study area. Hours of operation for both hired and family labour were calculated separately. Total hours of operation per HTW (.60 acre command area) were 1190 hours or 149 mandays (1 manday = 8 hours) out of which the contribution of family labour was 882 hours or 110 mandays and that of hired labour was 308 hours or 39 mandays. Thus the contibution of family labour was 73.83% of the total labour for operating the HTW and that of hired labour was 26.17% (Table 6). Per acre total mandays required for operating the HTW was calculated as

248 and it was 65 for hired labour. Thus,

Per acre cost of hired labour for operating the HTW	= Tk. 650.00
Interest on the cost of hired labour	= Tk. 9.49
Total	Tk. 659.49

Variable cost without any cost of labour for operating the HTW (i. e. the HTW was operated by family labour whose opportunity cost was considered to be zero)	Tk. 855.65-659.49 = Tk. 196.16
Per acre total mandays required for operating the HTW (p.24) was 248 mandays	
Therefore, the cost of labour for operating the HTW	= Tk. 2480.00
Interest on operation cost of the HTW	= Tk. 36.21
Total	Tk. 2516.21

Hence per acre variable cost of irrigation considering the full cost of labour = Tk. 2712.37 (i. e. Tk. 2516.21 + Tk. 196.16).

Average Return Per Acre

Paddy Yield

The average yields of IR-8 under the DTW, STW and HTW projects were 40.79 maunds, 44.18 maunds and 39.28 maunds respectively.

Net Return

Net return per acre averaged Tk. 2215.86, Tk. 2291.73 and Tk. 1365.84 for the DTW, STW and HTW projects respectively. Thus net return per acre under the STW project was slightly higher than that of the DTW project. Net return per acre under the HTW project was much lower than those of the DTW and STW projects.

However, if we would consider that the HTW was operated by family labour alone (whose opportunity cost was zero), then the net return per acre would be Tk. 2025.33 which was still lower than those of the DTW and STW project ; it was particularly due to low per acre yield under the HTW project.

Furthermore, if we would consider the full cost of labour for operating the HTW (both family and hired labour), then the net return would be negative i. e. a net loss of Tk. 499.88 would have been incurred per acre.

Again, if we would consider that the DTW was under the rental system, then the net return per acre would be Tk. 2455.55 which was much higher than those of both the STW and the HTW projects.

IV. ECONOMIC ANALYSIS OF THE DTW, STW AND THE HTW PROJECTS

Two discounted measures of project worth namely, Benefit-Cost Ratio (BCR) and Internal Economic Return (IER) were calculated for economic analysis of the tube-wells.

The average command areas of the DTW, STW and the HTW projects as stated were 54, 4.5 and .60 acres respectively. The analysis was performed considering the average command areas of the tube-well projects. For economic analysis at first it was assumed that 50% of labour was scarce in the winter season and accordingly the cost of 50% labour was taken into consideration. The Benefit–Cost–Ratios (BCR) and Internal Economic Returns (IER) worked out are presented below :

Type of Tube-well projects	BCR	IER
DTW	1.66	Greater than 50%
STW	1.58	Greater than 50%
HTD	1.07	45%

Source : Tables 7, 8, 9 & 10

The above results would show that individually any type of tube-well irrigation could be acceptable. But from comparative point of view if the choice involved a region where the geophysical situation was such that all these tube-wells could be installed, then definitely the investment choice should go for the DTW, as its BCR was the highest.

Benefit-cost Ratios and Internal Economic Returns of the DTW, STW and HTW Considering 25% Labour Scarcity in Winter Season

If we would have considered that 25% labour was scarce in the winter season then the shadow price for the remaining 75% labour would be zero. In this case, other things remaining the same (gross value of production, slavage value, investment cost, operation and mainterance cost, net benefit without project), for economic analysis, only the production cost under the DTW, STW and the HTW projects would change. A summary of the results of the benefit-cost ratios and the internal economic returns under the situation stated above is given below :

Types of Tube-wells	RCR at 15% discount rate	IER
DTW	1.90	Greater than 50%
STW	1.76	Greater than 50%
HTW	1.47	Greater than 50%

Source : Jaim 1976, pp. 176-178.

Benefit-cost ratios and the internal rate of returns in all the cases were found to be high, hence all the projects would be acceptable from the economic point of view. But again in a comparative sense, if all the projects were thought of for the same region, then the highest BCR of the DTW would suggest that the investment would be more profitable in this case.

Benefit-cost Ratios and Internal Economic Returns Considering Opportunity Cost of Labour During Winter Season to be Zero

Other things remaining the same (gross value of production, salvage value, investment cost, operation and maintenance cost, net benefit without project), for economic analysis, the production cost would change accordingly if the opportunity cost of labour in the winter season was considered to be zero. Given this situation, the benefit-cost ratios and the internal economic returns would be as follows :

Types of Tube-wells	BCR at 15% DF	IER
DTW	2.20	Infinity
STW	2.00	Infinity
HTW	2.36	Infinity

Source : Jaim 1976, pp. 179-181.

From the above results it would show that benefit-cost ratios for all the types of tube-well projects were greater than one, hence all the projects were acceptable from the economic point of view. The IERs for all the types were found to be infinity. Further, it is worth mentioning that the benefit-cost ratio was the highest in case of the HTW and sligtly higher than that of the DTW, implying its superiority in terms of profitability over the other types of projects, if all the pıojects were thought of for the same region.

V. FINANCIAL ANALYSES WITH RESPECT TO DTW, STW AND HTW PROJECTS

Since a farmer entrepreneur would invest some capital in an irrigation project, his usual expectation would be to realize the equity capital and make a profit over and above. Therefore, the analysis should be performed in keeping with the objective of the farmer and thus a measure of the internal rate of return in this case would provide a guideline to quantify the profitability and justify the investment from the farmer's point of view.

The analysis was based on a 1-acre model irrigated crop land in case of the STW and the DTW because it was found to be manageable and conceptually more conceiveable. One HTW was observed to have the potential capacity of irrigating ·60 acre of land. Therefore, in the analysis .60 acre was considered in projecting costs and benefits in case of the HIW.

Financial analysis of the farmer under the DTW was performed in two ways : (a) considering the DTW under the rental system and (b) investment cost of the DTW.

The average command areas of the DTW and the STW as stated were 45 and 4.5 acres respectively. From these average command areas all items were converted into per acre term. The average command area of the HTW was .60 acre. Therefore, .60 acre was taken as a unit and costs and benefits were expressed accordingly and in terms of a HTW.

Financial analyses of the DTW, STW are given in Tables 11, 12, I3 and 14. It was found that the internal financial renurns (I.F.R.) were more than 50% in all the cases. Considering the DTW under the rental system, the I.F.R. was found to be infinity, meaning a very high profit and potentiality of the investment from the farmer's point of view. However, it would have been more explanatory if the ranking of IFRs. could be accomplished for all the types of irrigation projects from the farmers' point of view ; but it was not possible since the discounting factors were not available beyond a discount rate of 50 percent. In the case of economic analysis the ranking was done by applying the BCRs but in the case of financial analysis, use of the BCR technique was not advisable.

VI. SENSITIVITY ANALYSIS

Sensitivity Analysis as Applied to the Economic Analysis

In this section, effects of different command areas of DTW and the STW projects on benefit-cost ratio and internal rate of return were examined. The investment cost remaining the same, the command area of the DTW and the STW may vary to a wide range. The range of command area within which the production increases with the increase in command area is too small in the case of the HTW irrigation, so the effect of command area on the benefit-cost ratio (BCR) and the internal economic return (IER) was not considered in this case.

The Effects of Command Area (CA) on Benefit-cost Ratio and Internal Rate of Return in the Case of the DTW

In the foregoing economic analysis of the DTW (considering 50% labour scarcity, Table 8) with command area of 45 acres, the benefit-cost ratio was derived as 1.65 and the internal rate of return was found to be more than 50%. Assuming different command areas of the DTW, sensitivity analysis was performed. The assumed areas were 60, 30 and 15 acres. The results of the analyses are given below :

Discounted measures of project worth.	Command Area		
	60 acres	30 acres	15 acres
BCR	1.72	1.56	1.31
IER	Infinity	More than 50%	42%

Source : Jaim 1966, pp. 182-184.

Effects of Command area on the BCR and IER in the case of the STW

In the foregoin economic analysis of the STW (considering 50% labour scarcity), with average command area of 4.5 acres, the BCR was calculated as 1.58 and the IER was found to be more than 50% (Table 9). On the basis of this analysis the effects on the BCR and the IER were examined due to varied command areas. The assumed command areas were 8, 6 and 2 acres. A summary of the results of the analyses is given below :

Discounted measures of project worth	Command area		
	8 acres	6 acres	2 acres
BCR	1.69	1.64	1.32
IER	Infinity	Infinity	More than 50%

Source : Jaim 1976, pp. 185-187.

Determination of the Floor level of operation of DTW and STW projects

By applying the sensitivity analysis (considering multiple variables), floor level of operation of the DTW and STW was determined (Tables 15 & 16) by regorous trial and error method. Here the floor level of operation refers to a condition under which the BCR is 1. The IER was calculated as 16% in this case. The floor level of investment in the case of the DTW and STW was determined by considering certain conservative assumptions as :

(1) The command areas of DTW and STW were assumed to be 15 and 2 acres respectively. (2) The lives of the DTW and STW projects were assumed to be 10 and 5 years respectively. (3) It was assumed that investment cost, operation and maintenance cost would be increased by 30% for both DTW and STW. (4) The benefit was assumed to be reduced by 12% for DTW and 5% for STW either due to change in price or yield or both. (5) The salvage value was assumed to be 60% for DTW and 7% for STW projects' initial cost of materials (pipes, strainer etc.) which was assumed to increase by 30%. (6) The present level of subsidy remaining in force.

These were the probable conditions and the manipulations of the parameters which produced a benefit-cost ratio of 1.00. Other things remaining the same any change in the above assumptions will determine whether the operation of a DTW and STW would be economically justified or not.

Sensitivity Analysis as Applied to Financial Analysis

The conditions upon which the financial analysis of the farmer's equity under the DTW, STW and the HTW projects were performed, were very likely to change. Therefore, sensitivity analysis was applied to examine these changed circumstances. Two factors were taken into consideration in this respect : (i) variation in yield and (ii) variation in the price of output.

(i) Effects on Internal Financial Returns Due to Variation in Yield

Other things remaining the same, the effects on the IFRs of the farmer's equity due to a 20% reduction in yield under the DTW, STW and the HTW projects were examined. The results are presented below :

Types of tube-wells	IFR
DTW (under the rental system)	Infinity
DTW (considering the investment cost)	More than 50%
STW	44%
HTW	More than 50%

Source : Jaim 1976, pp. 188–191.

The results would show that even if the yield of the IR-8 crop fell short of the average yields by 20%, it would not affect much the economic viability of the projects from the farmer's point of view.

(ii) Effect on the IFR Due to Change in Output Price

In the foregoing financial analysis of the farmer's equity under the DTW, STW and HTW projects, the price per maund of paddy was taken as Tk. 115.00. However, Government procurement price of paddy was fixed at Tk. 74.00 per maund (1975) effect of which was also studied. A summary of the results is given below :

Types of Tube-wells	IFR
DTW (under rental system)	Infinity
DTW (considering investment cost)	More than 50%
STW	35%
HTW	More than 50%

Source : Jaim 1976, pp. 192-159.

It is observed from the table that with the assumed lower price of paddy in all the cases IFRs were appreciably high. This would show again that the Government price was fixed quite rationally and it affected the profitability of the farmers only marginally.

(iii) The above findings justify the rationale of operating a deep tube-well with a coverage of around 15 acres from the farmers' point of view. However, crucial factor here is the very high level of subsidy given on tube-wells and hence the farmer's interest comes into conflict with social interest. The present level of subsidy is therefore, to a great extent, providing disincentive to increase the capacity utilisation of the highly expensive deep tube-wells.

VII. IDENTIFICATION OF PROBLEMS WITH DTW, STW AND HTW IRRIGATION

In our pursuit of studying the tube-well irrigation systems at the field level, we experienced some problems and grievences which would demand immediate attention of the concerned agencies. Otherwise, the expected benefits that should accrue due to these types of irrigation facilities would be lost soon. Therefore, we thought of documenting these problems systematically.

Problems with the DTW Paojects

Organizational problems

A wide variation of yield and command area was observed among different DTW projects. The main cause of the low per acre yield in some projects seemed to be the organisational problem. There was a very weak relationship between the manager and the members and there was no Managing Committee in these projects. The manager was all in all and no proper account was maintained. Discrepancy of water distribution was also observed and the small farmer-members had to depend upon the mercy of the manager for getting irrigation water.

Some of the DTW projects covered a low command area because there was no planning for command area and the irrigated plots did not consist of compact land and were situated scatteredly.

Fuel and Lubricants

The supply of oil and fuel by the BADC was not sufficient. It was found that the BADC supplied 63.99% of fuel and 59.09% of lubricants of the total requirements. The rest 36.01% of fuel and 40.01% of lubricants were purchased from the black market at a higher price. This created problem in smooth operation of the DTW projects.

Spare Parts

The DTWs faced trouble due to scarcity of spare parts. Lack of fund for purchasing spare parts was observed in some DTW projects. Ready made fund to meet these incidental expenses was not possible to create because the farmers were suspicious about the sincerity of the managers.

The other factors affecting the efficiency of the DTW projects were lack of technical knowledge of the drivers, lack of pucca drain, lack of land levelling and wrong site selection.

It was observed in some DTW projects that some non-members refused to allow field channels or drains across or alongside their plots.

Promlems with the STW Projects

Spare Parts

Mechanical breakdown was frequent in the case of the STWs. The STW projects were suffering from non-availability of spare parts. the supply of which by the BADC was not sufficient. Therefore, farmers often had to buy spare parts from the black market at a very high cost.

Fuel and Lubricants

It was observed that the BADC supplied 81.60% of fuel and 40% of lubricants and the rest was purchased from the black market at a high cost.

Mechanics

There were only one mechanic and two assistant mechanics for 95 DTWs and 30 STWs in Jamalpur Thana. The number of mechanics was too small in comparison with the number of the DTWs and the STWs.

It was observed that though the DTW and the STW projects were situated far away from the Jamalpur town yet the mechanics were not provided with adequate transportation facilities.

Problems with the HTW Projects

Operation of the HTW

The HTW operation was a very difficult and laborious job. Blisters were observed in farmers' hands developed from continuous pumping. As the HTW irrigation requires continuous pumping throughout the whole day and a portion of night, it was very difficult to make it a profitable one by using only hired labour. So availability of active surplus family labour was found to be one of the constraints in developing the HTW irrigation to a large extent.

Limitation of Command Area

Only one family labourer was not sufficient for operating the HTW. Two, three and even four labourers were found to operate a HTW alternatively. So it was very difficult to operate more than one HTW by using family labour. On the other hand operation of the HTW by hired labour was too much expensive.

The average command area of a HTW was only .60 acre. It was found that per acre yield sharply decreased beyond the command area of .70 acre. Because it would become too much difficult to irrigate land by the HTW when the command area would become a bit larger than .70 acre. But an individual farmer could irrigate more land under the DTW and the STW projects.

It was found that a farm family would irrigate 2.07 acres under the DTW, 1.74 acres under the STW, but only .60 acre under the HTW project. So the individual farmer under the HTW could irrigate more land if he could get the facility of the DTW or the STW irrigation (provided the farmer and possessed more than .60 acres of land).

Influence of Rainfall

The rainfall has a great impact on HTW irrigation. If the climate is not favourable, the farmers may have to face tremendous difficulty in irrigating the land, particularly if the command area is a bit larger.

Lack of Capital to Purchase the HTW

Though the cost of the HTW was not too much, yet it was difficult for some farmers to purchase a HTW for irrigation. Out of the 24 samples of HTW farmers, in 13 cases HTWs were owned by the farmers themselves and for the rest of the cases the HTWs were hired. The farmers had to pay high charges for hiring the HTWs. At the end of the season, each farmer had to pay 5 to 6 maunds of paddy to the owner of the HTW as rental for hiring a HTW. The farmers who owned the HTW used their past savings or sold bullocks or corrogated sheets of their houses to purchase the HTWs.

Lack of Operating Capital

Small farmers need credit not only for purchasing the HTW but also to meet up the operating cost of the HTW. As the HTW is a labour intensive technology, the wage for labour is the major cost. However, it is not always possible to operate the HTW by using family labour alone and hired labour has to complement it. Thus, whenever the hired labour is needed, credit may also be needed. Credit will also be required to partly finance other production costs.

VIII. SOME RECOMMENDATIONS

1. The manager and the members of the Managing Committee should be selected properly in the case of Deep and Shallow tube-well projects. There should be a proper water distribution system and the Managing Committee should keep proper accounts of the projects which should be audited.

2. Priority of sanctioning DTW should be linked with the existence of economically viable co-operative organization.

3. The concerned officers of the BADC should make an assessement of the requirment of oil and fuel of the DTW or the STW and this should be communicated to the supplying agencies well in advance so that the supply for oil and fuel could be better ensured.

4. The BADC should have a good stock of spare parts so that these would be always available. The spare parts which most frequently would disturb should be locally available. To ensure the supply of spare parts, new workshops should be set up on an emergency basis and a training programme of rural repairmen, blacksmiths, etc. should be undertaken at the Thana workshops.

5. The number of the BADC mechanics should be increased and they should be provided with adequate transportation facilities so that they could work more efficiently.

6. The BADC officers should avoid the influence of the power structure in selecting sites for DTW and STW project.

7. The fertilizer supply should be ensured in order to make the irrigation schemea a success.

8. The tenancy arrangement with respect to HTW irrigation should be reformed.

9. A comprehensive and a massive HTW irrigation programe should be chalked out for the low lying areas (Char areas). This should be arrangea on an emergency basis, because the DTWs and the STWs have not yet reached these areas due to bad communication system.

10. Law enforcing agencies should be more alert and watchful on the malpractices and corruptions that are involved with the irrigation facilities in Bangladesh.

TABLE 1 AVERAGE PER ACRE COST OF GROWING IR-8 UNDER THE DTW IRRIGATION PROJECT[a]

Items of cost	Quantity		Total Cost, Tk.	% of total gross cost
	Family	Hired		
Human labour (mandays)	33	75	1080.00	41.47
Animal labour (hours)	64	8	126.00	4.84
Seedlings (family supplied)	—	—	53.61	2.06
" (purchased)	—	—	72.44	2.78
Manures (maunds)	164.84	—	247.26	9.49
Fertilizers (seers)	—	89.21	128.13	4.92
Insecticides (seers)	—	.74	11.84	.45
Irrigation cost	—	—	451.37	17.33
Land use 6	—	—	408.80	15.70
Interest on operating capital	—	—	25.10	.96
Interest on borrowed capital	—	—	—	—
Total Gross Cost			2604.55	100.00
Credit from straw			129.56	
Total Net Cost			2474.99	

a Considering the capital cost of the tube-wells.

b Interest on land value was calculated @ 7%, the value of land per acre under the DTW was Tk. 14,000.

TABLE 2 AVERAGE PER ACRE COST OF GROWING IR-8 UNDER THE STW IRRIGATION PROJECT[b]

Items of Cost	Quantity		Total Cost, Tk.	% of total gross cost
	Family	Hired		
Human labour (mandays)	14	94	1080.00	36.75
Animal labour (hours)	64	—	112.00	3.81
Seedlings (Family supplied)	—	—	49.61	1.69
" (Purchased)	—	—	42.98	1.46
Manures (maunds)	96.11	—	144.17	4.91
Fertilizers (seers)	—	152.85	247.89	8.44
Insecticides (seers)	—	.76	12.16	.41
Irrigation cost	—	—	830.55	28.27
Land use 6	—	—	394.20	13.42
Interest on operating capital	—	—	24.66	.84
Interest on borrowed capital	—	—	—	—
Total Gross Cost			2938.22	100.00
Credit from straw			149.25	
Total Net Cost			2788.97	

a Considering the capital cost of the tub-wells

b Interest on land value was calculated @ 7%, the value of land per acre under the STW project was Tk. 13,500.

TABLE 3 AVERAGE PER ACRE COST OF GROWING IR—8 UNDER THE HTW IRRIGATION PROJECT[a]

Items of Cost	Quantity Family	Quantity Hired	Total Cost Tk.	% of the total gross cost
Human labour (mandays)	72	43	1150.00	35.01
Animal labour (hours)	64	8	126.00	3.84
Seedlings (Family supplied)	—	—	55.00	1.67
„ (Purchased)	—	—	74.00	2.25
Manures (maunds)	92	—	138.00	4.20
Fertilizers (Seers)	—	111.90	274.08	8.34
Insecticides (Seers)	—	.67	10.70	.34
Irrigation Cost	—	—	1059.65	32.26
Land Use [b]	—	—	350.40	10.67
Interest on operating capital	—	—	26.69	.81
Interest on borrowed capital	—	—	20.00	.61
Total Gross Cost			3284.52	100.00
Credit fram straw			133.16	
Total Net Cost			3151.36	

a Considering the capital cost of the tube-wells.

b Interest on land value was calculated @ 7%, the value of land per acre under the HTW project was Tk. 12,000.

TABLE 4 PER ACRE COSTS AND RETURNS OF IR-8 UNDER DTW, STW AND HTW PROJECTS

Particulars	DTW Considering		STW	HTW assuming		
	Capital cost	Rental system		Cost of hired labour only for operation	No cost of labour for operating HTW a	Full cost of labour for operating HTW
Yield per acre (maunds)	40.79	40.79	44.18	39.28	39.28	39.28
Gross return per acre (Tk)	4690.85	4690.85	5088.70	4517.20	4517.20	4517.20
Total net cost per acre (Tk.)	2474.99	2235.30	2788.97	3151.36	2491.87	5008.08
Total net return per acre (Tk.)	2215.86	2455.55	2291.73	1365.84	2025.33	—490.88
Gross return per Taka invested (Tk.)	1.90	2.10	1.82	1·43	1.81	.90
Cost of Production per maund (Tk.)	60.68	54.80	63.13	80.23	63.44	127.50

a Family labour operated

TABLE 5 COMPARATIVE PER ACRE IRRIGATION COST OF DTW, STW AND HTW

Nature of cost	DTW		STW	HTW considering		
	Capitat cost	Rental system		a	b	c
Fixed	268.22	28.53	400 03	204.00	204.00	204.00
Variable	183.15	182.15	430 52	855.65	196.16	2712.37
Total	451.37	211.68	830.55	1059.65	400.16	2916.37

a only the cost of hired labour for operating HTW

b Considering no cost of labour for family labour operated HTW.

c Full Cost of labour, both family and hired.

TABLE 6 BREAK-UP OF ANNUAL FIXED COST PER DTW, STW AND HTW

(In Taka)

Particulars	DTW	STW	HTW
Depreciation on tube-well materials	1212.50	245.00	85.20
Depreciation on pump and engine	3750.00	875.00	—
Depreciation on pump house of the DTW	525.00	—	—
Installation and other associated cost, i. e. site development, boring etc. (Annual average of the initial cost)	2250.00	175.00	—
Interest on tube-well materials and pump house (for the DTW only)	1277.29	94.70	37.20
Interest on pump and engine	1443.75	343.01	—
Interest on installation and other associated initial costs	1653.75	67.40	—
Total Annual Fixed cost per tube-well	12112.29	1800.11	122.40
Per acre fixed cost of command area	268.22	400.03	204.00

Annual fixed cost of the DTW under the rental system :

Annual rent	Tk. 1200.00
Interest on rent at the rate of 7 per cant per annum	84.00
Total	Tk. 1284.00
Per acre annual cost	28.53

TABLE 7 BREAK UP OF ANNUAL VARIABLE COST PER DTW, STW AND HTW

Particulars	DTW (45 acres) (Taka)	STW (4.5 acres) (Taka)	HTW (.60 acres) (Taka)
Oil and fuel cost	6412.25	1445.50	—
Carrying cost of oil and fuel	475.00	30.00	—
Repairing cost	236.00	384.00	36.00
Driver's charge	1000.90	—	—
Cost of hired labour for operating the HTW (39 mandays)	—	—	390.00
Cost of sheds for the STW and HTW	—	50.00	50.00
Sinking (installation) cost of the HTW	—	—	30.00
Interest on operating capital	118.60	27.88	7.39
Total annual variable cost per tube-well	8241.85	1937.38	513.29
Per acre variable cost	183.15	430.52	855.65a

a This included the cost of hired labour only for operating the HTW along with interest on the cost of hired labour.

TABLE 8 ECONOMIC ANALYSIS OF THE DTW ASSUMING 50% LABOUR SCARCITY IN WINTER SEASON

Particulars	Without Project	With Project (Years)					
		1	2-10	11	12-19	20	Total (1–20)
1. *Inflow*							
A. Gross value of Production	61830	165564	165564	165564	165564	165564	3311280
B. Salvage value	—	—	—	—	—	10271	10271
Total	61830	165564	165564	165564	165564	175833	3321551
2. *Outflow*							
A. Investment cost	—	89338	—	28125	—	—	117463
B. O & M cost	—	7028	7028	7028	7028	7028	140560
C. Production cost	42570	59882	59889	59889	59889	59889	1197780
Total	42570	156255	66917	95042	66217	66917	1455803
3. Net benefit without project	19260	19260	19260	19260	19260	19260	385200
4. Total cost due to project		175515	86177	114302	86177	86177	184100
5. Incremental benefit		—9951	79387	51262	79387	89658	1480548
6. D. F. 15%		.870	4.149	.215	.964	.061	6·259
7. P. W. of gross benefit at 15% discount rate		144041	686925	35596	159604	10725	1036891
8. P. W. of gross cost at 15% discount rate		152698	357548	24575	83075	5257	623153
9. D. F. 50%		.667	1.298	.012	.022	.000	1.999
10. P.W. of incremental benefit at 50% DF		—6637	103044	615	1747	0	98769

BCR = 1036891 / 623153 = 1.66 ; IER is greater than 60%

TABLE 9 ECONOMIC ANALYSIS OF THE STW ASSUMING 50% LABOUR SCARCITY IN WINTER SEASON

(IN TAKA)

Particulars	Without Project	With Project (Years)					
		1	2	3	4–9	10	Total (1-10)
1. Inflow							
A, Gross Value of Production	6183	17985	17985	17985	17985	17985	179850
B. Salvage Value	—	—	—	—	—	1662	1662
2. Qutflow							
A. Investment cost	—	10723	—	—	—	—	10723
B. O & M cost	—	1460	1450	1450	1450	1450	14500
C. Production cost	4257	6220	6220	6220	6220	6220	62200
Total	4257	18393	7670	7670	7670	7670	87423
3. Net Benefit without Project	1926	1926	1926	1926	1926	1926	19260
4. Total Cost due to Project		20319	9596	9596	9596	9596	106683
5. Incremental Benefit		—2334	8389	8389	8389	10051	74829
6. D. F. 15%		·870	·756	·658	2·489	·247	5·020
7. P. W. of Gross Benefit at 15% discount rate		15647	13597	11834	44765	4853	90696
8. P. W. of Gross Cost at 15% discount rate		17678	7255	6314	23884	2370	57501
9. D· F. 50%		·667	·444	·296	·541	·017	1·965
10. P. W. of Incremental Benefit at 50% D· F.		—1557	3725	2483	4538	171	+9360

BCR = 90696/57501 = 1·58 ; I. E. R. is greater than 50%

TABLE 10 ECONOMIC ANALYSIS OF THE HTW ASSUMING 50% LABOUR SCARCITY IN WINTER SEASON

(In Taka)

Particulars	Without Project	With Poject Years 1	2	3	4-9	10	Total (1-10)
1. Inflow							
A. Gross Value of Production	824	2131	2131	2131	2131	2131	21310
B. Salvage Value	—	—	—	—	—	148	148
Total	824	2131	2131	2131	2131	2279	21458
2. Outflow							
A. Investment cost	—	916	—	—	—	—	916
B. Operating cost of HTW	—	745	745	745	745	745	7450
C. O & M cost	—	84	84	84	84	757	840
D. Production cost	568	757	757	757	757	757	7570
Total	568	2502	1586	1586	1586	1586	16776
3. Net benefit without Project	256	256	256	256	256	256	2560
4. Total cost due to Project		2758	1842	1842	1842	1842	19336
5. Incremental benefit		—627	289	282	289	437	2122
6. D. F. 15%		.870	.756	.658	2.489	.247	5.020
7. P. W. of gross benefit at 15% D. F.		1854	1611	1402	5304	563	10734
8. P. W. of gross cost at 15% D. F.		2399	1393	1212	4585	455	10044
9. D. F. 40%		.714	.510	.364	.790	.035	2.413
10. P. W. of incremental benefit at 40% D. F.		—448	147	105	228	15	+47
11. D. F. 45%		.690	.476	.328	.651	.024	2.219
12. P. W. of incremental benefit at 45% D. F.		—433	138	95	188	10	—2

BCR = 10734/10044 = 1.07 ; I.E.R. 40+5× 47/(47+2)=44.8%

TABLE 11 FINANCIAL ANNALYSIS OF DTW FROM THE FARMER'S POINT OF VIEW (CONSIDERING THE CAPITAL COST)

(In Taka)

Particulars	Without Project	With Project (Years) 1	2–10	11	12–19	20	Total (1-20)
1. Inflow							
A. Gross value of production	1794	4820	4820	4820	4820	4820	96400
B. Salvage value	—	—	—	—	—	331	331
Total	1794	4820	4820	4820	4820	5151	96731
2. Outflow							
A. Investment cost	—	2937	—	833	—	—	3770
B. O & M cost	—	234	234	234	234	234	4680
C. Production cost	726	1389	1389	1389	1389	1389	27780
Total	726	4560	1625	2450	1623	1623	36224
3. Net Benefit	1068	260	3197	2364	3197	3528	60501
4. Net Benefit without Project	1068	1068	1068	1068	1068	1068	21360
5. Incremental Benefit		—808	2129	1296	2129	2460	39141
6. D. F. 50%		.667	1.298	.012	.022	.000	1.999
7. P. W. of Incremental Benefit at 50% D. F.		—539	2763	156	47	0	+2427

I. F. R. in greater than 50%

TABLE 12 FINANCIAL ANALYSIS OF DTW FROM THE FARMER'S POINT OF VIEW
(CONTIDERING THE RENTAL SYSTEM)

(IN TAKA)

Particulars	Without Project	Without Project (Years)				
		1	2	3	4-20	Total (1-20)
1. *Inflow*						
A. Gross value of production	1794	4820	4820	4820	4820	96400
B. Salvage value	—	—	—	—	—	—
Total	1794	4820	4820	4820	4820	96400
2. *Outflow*						
A. Rent for DTW	—	27	27	27	27	540
B. O & M cost	—	234	234	234	234	4680
C. Production cost	726	1389	1389	1389	1389	27780
Total	726	1650	1650	1650	1650	33000
3. Net Benefit	1068	3170	3170	3170	3170	63400
4. Net Benefit without project	1068	1068	1068	1068	1068	21360
5. Incremental benefit	0	2102	2102	2102	2102	42040

I. F. R.=Infinity

TABLE 13 FINANCIAL ANALYSIS OF STW FROM THE FARMER'S POINT VIEW

(In Taka)

Particulars	Without Project	With Project (Years) 1	2	3	4-9	10	Total (1—10)
1. Inflow							
A. Gross value of production	1794	5230	5230	5230	5230	5230	52300
B. Salvage value	—	—	—	—	—	544	544
Tatal	1794	5230	5230	5230	5230	5774	52844
2. Outflow							
A. Investment cost	—	3422	—	—	—	—	3422
B. O & M cost	—	501	501	501	501	501	5010
C. Production cost	726	1549	1549	1549	1549	1549	15490
Total	726	5472	2050	2050	2050	2050	23922
3. Net benefit with project		—242	3180	3180	3180	3180	28378
4. Net benefit without project	1068	1068	1068	1068	1068	1068	10680
5. Incremental net benefit		—1310	2112	2112	2112	2112	17698
6. D. F. 50%		.667	.444	.296	.541	.017	1.965
7. Incremental benefit at 50% D. F.		—874	938	625	1143	45	+1877

I. F. R. is greater than 50%

TABLE 14 FINANCIAL ANALYSIS OF HTW FROM THE FARMER'S POINT OF VIEW

(In Taka)

Particulars	Without Project	With Project (Year)					
		1	2	3	4–9	10	Total (1–10)
1. Inflow							
A. Gross value of production	1076	2790	2790	2790	2790	2790	27900
B. Salvage value	—	—	—	—	—	148	148
Total	1076	2790	2790	2790	2790	2938	28048
2. Outflow							
A. Investment cost	—	1000	—	—	—	—	1000
B. Operating cost of HTW	—	390	390	390	390	390	3900
C. O and M cost	—	96	96	96	96	96	960
D. Production cost	436	677	677	677	677	677	6770
Total	436	2163	1163	1163	1163	1163	12630
3. Net benefit	640	627	1627	1627	1627	1775	15418
4. Net benefit without project	640	640	640	640	640	640	6400
5. Incremental benefit	—	—13	987	987	987	1135	9018

I. F. R. is greater than 50%.

TABLE 15 SENSITIVITY ANALYSIS AS APPLIED TO ECONOMIC ANALYSIS OF THE DTW (DETERMINATION OF FLOOR LEVEL OF OPERATION)

(In Taka)

Particulars	Without Project	With Project (Years)					
		1	2	3	4-9	10	Total (1–10)
1. *Inflow*							
A. Gross value of Production	20610	48559	48559	48559	48559	48559	485590
B. Salvage value	—	—	—	—	—	26704	26704
Total	20610	48559	48559	48559	48559	75263	512294
2. *Outflow*							
A. Investment cost	—	116140	—	—	—	—	116140
B. O & M cost	—	3045	3045	3045	3045	3045	30450
C. Production cost	14190	19963	19963	19963	19963	19963	199630
Total	14190	139148	23008	23008	23008	23008	346220
3. Net benefit without project	6420	6420	6420	6420	6420	6420	64200
4. Total cost due to project		145568	29428	29428	29428	29428	410420
5. Incremental benefit		—97009	19131	19131	19131	45835	101874
6. D. F. 15%		·870	.756	.658	2.489	.247	5·020
7. P. W. of gross benefit at 15% D. F.		42246	36710	31952	120863	18590	250361
8. P. W. of gross cost at 15% D. F.		126644	22248	19364	73246	7269	248771
9. D. F. 20%		.833	·694	.579	1.925	.162	4.193
10. Incremental benefit at 15% D. F.		—84398	14463	12588	47617	11321	+1591
11. Incremental benefit at 20% D. F.		—80808	13277	11077	36827	7425	—12202

BCR = 250361/248771 = 1.006 or 1 (Approx.) ; IER = 15 + 5 × 1591/(1591 + 12202) = 15.57 = 16%

TABLE 16 SENSITIVITY ANALYSIS AS APPLIED TO ECONOMIC ANALYSIS OF THE STW
(DETERMINATION OF FLOOR LEVEL OF OPERATION)

(In Taka)

Particulars	Without Project	With Project (Years) 1	2	3	4	5	
1. Inflow							
A. Gross Value of Production	2748	7673	7673	7673	7673	7673	
B. Salvage Value	—	—	—	—	—	3028	
Total	2748	7673	7673	7673	7673	10701	
2. Outflow							
A. Investment cost	—	13939	—	—	—	—	
B. O & M cost	—	836	836	836	836	836	
C. Production cost	1892	2765	2765	2765	2765	2765	
3. Net Benefit without Project	856	856	856	856	856	856	
4. Total Cost due to Project		18396	4457	4457	4457	4457	
5. Incremental Benefit		—10723	3216	3216	3216	6244	
6. D. F. 15%		.870	.756	.658	.572	.497	
7. P. W. of Gross Benefit at 15% D. F.		6676	5801	5049	4389	5358	= 27233
8. P. W. of Gross Cost at 15% D.F.		16004	3369	2933	2549	2215	= 27070
9. P.W. of incremental benefit at 15% D. F.		—9329	2431	2116	1840	3103	= +161
10. D. F. 20%		.833	.694	.579	.482	.402	
11. P. W. incremental benefit at 20% D. F.		—8932	2232	1862	1550	2510	= —778

BCR = 27233/27070 = 1·006 = 1.0 (Approx.) I. E. R. = 15+5×161/(16+778) = 15.86%

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Appendix I

Conversion Fectors for Different Items

Name of the Product/Service	Conversion Factors
1. Petroleum	.65
2. Spares	.60
3. Machinery	.60
4. Transport Service	.60
5. Trade Service	.55
6. Civil Engineering	.55
of which (a) unskilled labour	.50
(b) other inputs	.60
7. Undeveloped land	.63
8. Land Development	.55
9. Skilled labour	1.00
10, Unskilled labour	.50
11 Everything else	.67

Source : The Planning Commission Workshop on Project Evaluation 16-18 August, 1973.