
BAMBOO AND SHALLOW TUBEWELLS IN PURNIA DISTRICT-BIHAR

**AN EX-POST
EVALUATION STUDY**



**NATIONAL BANK FOR
AGRICULTURE AND RURAL DEVELOPMENT**
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The National Bank for Agriculture and Rural Development (NABARD) was established on July 12, 1982. The Agricultural Refinance & Development Corporation (ARDC) ceased to exist from that day and its functions were taken over by the NABARD. The subject-schemes were sanctioned by the erstwhile ARDC. For the sake of convenience, the report refers to ARDC although it does not exist any more.

FOREWORD

This study report brings out the results of a comparative evaluation of investments in shallow tubewells and bamboo tubewells financed under a group of schemes in Purnia district of Bihar.

The study shows that the investments in both types of tubewells under the schemes have brought about improvements in cropping pattern, cropping intensity, crop yields and beneficiaries' income. The financial rate of return was also satisfactory in respect of these investments.

An important finding of the study is that in regions where good aquifers are available within reasonable depths, the investment in bamboo tubewells is better suited to the needs of small farmers than shallow tubewells. However, the productivity levels were found to be sub-optimal on small farms with bamboo tubewells on account of slow adoption of improved farm practices, under-utilisation of irrigation potential and inadequate input use arising from difficulties in obtaining short-term credit. Hence, the emphasis must be on improving productivity levels of small farms through better support services like extension, input supply and crop loans. In addition, the study draws attention to the need for institutional reforms like consolidation of holdings to further improve the viability of the composite investment in a bamboo tubewell and pumpset.

A disturbing finding of the study is the poor recovery of investment loans notwithstanding the adequate incremental income realised by the beneficiaries.

The usual disclaimer regarding the National Bank's responsibility for the facts and views in the report is intended.

NATIONAL BANK FOR AGRICULTURE
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M. V. Gadgil
Managing Director

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CREDIT LIST

Overall Direction

Shri C. Ramalingam, General Manager

Dr. H.P. Singh, Manager

Analysis and Drafting of Report

Dr. M.M. Mishra, Deputy Manager

Shri S.R. Aluru, Deputy Manager

Dr. E.S. Patole, Deputy Manager

Field Work and Tabulation of Data

Shri N. Choudhary, Field Investigator

ABBREVIATIONS

ARDC	:	Agricultural Refinance and Development Corporation
BSLDB	:	Bihar State Land Development Bank Ltd.
BTW	:	Bamboo Tubewell
FRR	:	Financial Rate of Return
GDP	:	Gross Domestic Product
PACS	:	Primary Agricultural Credit Society
PS	:	Pumpset
RRB	:	Regional Rural Bank
STW	:	Shallow Tubewell
VLW	:	Village Level Worker

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BASIC DATA SHEET

Names of the implementing banks	:	Bihar State Land Development Bank (BSLDB) and Kosi Regional Rural Bank (RRB)
Number of schemes evaluated	:	Three
Implementation period of the selected schemes	:	1969-1979
Reference year of the study	:	1981-82

Particulars	STW with PS	BTW with PS	BTW alone
1	2	3	4
1. Number of beneficiaries financed under the selected schemes	1,926	1,182	942
2. Study sample	40	40	33
3. Average unit cost at historical prices (Rs. per unit) :			
i) Anticipated	9,000	5,450	600
ii) Actual	7,694	5,450	600
4. Actual cost of investment at reference year's prices (Rs.)	10,400	6,606	720
5. Average operational holding (Acres)	16.51	7.80	2.87
6. Of which, average area benefited from the investment (Acres)	7.97	4.15	2.60
7. Increase in cropping intensity over 'control' (In percentage points)	57	51	48
8. Incremental income (Rs.)			
i) Per acre of benefited area	541	388	449
ii) Per unit of investment*	4,403	1,704	1,167
9. FRR (%)	36	18	More than 50
10. Incremental on-farm employment per unit of investment (Mandays)			
i) Non-recurring	104.88	23.69	20.22
ii) Recurring per annum	215.11	114.58	63.99

* Inclusive of the net income from sale of water, at only Rs. 91 in the case of STW with PS and Rs. 94 in the case of BTW with PS. Such income did not accrue to the beneficiaries of the single purpose BTWs.

Particulars	Unit	STW with PS	BTW with PS	BTW alone	All TWs
1	2	3	4	5	6
II. Macro-level impact^a of the selected schemes :					
i) Additional area brought under irrigation	Acres	15,350	4,905	2,020	22,275
ii) Value of additional production	Rs. lakhs	225.50	65.83	27.65	318.98
iii) Contribution to GDP	Rs. lakhs	84.80	20.14	9.07	114.01
iv) Additional on- farm employment :	Mandays in lakhs				
a) Non-recurring		2.02	0.28	0.16	2.46
b) Recurring per year		4.14	1.35	0.50	5.99

The estimates in respect of the investment in 'BTW alone' have been adjusted for the observed incidence of misutilisation of entire loan and are based on 777 units actually installed by the scheme beneficiaries.

SUMMARY AND CONCLUSIONS

This report presents the results of an evaluation of the economics of shallow tubewells (STWs) and bamboo tubewells (BTWs) in Purnia district, Bihar, which forms part of the alluvial Gangetic plain. Three schemes were evaluated. Two of these schemes were implemented by BSLDB and one by Kosi RRB, covering investments in STWs with pumpsets (PS), BTWs (improved) and PS, and the investments in BTWs (traditional) alone. The study is based on a sample of 40 STWs with PS, 40 BTWs with PS and 33 BTWs without PS.*

2. BTWs provide an excellent example of "intermediate technology" well suited to the needs of regions such as Bihar, where extensive fragmentation of the small sized land holdings has rendered the investment in STWs unviable for small and marginal farmers, despite abundant availability of groundwater. BTWs are essentially tubewells upto 60 ft. to 80 ft. depth with coir strainers, some with a bamboo casing (traditional BTW) and others with the top five metres of the casing replaced by a metal pipe (improved BTW).
3. BTWs have become highly popular in the region, particularly amongst small and marginal farmers, due to their low capital cost (about Rs. 720 as compared to Rs. 4,900 for STWs in 1981-82 prices) and the simple technology involved. BTWs are being drilled and installed by local artisans in a relatively shorter period of time. While implementing banks found it relatively hard to achieve targets for STW under the schemes evaluated, demand was noted to be high for BTWs, particularly of the cheaper traditional type, with the concerned bank (the RRB) over-achieving physical targets in respect of this item. The field survey revealed that demand for BTWs was high amongst small and marginal farmers. Out of the 67 small farmers in the sample, altogether 59 small farmers (88 per cent) opted for BTWs in preference to STWs, whereas as many as 80 per cent of the sample STWs were installed

* The beneficiaries operated these BTWs with hired pumpsets.

- by large farmers. Clearly, the advent of BTWs has enabled small and marginal farmers, who may not have found the investment in STWs to be viable, to benefit from an assured source of irrigation.
4. However, BTWs are technically feasible only in regions where good aquifers are available within a maximum depth of 80 ft. At depths in excess of this, BTWs tend to buckle and collapse. They are also unsuited to underground strata with fine sand particles which seep into the strainers and choke them. This problem has been largely overcome by the improved type of BTWs with iron pipes. However, since such improved BTWs cost more (Rs. 1,100 per unit)* than the traditional BTWs (Rs. 720 per unit),* the preference in the region has been for the traditional BTWs.
 5. Due to the low level of rural electrification, a large number of tubewells (TWs) in the region were operated by diesel pumpsets. In fact, all the sample TWs were operated by diesel pumpsets in spite of the higher operating cost compared to that of electric pumpsets. The primary reason for this was the erratic and unreliable supply of electricity.
 6. During the survey, no instance of failure of TWs was noticed. BTWs even 6-7 years after their installation and STWs after 13 years were found working satisfactorily. Hence, the economic life of STW generally assumed at 15 years and that of BTW (improved) at 7 years need no modification. However, the life of a traditional BTW may be taken as 5 years.
 7. During the survey, instances of misutilisation were detected in respect of the single purpose BTW loans. About 17.5 per cent of the total BTW (without PS) beneficiaries misutilised the entire loan as the implementing bank lacked effective post-loan supervision.
 8. On an average, the benefited area under the investments in STW with PS, BTW with PS and BTW alone was 7.97 acres, 4.15 acres and 2.60

* At the reference year's prices.

acres respectively. It was higher than the scheme appraisal assumption in regard to the minimum irrigated area of 5 acres for STW with PS, 3 acres for BTW with PS, and 0.5 acres for BTW alone.

9. With the switchover to irrigated farming, considerable improvements were recorded in cropping pattern, cropping intensity and crop yields. There was a shift from a cropping pattern dominated by local paddy and jute, to the cultivation of HYV paddy and improved jute varieties, while wheat and oilseeds were also introduced in the rabi season. Thus, there was a significant improvement in cropping intensity from 127 per cent to 184 per cent under STWs with PS, 133 per cent to 184 per cent under BTWs with PS, and from 130 per cent to 177 per cent under BTWs alone. The improvement in the yields of paddy and jute, the two crops grown under both irrigated and unirrigated conditions, was significant in respect of all the three investments. On an average, the per acre yield of paddy improved from 4.5 quintals to 10.2 quintals in the case of STW with PS, from 4.2 quintals to 9.4 quintals in the case of BTW with PS and from 3 quintals to 9.2 quintals in respect of BTW alone. The increase in jute yield varied between 124 per cent under BTW with PS and 178 per cent under STW with PS. The average yield of wheat obtained by the beneficiaries was in the range of 8.6 quintals per acre (BTW with PS) to 9.5 quintals per acre (STW with PS) and compared favourably with the average yield under irrigated conditions in the area.
10. The investment induced changes resulted in net incremental income per net sown acre of the order of Rs. 541, Rs. 388 and Rs. 449 from the benefited area under STW with PS, BTW with PS and BTW alone, respectively. The incremental income per unit of investment was of the order of Rs. 4,403, Rs. 1,704, and Rs. 1,167 under STWs with PS, BTWs with PS and BTWs alone, respectively.
11. The results of the financial analysis show that the investment in STW with PS was viable with FRR at 36 per cent, whereas, that in BTW (improved) with PS and BTW (traditional) alone was viable with FRR

at 18 per cent and more than 50 per cent respectively. The relatively lower value of FRR in respect of the BTW with PS is mainly on account of the capital cost of the diesel pumpset not generating commensurate returns. Field-level enquiries revealed that 3 h.p. pumpsets were more appropriate for lifting water from BTWs. Notwithstanding this fact, bank finance was provided for 5 h.p. diesel pumpsets, (probably due to the non-availability of 3 h.p. pumpsets) which had lowered the viability of the composite BTW investment. The sensitivity analysis showed that under adverse conditions, the composite investment in BTW with PS would be only marginally viable at 15% FRR. On the other hand, the FRR values in respect of STW with PS and BTW alone would be comfortably higher at about 32 per cent and more than 50 per cent respectively.

12. The branch-level recovery performance under the scheme investments was better in the case of the RRB branches than those of the LDB. At beneficiary level, altogether about 33 per cent, 15 per cent and 76 per cent of the sample beneficiaries respectively under STW with PS, BTW with PS and BTW alone were in default. The default was, by and large, wilful as the defaulters had the necessary repaying capacity from out of the incremental income to service the loans.
13. The macro-level impact of the three schemes under review was assessed in terms of the incremental irrigated area, crop production, farm income and employment in the area. The tubewell investments together resulted into an extension of irrigation over additional area of 22,275 acres, a contribution to GDP of the order of Rs. 114 lakhs (at 1981-82 prices), and about 2.46 lakh mandays of the initial non-recurring and about 6 lakh mandays of additional recurring employment per year.
14. A major area of concern, nevertheless, is the fact that crop yields still remain below feasible levels. For example, yield levels of paddy and wheat in Ludhiana district of Punjab, the foremost ranking district in the country in this respect and one which is comparable in agro-climatic conditions to Purnia, are much higher at 16.71 quintals and 13.70 quintals

per acre* respectively, in comparison to the highest realised yields by sample farmers of 10.20 quintals per acre for paddy and 9.50 quintals for wheat. One reason for this is the fact that the investment in the improved bio-chemical technology remains fairly low. As one indicator, only 40 per cent to 50 per cent of the gross cropped area under different investment types was under high yielding varieties of crops.

15. Another factor contributing to low yield levels is the sub-optimal application of irrigation. Levels of actual irrigation fell short of those recommended by agricultural scientists for the soil types of the region by approximately 11 per cent in the case of STWs and as much as 24 per cent in the case of BTWs, despite adequate availability of irrigation water in the TWs. The under-utilisation of irrigation capacity was on account of a two-fold reason. Firstly, the small command of tubewells in relation to their potential, is caused by a structural constraint, viz., small and fragmented land holdings. Secondly, low intensity of irrigation was attributed to the high cost of diesel and problems in its availability, as also to a lack of extension effort in ensuring optimal use of irrigation.

16. Another cause for concern is the lower level of returns achieved by BTW owners relative to that of STW owners, both in terms of net income per net sown acre (Rs. 733 for STW with PS owners in comparison to Rs. 605 for BTW with PS, and Rs. 614 for BTW alone) and in terms of incremental income per net sown acre (Rs. 541 for STW with PS, and Rs. 388 and Rs. 449 for BTW with PS and BTW alone respectively, when net income was computed based on cost of cultivation exclusive of the imputed value of family labour). This could be attributed to the higher yields obtained by beneficiaries investing in STWs, which in turn resulted from their higher level of use of irrigation and that of associated material inputs. Both factors may be ascribed to the relatively better resource position of STW owners, who were mainly large farmers. The per acre incremental income under STWs being higher than that under BTWs is indicative of a worsening of the relative income position of BTW beneficiaries, i.e., small and marginal farmers.

Figures relate to the agricultural year 1981-82. Source : CMIE, **Profiles of Districts**, Part 2, July 1985, p. 482

There are also indications that BTW owners are not getting a level of return commensurate with their level of expenditure on crop production.*

17. The sample beneficiaries reported difficulties in obtaining short-term credit support from the primary agricultural credit societies (PACS), which were working unsatisfactorily. About 37 per cent of the sample beneficiaries did not have any access to institutional short-term credit. Improved availability of production credit needs to be ensured, especially in the case of small farmers.
18. The incremental capital-output ratio works out to 2.36 : 1 for the investment in STW with PS, 3.88 : 1 for BTW with PS and only 0.62 : 1 in the case of BTW alone.
19. As regards the choice of technology appropriate to meet the needs of small farmers, though the single purpose BTW investment is ideal, there is a physical limitation to availability of pumpsets on custom hire. Hence, the composite investment in BTWs appears to be more suitable for small farmers and that in STWs for other farmers. It may, however, be emphasised that the viability of the composite investment in BTW with pumpset needs to be improved through, (i) higher farm productivity via efficient input use, including irrigation, HYV seeds, fertilizers, etc; (ii) sale of excess water; and (iii) custom hiring of pumpsets to those with single purpose BTWs. Consolidation of land holdings will also have a favourable effect on viability of investment in BTW with PS on small farms. If income distributional considerations call for a preference for BTW investments in the region, emphasis must lie on greater extension efforts and land reforms including consolidation of holdings in the state.

For instance, the incremental cost of cultivation per net sown acre was higher in the case of BTW with PS beneficiaries (Rs. 954) than those with STW with PS (Rs.928). However, the relative inefficiency of the former beneficiaries originated from the composition of cultivation cost. They spent relatively less on material inputs, especially fertilisers and realised lower incremental income.

CHAPTER I

INTRODUCTION

- 1.1 Like other regions of the alluvial Gangetic plains, the groundwater conditions in the plains of Bihar are eminently suitable for undertaking minor irrigation investments. Keeping in view the considerable unexploited potential for groundwater development in this State, the cumulative disbursements of refinance by the National Bank (including the erstwhile ARDC) for various investments in minor irrigation increased from Rs. 2,625 lakhs in 1976* to Rs. 18,293 lakhs in 1986*. The refinance disbursed under minor irrigation accounted for 81 per cent of the total refinance support for all purposes upto 1976 and 44 per cent upto 1986.
- 1.2 A large number of minor irrigation schemes[●] have been sanctioned in the past in almost all the districts of Bihar. The various investments financed under these schemes included dugwells, deep tubewells, shallow tubewells, bamboo tubewells, lift irrigation, single purpose pumpsets, etc. Among the different irrigation structures, shallow tubewells and bamboo tubewells are most common and they together account for about 50 per cent of the total irrigated area in the State. Therefore, the private investment is mainly concentrated in shallow tubewells (STWs) and bamboo tubewells (BTWs).
- 1.3 The STWs are comparatively deeper (upto 200 ft.) and tap more aquifers than the BTWs. As a result, the former are expected to yield more water and irrigate a larger area than the latter tubewells. It may be mentioned that a BTW is essentially a shallow tubewell but drilled upto a depth of only 60 ft. to 80 ft. It is cased either with MS pipe or with a pipe made of bamboo strips. Originally the casing consisted of strips of bamboo tied to steel rings of about 10" diameter and wrapped with burlap and coated with coal tar. This tubewell has a coir strainer.

* As on 30 June of the respective year.

● As many as 1,307 M.I. Schemes have been sanctioned in this State upto 30 June 1986.

A recent innovation has been an "improved" BTW in which the top 16 ft. portion (about 5 meters) of the casing is replaced by a metal pipe. Further improvement has also been made in the type and quality of strainer by replacing bamboo strips by iron rods and providing a nylon net under the coir winding. While the draft of the tubewell remains the same in both types, the improved BTW has a longer economic life than the traditional BTW.

- 1.4 Over past few years, BTWs have become popular among the farmers, and in certain areas where hydrogeological conditions are favourable, BTWs are even preferred over STWs by them. The greater popularity of BTWs over STWs is mainly because of : (i) their very low cost, (ii) the relative ease in completing construction of these structures within 6-8 hours with the help of local artisans, and (iii) most importantly the availability of adequate groundwater from shallower aquifers. Additionally, BTWs are suited to the requirements of the small and fragmented holdings of agriculturists. The BTWs are, however, unsuitable in areas where good aquifers are available only at depth exceeding 60 ft. to 80 ft. from ground surface. Beyond this depth, the coir strainers used in BTWs do not remain in vertical position and are apt to buckle. Another limitation on a large-scale installations of BTWs is the size of sand particles. Areas where top aquifers contain very fine sand as in certain parts of west of Kosi in Purnia district and in adjoining Saharsa district, BTWs do not last long due to the frequent seeping of fine sand into the pump. Such areas are more suitable for STWs.
- 1.5 Hence, with a view to examining the comparative economics of STWs and BTWs, and other related aspects, the present study was carried out in Purnia district. The scope of the study was restricted to those beneficiaries who had taken loans from banks under ARDC refinanced schemes referred to in Chapter II, paras 2.1 to 2.5. Purnia district is situated in the north-eastern corner of Bihar. The district forms part of the Gangetic plain.

- 1.6** The area covered under present study lies mostly in the east of Kosi river, which has a high potential for groundwater development due to favourable sub-surface strata and heavy rainfall. Occurrence of the near-surface permeable rock formation enables high groundwater recharge. The aquifers receive enormous recharge from direct precipitation and river floods, seepage from canals, etc., and because of the high permeability of the sub-surface and the extensive lateral and vertical extent they act as good storages of water. The static water level ranges from 6 ft. to 18 ft. during rabi season. Groundwater investigations carried out by the Central Groundwater Board and other agencies show that the area is geohydrologically important for its high potentiality.
- 1.7** The specific objectives of the study and methodology adopted for the field survey and analysis of data are as out-lined in Annexure - I.

CHAPTER II

IMPLEMENTATION OF THE SELECTED SCHEMES

The Schemes

- 2.1** The present evaluation study relates to three minor irrigation schemes implemented in Purnia district in Bihar State. These schemes were sanctioned by the Agricultural Refinance and Development Corporation (ARDC) to Bihar State Land Development Bank (BSLDB) and Kosi Regional Rural Bank (Kosi RRB) for the construction of shallow tube-wells, bamboo tubewells and installation of pumpsets. Out of the three schemes selected for evaluation, two schemes were implemented by Bihar State Land Development Bank and the remaining one by Kosi Regional Rural Bank.
- 2.2** The original scheme sanctioned to BSLDB in January 1969 envisaged provision of long-term finance to the farmers for construction of 7,329 shallow tubewells with pumpsets in Purnia and Saharsa districts involving a credit assistance of Rs. 808.88 lakhs. The area of operation of scheme was confined to 43 blocks (25 blocks of Purnia and 18 blocks of Saharsa districts) which was later extended to all the 61 blocks of Purnia and Saharsa districts.
- 2.3** The scheme was to be implemented through Purnia, Kishanganj, Araria and Forbisganj branches of the BSLDB in Purnia district and Saharsa, Supaul, Medhepura and Murliganj branches in Saharsa district. The scheme was phased for implementation over a period of three years, i.e., 1969-70 to 1971-72. It was first rephased by the ARDC in February 1970. The rephased scheme provided a reduced financial assistance of Rs. 675.30 lakhs and the period of implementation was extended by another two years i.e., upto 1973-74. Since the physical and financial achievement under the scheme was not satisfactory, the scheme was again rephased on the request of the BSLDB with a reduced physical

and financial programme of 2,000 shallow tubewells with pumpsets and 6,050 pumpsets alone, involving financial assistance of Rs. 414.66 lakhs, and the period of implementation was extended upto June 1975. The BSLDB achieved both physical and financial targets by advancing loans of Rs. 442.30 lakhs for 1,926 shallow tubewells and 6,536 pumpsets. The scheme was closed in March 1975.

- 2.4** On completion of the above scheme and on account of the growing popularity of the bamboo tubewells in the scheme area which was cheaper than the shallow tubewell and yet gave almost the same discharge as a shallow tubewell, the BSLDB had submitted a supplementary scheme to ARDC for approval. The scheme envisaging construction of 4,000 bamboo tubewells with pumpsets and 4,000 pumpsets alone involving credit assistance of Rs. 368.00 lakhs and refinance assistance of Rs. 331.20 lakhs was sanctioned to the BSLDB in May 1976. The scheme was phased for implementation over a period of about 5 years. The scheme was closed in June 1980. The bank had achieved the financial programme to the tune of Rs. 373.72 lakhs covering 1,043 tubewells with pumpsets and 6,081 single purpose pumpsets.
- 2.5** A minor irrigation scheme with financial outlay of Rs. 14.36 lakhs for construction of 429 bamboo tubewells alone, 100 bamboo tubewells with pumpsets and 255 pumpsets alone was sanctioned by the ARDC to Kosi Regional Rural Bank in September 1978. The scheme was phased for implementation over three years (i.e., 1978-80). Since there was high demand for bamboo tubewells in the scheme area, the bank achieved the scheme targets much earlier (i.e., in March 1979), than the stipulated period.

Implementation

- 2.6** The physical and financial targets and achievements under the selected schemes are summarised in Table 2.1. It may be seen that both banks had achieved the financial targets approved under the three schemes and also availed of full refinance from ARDC. As regards the physical

targets, the BSLDB lagged behind in respect of STWs and BTWs with PS but exceeded the target in respect of PS alone. On the other hand, the RRB financed far more BTWs with PS and BTWs alone than the scheme targets. However, the achievement of the RRB for single purpose pumpsets fell far short of the target. This also indicated that BTWs were gaining more popularity.

Table 2.1
Investment-wise Targets and Achievements under
the Selected Schemes

(Amount in Rs. lakhs)

Particulars	STW with PS		BTW with PS		BTW alone		PS alone		Total credit assistance	ARDC's refinance (90 per cent of the assistance approved)
	Num-ber	Credit assis-tance	Num-ber	Credit assis-tance	Num-ber	Credit assis-tance	Num-ber	Credit assis-tance		
1	2	3	4	5	6	7	8	9	10	11
1. Original Scheme (BSLDB)										
i) Targets	2000	141.81	-	-	-	-	6050	272.85	414.66	373.19
ii) Achievements	1926	148.18	-	-	-	-	6536	294.12	442.30	373.19
2. Supplementary Scheme (BSLDB)										
i) Targets	-	-	4000	200.00	-	-	4000	168.00	368.00	331.20
ii) Achievements	-	-	1043	54.25	-	-	6081	319.47	373.72	331.20
3. RRB Scheme										
i) Targets	-	-	100	3.83	429	1.93	255	8.60	14.36	12.92
ii) Achievements	-	-	139	7.09	942	5.65	36	1.62	14.36	12.92

- 2.7** It is worth mentioning that the BTWs financed by the BSLDB under the supplementary scheme were of "improved" type with 4" diameter and a 20 ft. iron casing pipe; those financed by the RRB were, however, of traditional type also with 4" diameter, but without the iron casing pipe. The traditional BTWs were cheaper than the improved BTWs and hence, more popular in the scheme area, especially among the small and marginal farmers and those with fragmented holdings. Additionally, the pumpsets to be financed under the schemes were 5 h.p. diesel sets. Due to the low level of rural electrification and consequent problems of erratic and unreliable supply of electricity in the scheme area, the farmers preferred diesel pumpsets over electric pumpsets. Diesel pumpsets, being portable were favoured also because they could be used for lifting water from other TWs, rivulets, streams, etc., and for custom hiring to the owners of BTWs alone.
- 2.8** Data in Table 2.2 show that the unit cost assumed at the time of the scheme appraisal (at historical prices) was Rs. 9,000 per STW with PS, Rs. 5,450 per BTW with PS and Rs. 600 per BTW alone. The actual cost incurred by the beneficiaries was lower at Rs. 7,694 in the case of the STW with PS, investment* and about the same as was assumed in the case of BTW with PS and BTW alone. The average loan disbursed by the banks as against the actual cost was Rs. 7,694 per STW with PS, Rs. 5,200 per BTW (improved) with PS, Rs. 5,100 per BTW (traditional) with PS and Rs. 600 per BTW alone.
- 2.9** The STW structures were completed by the Minor Irrigation Department (MID) of the State Government on behalf of the beneficiaries and loans equivalent to the cost of the structures were disbursed directly to the MID by the bank. BTWs were, however, installed by the local artisans ("mistris").
- 2.10** The break-up of the estimated actual cost (at historical prices) in respect of STW and BTW (improved) was as shown in Tables 2.3 and

* The unit cost at appraisal was estimated for 200 ft. depth of a tubewell. However, due to the favourable geo-hydrological conditions, a depth of 100 ft. was found adequate. Hence, the actual cost was lower.

Table 2.2
Unit Cost (Assumed & Actual) and
Average Loan Disbursed

(Rs. at historical prices)

Investment	Unit cost		Average loan disbursed
	Assumed	Actual	
1	2	3	4
1. Original Scheme (BSLDB)			
STW with PS	9,000*	7,694	7,694
2. Supplementary Scheme (BSLDB)			
BTW (improved) with PS	5,450	5,450	5,200
3. Kosi RRB Scheme			
i) BTW (traditional) with PS	5,100	**	5,100 [●]
ii) BTW (traditional) alone	600	600	600

* Unit cost approved at the time of the final rephasement.

** Not covered in the Study sample.

● Assessed based on bank records.

2.4. Under the schemes capital subsidy was available to small farmers, especially for BTWs, from the Small Farmer Development Agency (SFDA). However, the release of subsidy was delayed considerably. As a result, the banks had to disburse loans to cover the investment cost in full. Subsidy received subsequent to bank finance was treated as loan recovery and adjusted in the respective loan accounts.

2.11 The sample survey revealed that the demand for BTWs was high amongst small and marginal farmers. As many as 65 per cent of the sample beneficiaries under BTW with PS and 100 per cent of BTW alone were

Table 2.3

Estimated Actual Cost of STW with PS

(Per unit at historical prices)

Items of cost	Actual cost as per MID (Rs.)
1	2
A. STW	
i) 70' Iron pipe	1,960
ii) 30' Strainer	1,230
iii) 4" Socket	69
iv) T. Socket	35
v) Labour charges & other miscellaneous charges	200
Sub-total	3,494
B. Diesel Pumpset (5 h.p.)	4,200
Investment cost per unit	7,694

Table 2.4

Estimated Actual Cost of BTW with PS

(Per unit at historical prices)

Items of cost	Rs.
1	2
A. BTW (improved)	
i) Bamboo (10 No.)	120
ii) Iron pättar (18 kg.)	117
iii) Coir (20 kg.)	180
iv) Jute mat	100
v) Plastic net	60
vi) Nails	45
vii) Labour charges, etc.	300
Sub-total	922
B. Diesel Pumpset (5 h.p.)	4,528 ^a
Investment cost per unit	5,450

^a Higher due to price escalation

small farmers. In contrast, as may as 80 per cent of the STWs were installed by 'other' farmers (Table 2.5). On the whole, 67 (60 per cent) of the 113 sample beneficiaries of the three schemes were small farmers and the remaining were 'other' farmers. Out of the 67 small farmers, altogether 59 small farmers (88 per cent) opted for BTWs in preference to STWs.

Table 2.5

Classification of Sample Beneficiaries
According to the Pre-investment Size of Holding

Holding size (Acres)	Sample beneficiaries			Total
	STW with PS	BTW with PS	BTW alone	
1	2	3	4	5
Upto 5	2 (5)	22 (55)	32 (97)	56 (50)
5.1 - 8.8*	6 (15)	4 (10)	1 (3)	11 (10)
Above 8.8	32 (80)	14 (35)	-	46 (40)
Total	40 (100)	40 (100)	33 (100)	113 (100)

* As per ARDC's definition applicable to the study area, unirrigated holdings upto 8.8 acres were deemed as small.

Note : Bracketed figures indicate percentages.

2.12 Observations made, during the field-survey, on other aspects having a bearing on the quality of implementation of the schemes by the banks can be summarised as under :

- i) The banks were to charge to ultimate borrowers an interest rate of 10.5 per cent per annum. This stipulation was adhered to.
- ii) The repayment period was fixed at 7 years for pumpsets, 5 years for BTWs and that for STWs at 9 years for 'other farmers' and 15 years for small farmers.
- iii) It was observed from the loan applications submitted to the BSLDB as also to the RRB that the requisite details for estimation of

the pre and post-development income of the beneficiaries had not been furnished. As a result, difficulties were faced by the banks while making an assessment of the likely incremental income from the investment and the repaying capacity to meet the debt service obligation.

- iv) A time-lag analysis showed that by and large, the loans were sanctioned and disbursed by the banks within 2 months from the date of application. The completion of investments also did not involve any delay as they were completed within 15 days from the commencement of the work.
- v) No cases of infructuous investment were reported, except one under the BTW investment. Since adequate expertise was available with the MID, no instances of failures were reported for STWs.
- vi) BTWs were reported to be working satisfactorily without any reduction in the discharge, even after 6 to 7 years. Some of the STWs were drilled about 13 years ago, and were reportedly working satisfactorily. Therefore, the life of a properly constructed BTW and STW can safely be assumed at 5 years (7 years for 'improved' BTW) and 15 years respectively.
- vii) Effective supervision to ensure the end-use of credit was generally lacking, due mainly to the inadequacy of field staff, both with BSLDB and Kosi RRB. Some instances of misutilisation of BTW loan (17.5 per cent of those contacted) were reported. The field-staff of BSLDB was mainly involved in the disbursement and recovery of loans. So far as Kosi RRB was concerned, most of its branches had no field officials to supervise the loan utilisation and for attending to other post-loan follow-up.
- viii) Extension support provided to the beneficiaries by the concerned Government Department was reportedly satisfactory. About 66 per cent of the sample beneficiaries reported that they received

adequate guidance in regard to HYV seeds, timely sowing of crops, use of fertilizers and pesticides, etc., from the VLWs and other extension officials. Necessary farm inputs were also readily available either from the block level agencies or from open market. Nevertheless, the fact that the use of irrigation facility and crop yields remained at sub-optimal levels, is indicative of inadequate extension efforts.

- ix) The beneficiaries reported difficulties in obtaining short-term credit support from the PACS, which were said to be working unsatisfactorily. Only 20 per cent of sample beneficiaries availed S.T. credit from co-operatives. About 27 per cent and 16 per cent of the sample beneficiaries borrowed production credit from commercial banks and RRB branches respectively. The remaining 37 per cent beneficiaries were left without any Institutional S.T. credit support.

- x) Beneficiaries also reported considerable difficulties in regard to marketing of jute. Although the centres of the Jute Corporation of India were operating in the scheme area, their functioning was far from satisfactory. Beneficiaries reported that they frequently had to wait 2 to 3 days at such centres, before they could off-load the crop. They were also not paid promptly for the crop delivered. Such difficulties often forced the farmers to resort to distress sale at lower prices to private traders.

CHAPTER III

ECONOMICS OF INVESTMENT IN TUBEWELLS

3.1 As stated earlier, the study sample consisted of 40 beneficiaries under STWs with PS, 40 under BTWs with PS, and 33 under single purpose BTWs. In this Chapter, an attempt is made to describe the basic features of the sample farms and also to examine the effects of the scheme investment in irrigation structures on cropping pattern, cropping intensity, crop yields and income. No separate "Control" sample was selected for comparisons. The rainfed portion of the beneficiaries' holdings represented the "without investment" situation. Valuation of inputs and output is at 1981-82 prices. For valuation of farm output, the farm-gate prices have been used.

Average Size of Operational Holdings and Benefited Area

3.2 The investment-wise details regarding the average size of operational holdings of the sample beneficiaries and the average benefited area are presented in Table 3.1. It may be observed that the average size of operational holdings was 16.51 acres under the STW with PS, 7.80 acres under BTW with PS and only 2.87 acres under BTW alone. The proportion of benefited area in the average operational holdings of the beneficiaries of STW with PS, BTW with PS and BTW alone was about 48.3 per cent, 53.2 per cent and as much as 90.6 per cent respectively. The relatively lower extent of irrigation in respect of the beneficiaries of the former two investments was due to the fragmented and scattered nature of their holdings. The entire irrigation facility available on the beneficiary holdings was on account of the scheme investments. The area benefited from the scheme investments averaged 7.97 acres under STW with PS, 4.15 acres under BTW with PS and 2.60 acres under BTW alone. It may be mentioned that in the case of the investment in BTW alone, water was drawn by using hired pumpsets.

Table 3.1
Average Size of Holding and Benefited Area

(Acres)

Type of investment	Average operational holding	Of which		Area benefited from the investment
		Irrigated	Unirrigated	
1	2	3	4	5
STW with PS	16.51 (100.00)	7.97 (48.27)	8.54 (51.73)	7.97 (48.27)
BTW with PS	7.80 (100.00)	4.15 (53.21)	3.65 (46.79)	4.15 (53.21)
BTW alone	2.87 (100.00)	2.60 (90.59)	0.27 (9.41)	2.60 (90.59)

Note : Bracketed figures indicate percentages.

3.3 It is evident from above that the beneficiaries had both irrigated area and rainfed area for cultivation in post-investment stage. The comparative economics of the irrigated and rainfed cultivation has, therefore, been studied for the beneficiary holdings to assess the benefits from the scheme investments, at the micro-level.

Cropping Pattern

3.4 Table 3.2 shows the cropping pattern adopted by the beneficiaries in their irrigated as well as unirrigated portions of holdings. Paddy in kharif and wheat in rabi season were the pre-dominant crops under irrigated conditions accounting for about 88 per cent, 92 per cent and 88 per cent of gross sown irrigated area in respect of STW with PS, BTW with PS and BTW alone, respectively. The remaining area was under pulses, oilseeds and jute. Under rainfed conditions, however, paddy alone accounted for as much as 78 per cent, 71 per cent and 80 per cent of the gross cropped area respectively in the case of the three types of beneficiary holdings. Jute was the only other rainfed

Table 3.2
 Cropping Pattern Followed by the Beneficiaries
 Under 'With' and 'Without' Investment Situations

Crop	(Acres)					
	STW with PS		BTW with PS		BTW alone	
	With investment (Irrigated)	Without investment (Rainfed)	With investment (Irrigated)	Without investment (Rainfed)	With investment (Irrigated)	Without investment (Rainfed)
1	2	3	4	5	6	7
Paddy	7.43 (50.75)*	8.50 (78.27)	3.54 (46.28)	3.47 (71.40)	2.32 (50.33)	0.28 (80.00)
Wheat	5.40 (36.88)	-	3.51 (45.88)	-	1.73 (37.53)	-
Pulses & Oilseeds	1.38 (9.43)	-	0.20 (2.61)	-	0.35 (7.59)	-
Jute	0.43 (2.94)	2.36 (21.73)	0.40 (5.23)	1.39 (28.60)	0.21 (4.55)	0.07 (20.00)
Gross cropped area	14.64 (100.00)	10.86 (100.00)	7.65 (100.00)	4.86 (100.00)	4.61 (100.00)	0.35 (100.00)

* Figures in brackets indicate percentages.

crop. This shows that the investments in tubewells (TWs) resulted in a more diversified cropping pattern with the introduction of wheat, pulses and oilseeds in rabi season. The survey data revealed that the beneficiaries preferred high yielding varieties, particularly of wheat, under irrigated conditions. Table 3.3 shows the extent of the irrigated area brought under high yielding varieties of crops. Thus, there was a switch-over from a cropping pattern dominated by local paddy and jute to HYV paddy and improved varieties of jute, while HYV wheat, pulses and oilseeds could also be introduced in the rabi season due to the availability of irrigation.

Table 3.3
Area under Hybrid/Improved Crop Varieties (Acres)

Type of investment	Gross cropped area	Area under hybrid/improved varieties	% area under HYVs
1	2	3	4
STW with PS	14.64	6.70	45.77
BTW with PS	7.65	3.54	46.27
BTW alone	4.61	1.91	41.43

Cropping Intensity

3.5 As can be seen from the data in Table 3.4, the intensity of cropping on the benefited area of the tubewells was significantly higher than that on the non-benefited (i.e., rainfed) portions of the beneficiary holdings. The cropping intensity index under irrigated condition compared to that under unirrigated condition was about 184 per cent as against 127 per cent in the case of STW with PS, 184 per cent as against 133 per cent in the case of BTW with PS and 177 per cent as against 130 per cent in the case of BTW alone. The higher intensity by about 57, 51 and 48 percentage points on the benefited area of the respective investments is attributed to the assured irrigation from the tubewells. However, there appears to be no sizeable difference in the crop pattern on the benefited area as between the three types of investments.

Table 3.4
Intensity of Cropping

Particulars	STW with PS		BTW with PS		BTW alone	
	Irrigated	Unirrigated	Irrigated	Unirrigated	Irrigated	Unirrigated
1	2	3	4	5	6	7
Net sown area (acres)	7.97	8.54	4.15	3.65	2.60	0.27
Gross sown area (acres)	14.64	10.86	7.65	4.86	4.61	0.35
Cropping intensity (%)	183.69	127.17	184.34	133.15	177.31	129.63

Crop yields

3.6 The per acre average yield levels of crops grown under irrigated and unirrigated conditions for the different investments are given in Table 3.5. The improvement in the yields of paddy and jute, the two crops grown under both irrigated and unirrigated conditions, was significant in respect of all the three investments. Similarly, the average yield of the newly introduced crop, viz., wheat compared favourably with the average yield in the area. The data show that, on an average, the per acre yield of paddy improved from 4.5 quintals to 10.2 quintals in respect of STW with PS, from 4.2 quintals to 9.4 quintals in respect of BTW with PS and from 3 quintals to 9.2 quintals in the case of BTW alone. The jute yield was more than doubled. The average yield realised for wheat was in the range of 8.6 quintals per acre (BTW with PS) to 9.5 quintals per acre (STW with PS).

Table 3.5
Crop Yields in Irrigated and Un-irrigated Holdings (Investment-wise)
(Quintals per acre)

Crop	STW with PS		BTW with PS		BTW alone	
	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed
1	2	3	4	5	6	7
Paddy	10.2	4.5	9.4	4.2	9.2	3.0
Wheat	9.5	-	8.6	-	8.8	-
Pulses & Oilseeds	4.5	-	4.0	-	3.5	-
Jute	6.4	2.3	5.6	2.5	5.1	2.0

3.7 Though there has been an improvement in the yield levels of different crops due to the availability of assured irrigation, the impression gathered during the survey supports the view that there is scope for further improvement in the yield levels. The irrigation facility created by the investments appeared to have been under-utilised by the beneficiaries. Data presented in Table 3.6 show that irrigation use fell short of the

levels recommended by agricultural scientists for the soil types of the region by about 11 per cent in the case of the STWs and as much as 24 per cent in the case of the BTWs.* During the course of field-work, the technical expert estimated the discharge feasible from BTWs in the area at 12.58 lps, i.e., approximately 29.30 acre feet based on an average pumping for 6 hours per day for 158 days in a year, as is the prevalent practice in the region. The discharge from STWs was potentially even greater due to their ability to tap deeper aquifers. This low level of utilisation of TWs was attributed to the high cost of diesel and also its intermittent shortages.

Table 3.6
Recommended and Actual Levels of Water Use

Type of investment	Crop	Area (Acres)	Per acre water use (Acre inches)		Total water use (Acre inches)	
			Recom- mended	Actual	Recom- mended	Actual
1	2	3	4	5	6	7
STW with PS	i) Paddy [⊙]	7.43	4	4	29.72	29.72
	ii) Wheat	5.40	17	15	91.80	81.00
	iii) Pulses & oilseeds	1.38	4	2	5.52	2.76
	iv) Jute	0.43	6	4	2.58	1.72
		14.64	-	-	129.62	115.20
BTW with PS	i) Paddy [⊙]	3.54	4	4	14.16	14.16
	ii) Wheat	3.51	17	12	59.67	42.12
	iii) Pulses & Oilseeds	0.20	4	2	0.80	0.40
	iv) Jute	0.40	6	4	2.40	1.60
		7.65	-	-	77.03	58.28

⊙ Irrigation is supplementary in nature.

Gross Value of Produce

3.8 It was assumed that the investment in irrigation would facilitate an upward movement of the production function due to the adoption of an improved technological package of modern inputs alongwith irrigation,

* Use levels were the same for the investors in BTW with PS and BTW alone.

which distinguishes it from the earlier production function characterised by the use of traditional inputs (mainly land and labour) on rainfed farms. As can be seen from Table 3.7, the gross value of irrigated crops of the sample beneficiaries owning STW with PS averaged Rs. 2,019 per acre as against that of their unirrigated crops at Rs. 550 per acre. Thus, the gross value of crops raised on the benefited area under STWs was 267 per cent higher than that of the rainfed crops. The same was higher by 245 per cent and as much as 350 per cent in the case of BTW with PS and BTW alone respectively. As between the three investments, the per acre gross income from irrigated crops was higher (in absolute terms) in the case of the STW with PS than the other two investments. The increase in the gross value of crop produce

Table 3.7
Gross Value of Farm Produce

Particulars	STW with PS		BTW with PS		BTW alone	
	Irri- gated	Unirri- gated	Irri- gated	Unirri- gated	Irri- gated	Unirri- gated
1	2	3	4	5	6	7
1. Net sown area (Acres)	7.97	8.54	4.15	3.65	2.60	0.27
2. Gross value of produce per acre (Rs.)	2,019	550	1,890	548	1,760	391
3. Incremental gross value of produce per acre (Rs.)	1,469 (267.09)*	-	1,342 (244.89)	-	1,369 (350.00)	-
4. Incremental gross value of produce per unit of investment (Rs.)	11,708	-	5,569	-	3,559	-

* Bracketed figures indicate percentage increase in gross value over the gross value of produce obtained from unirrigated area.

from the benefited area was on account of higher levels of crop production on beneficiary farms and can be attributed to the changes in crop pattern, cropping intensity and use of modern inputs including HYV seeds, fertilizers, etc., consequent upon the availability of irrigation from the TWs. The higher expenditure on production inputs is evident from data relating to the itemwise break-up of the cost of cultivation presented in Table 3.8.

Cost of Cultivation

- 3.9** The concept of cost of cultivation used in this study corresponds to cost A1 of Farm Management Studies. It includes the value of owned and purchased seed and manure, value of fertilizers and pesticides, wages paid to hired human labour, operations and maintenance cost of pumpset, maintenance of owned bullocks and other costs incurred like land revenue, interest on crop loan, etc. Additionally, another estimate of cost of cultivation has been presented by including the imputed value of family labour. The value of family labour has been imputed on the basis of the wage rates paid by the beneficiaries to hired labour during the reference year.
- 3.10** The data in Table 3.8 reveal that the per acre paid-out cost of cultivation averaged Rs. 1,286, Rs. 1,285 and Rs. 1,146 for the benefited area and Rs. 358, Rs. 331 and Rs. 226 for the rainfed portions of the beneficiary holdings in respect of the STW with PS, BTW with PS and BTW alone respectively. In other words, the beneficiaries incurred an additional per acre cultivation cost of the order of Rs. 928, Rs. 954 and Rs. 920 respectively in the case of STW with PS, BTW with PS and BTW alone for raising irrigated crops in the benefited area, compared to that for those grown in the rainfed part of their holdings. The survey data show that the beneficiaries had significantly increased their expenditure on seed, fertilizers, and hired labour (both human and bullock) in respect of the crops grown on the benefited area.

Table 3.8
Cost of Cultivation per net Sown Acre

(Rs.)

Items of cost	Type of Investment					
	STW with PS		BTW with PS		BTW Alone	
	Irri- gated	Unirri- gated	Irri- gated	Unirri- gated	Irri- gated	Unirri- gated
1	2	3	4	5	6	7
Seeds	146.56 (11.32)	26.32 (7.36)	147.87 (11.51)	29.12 (8.81)	132.63 (11.57)	27.48 (12.17)
Manure	65.18 (5.07)	16.98 (4.76)	92.12 (7.17)	15.79 (4.78)	79.60 (6.95)	15.56 (6.89)
Fertilizers	252.00 (19.60)	8.96 (2.51)	210.27 (16.37)	18.65 (5.64)	175.34 (15.30)	- -
Pesticides	23.81 (1.85)	-	27.29 (2.12)	-	19.89 (1.74)	-
Hired Human Labour	237.70 (18.48)	120.53 (33.71)	241.65 (18.81)	108.41 (32.79)	196.59 (17.16)	66.89 (29.62)
Bullock Labour	290.38 (22.58)	145.14 (40.59)	273.59 (21.30)	119.82 (36.24)	220.61 (19.25)	85.30 (37.77)
O & M cost of PS	169.42 (13.17)	-	184.09 (14.33)	-	224.93* (19.62)	-
Others (Land revenue, interest on ST loans etc.)	101.94 (7.93)	39.59 (11.07)	107.75 (8.39)	38.80 (11.74)	96.31 (8.41)	30.59 (13.55)
Cost A 1	1286.00 (100.00)	357.52 (100.00)	1284.63 (100.00)	330.59 (100.00)	1145.90 (100.00)	225.82 (100.00)
Incremental cost per acre	928.48	-	954.04	-	920.08	-
Imputed value of family labour	27.00	9.18	27.05	29.48	50.40	57.04
Cost of cultivation (Inclusive of family labour)	1313.00	366.70	1311.68	360.07	1196.31	282.86

* Charges for hiring pumpsets @ Rs. 9 per hour of pumping.

3.11 If the imputed value of family labour is included, the per acre cost of cultivation would work out to Rs. 1,313, Rs. 1,312 and Rs. 1,196 for the benefited area as against Rs. 367, Rs. 360 and Rs. 283 for

the rainfed area of the beneficiaries of STW with PS, BTW with PS and BTW alone respectively. The use of family labour was relatively more on both irrigated and unirrigated parts of the beneficiary holdings with the single purpose BTW investment.

- 3.12** The break-up of the cost of cultivation as given in Table 3.8 also indicates that the beneficiaries of BTW alone incurred a relatively higher per acre cost of irrigation as compared to the beneficiaries having composite investments in TWs with pumpset. The beneficiaries of single purpose BTW investment were hiring pumpsets for drawing water at the rate of Rs. 9 per hour of pumping, which worked out to be relatively more expensive than the O & M cost incurred by the beneficiaries owning pumpsets.

Net Income and Incremental Income per Acre

- 3.13** Two estimates of net income have been provided : One excluding the imputed value of family labour and the other including this imputed value. The investmentwise data pertaining to the gross value of farm produce and cost of cultivation separately for the 'with' and 'without' investment situations have been reproduced and presented in Table 3.9. The data show that the net income per net sown acre realised from the irrigated portions was Rs. 733, Rs. 605 and Rs. 614 as against Rs. 192, Rs. 217 and Rs. 165 from the unirrigated portions of holdings by the three categories of beneficiaries, viz., STW with pumpset, BTW with PS and BTW alone respectively. If the imputed value of family labour is accounted for, the corresponding net income estimates would be Rs. 706, Rs. 578 and Rs. 564 respectively for the benefited area under the three investments and Rs. 183, Rs. 188 and Rs. 108 respectively for their unirrigated parcels, representing the 'without' investment situation in the present case.

- 3.14** The 'with' and 'without' investment comparison of net income (without including the imputed value of family labour in the cost of cultivation) shows that on an average, the net incremental income accrued to the

beneficiaries from STW with PS was Rs. 541 per acre. The same was Rs. 388 and Rs. 449 per acre for the investments in BTW with PS and BTW alone respectively. Clearly, the STW beneficiaries realised a relatively higher per acre net incremental income from the benefited portions of their holdings than other beneficiaries. It is evident from the cropwise and investmentwise data in Annexure - II that the STW beneficiaries spent relatively more on material inputs, especially on fertilizers, as compared to other beneficiaries and also obtained higher yields for crops raised on benefited area. The higher incremental yields also led to higher incremental incomes in their case.

Table 3.9
Per Acre Incremental Income Due to the Investment

(Rs.)

Particulars	STW with PS		BTW with PS		BTW alone	
	Irri-gated	Unirri-gated	Irri-gated	Unirri-gated	Irri-gated	Unirri-gated
1	2	3	4	5	6	7
Gross value of produce	2,019	550	1,890	548	1,760	391
Cost of cultivation						
(a)*	1,286	358	1,285	331	1,146	226
(b)**	1,313	367	1,312	360	1,196	283
Net income						
(a)	733	192	605	217	614	165
(b)	706	183	578	188	564	108
Net incremental income						
(a)	541	-	388	-	449	-
(b)	523	-	390 [ⓐ]	-	456 [ⓐ]	-

* Without the imputed value of family labour.

** With the imputed value of family labour.

ⓐ For BTW investments, the incremental income is some what higher when calculated after the inclusion of the imputed value of family labour in the cultivation costs than that realised when this cost was excluded; which can be explained by the fact that the shift to irrigated farming caused a marginal reduction in the use of family labour.

Sale of Water

- 3.15** The incremental income accrued to the beneficiaries due to the investment in TWs is dependent on the incremental income per net sown acre, the size of the benefited area and the possibilities of adding to agricultural income through the sale of surplus irrigation water. The survey data (Table 3.10) revealed that about 33 per cent and 35 per cent of the sample beneficiaries owning STW with PS and BTW with PS respectively had sold irrigation water in the reference year. No sale of water was reported by those owning the single purpose BTWs presumably due to the fact that they did not own pumpsers.
- 3.16** On an average, each STW beneficiary reporting sale of water sold it for about 47 hours of pumping and that of BTW sold for about 45 hours of pumping. They had sold water to 2 to 3 cultivators each. The average area irrigated with the help of the purchased water by the neighbouring farmers worked out to about one acre. It was observed that the owners of TWs were reluctant to sell surplus water as the payment of water charges were often delayed till the harvest. It was also reported that the demand for water was declining with the advent of low cost BTWs, which small and marginal farmers were installing on their holdings in preference to the option of operating as buyers in the market for irrigation water.
- 3.17** The sale of water was on the basis of informal contracts and mutual understanding between the beneficiaries and the farmers purchasing water. The water was priced at an average rate of Rs. 10 per hour of pumping. After accounting for the O & M costs involved, the net income earned by the beneficiaries averaged Rs. 6 per hour of pumping. For the sample as a whole (i.e. reporting as also non-reporting beneficiaries together), this would mean an additional net income of Rs. 91 per STW with PS and Rs. 94 per BTW with PS.*

* As shown in Table 3.10, the average sale of water for the total sample works out to 15.2 hours and 15.6 hours in the case of STW and BTW with PS respectively.

Table 3.10
Sale of Water

Type of investment	Size of beneficiary sample	Number reporting sale of water	Actual sale of water (Hours of pumping)		6	7	Net income from Sale of water		9	10	11	12
			Total	Average			Total	Per reporting beneficiary whole				
			Per reporting beneficiary whole	Average for the sample as a whole			Per reporting beneficiary whole	Average for the sample as a whole				
1	2	3	4	5	6	7	8	9	10	11	12	
STW with PS	40	13	608	46.77	15.20	3,640	280.00	91.00	33	43	1.30	
BTW with PS	40	14	625	44.64	15.62	3,760	268.57	94.00	47	45	0.96	

**Net Incremental Income per
Unit of Investment**

3.18 Thus, as can be seen from Table 3.11, the incremental income accrued to the beneficiaries from crop production on the benefited area and net income from sale of water together amounted to Rs. 4,403 per STW with PS, Rs. 1,704 per BTW with PS and Rs. 1,167 per BTW alone. The relatively higher incremental income per unit of investment in STWs with PS was the result of mainly the higher crop productivity and the larger size of the area benefited due to this investment in comparison with the BTW investments.

**Table 3.11
Net Incremental Income per Unit of Investment**

(Amount in Rs.)

Particulars	Investment		
	STW with PS	BTW with PS	BTW alone
1	2	3	4
Benefited area (Acres)	7.97	4.15	2.60
Net incremental income* per net sown acre	541	388	449
Net incremental income from own farm per unit of investment (Items 1 x 2)	4,312	1,610	1,167
Net income from sale of water	91	94	-
Total (Items 3 + 4)	4,403	1,704	1,167

* Excluding the imputed value of family labour from the cost of cultivation.

Impact on Employment

3.19 In addition to the accrual of incremental income to the beneficiaries, the investment in irrigation also generated increased employment opportunities for human labour. The increase in employment was of two types : (i) non-recurring and (ii) recurring. The non-recurring employment created by the investment in STW with PS, BTW with PS and BTW alone at the installation stage has been estimated at 105 mandays, 24 mandays and 20 mandays respectively. As regards the recurring additional on-farm employment per year, the relevant details are given in Table 3.12.

Table 3.12
Incremental On-farm Employment* Generated for
Human Labour Per Unit of Investment

Particulars	(Mandays)					
	STW with PS		BTW with PS		BTW alone	
	Irri- gated	Unirri- gated	Irri- gated	Unirri- gated	Irri- gated	Unirri- gated
1	2	3	4	5	6	7
1. Mandays utilised per net sown acre						
a) Family labour	5.40	1.84	5.42	5.52	10.09	11.41
b) Hired labour	47.54	24.11	48.33	20.62	39.31	13.38
c) Total	52.94	25.95	53.75	26.14	49.40	24.79
2. Incremental employment per unit						
a) Family labour	28.37	-	(-)0.42	-	(-) 3.43	-
b) Hired labour	186.74	-	115.00	-	67.42	-
c) Total	215.11	-	114.58	-	63.99	-

* Recurring every year.

3.20 It may be observed that the per acre utilisation of human labour on the irrigated portions of holdings was substantially higher than that

on the unirrigated portions in respect of all the three types of investments. The increased labour requirement of irrigated crops was met mainly by hired labour. The per acre use of family labour was also found marginally lower on the irrigated area than that on the rainfed area in the case the BTW beneficiaries (both 'with' or 'without' PS). It may be mentioned, however, that all the sample beneficiaries having the single purpose BTW investment were small farmers. In their case, the per acre use of family labour was twice that of the STW and BTW with PS beneficiaries. As regards the over-all impact on human labour employment, the data reveal that the incremental recurring employment created during the reference year due to the investment was of the order of 215 mandays per STW with PS, 115 mandays per BTW with PS and 64 mandays per BTW alone.

CHAPTER IV

FINANCIAL VIABILITY

4.1 Details regarding the beneficial effects and their quantification have been presented in the preceding chapter. An attempt is now made to examine the financial viability of the investments financed under the evaluated schemes. The Financial Rate of Return (FRR) has been estimated separately for the investments in STW with PS, BTW with PS and BTW alone to ascertain financial viability. The relevant cash flow statements, as presented in Tables 4.1, 4.2 and 4.3 have been prepared for the purpose with the following assumptions :

- i) The average economic life of a shallow tubewell and a pumpset is 15 years each, and that of a bamboo tubewell (improved) and bamboo tubewell (traditional) is 7 years and 5 years respectively.
- ii) The investment is completed in year zero.
- iii) Financial benefits accrue by way of incremental income from crop production and sale of water, and full benefits accrue from third year onwards. The incremental benefits assumed in the first and second years are 50 per cent and 75 per cent of the full benefits respectively.
- iv) The residual value of the pumpset is considered as a benefit in the terminal year of the STW/BTW.
- v) Valuations of cost and the benefit streams is at constant 1981-82 prices.

4.2 The results of the financial analysis show that the investments in STW with PS, BTW (improved) with PS and BTW (traditional) alone were financially viable with FRR at 36 per cent, 18 per cent and more than 50 per cent respectively (Tables 4.1, 4.2 and 4.3). The relatively lower value of FRR of the improved BTW with PS is on account of the capital cost of the pumpset, not generating commensurate incremental returns. It may be recalled that the beneficiaries used 5 h.p. diesel

engines. Enquiries during the field-survey revealed that a pumping unit not more than 3 h.p. was required for lifting water from BTWs. If investment is made in future in lower h.p. pumpsets by the BTW beneficiaries, the viability of the composite investment would improve. However, the 3 h.p. pumpsets were not readily available. Hence the beneficiaries had gone for over-size pumpsets. Efforts are necessary to encourage beneficiaries for custom hiring of their pumpsets to those owning only single purpose BTWs.*

Table 4.1
Cash Flow for STW with PS

Particulars	Years					(Rs.)
	0	1	2	3-14	15	
	2	3	4	5	6	
A. Outflow						
Cost of investment	10,400	-	-	-	-	-
B. Inflow						
i) incremental income** from crops	-	2,156	3,234	4,312	4,312	
ii) Net income from sale of water	-	46	68	91	91	
iii) Residual value of pumpset	-	-	-	-	275	
Total of (B)	-	2,202	3,302	4,403	4,678	
C. Net cash flow (B - A)	10,400	2,202	3,302	4,403	4,678	
D. FRR :	36 %					

* This study, however, did not explore this aspect. To that extent, the benefits of the composite investment in BTWs have been under-estimated.

** Without the imputed value of family labour.

Table 4.2
Cash Flow for BTW (improved) with PS

(Rs.)

Particulars	Years				
	0	1	2	3-6	7
I	2	3	4	5	6
A. Outflow					
Cost of investment	6,606	-	-	-	-
B. Inflow					
i) Incremental income* from crops	-	805	1,208	1,610	1,610
ii) Net income from sale of water	-	47	71	94	94
iii) Residual value of PS	-	-	-	-	2,933
Total of (B)	-	852	1,279	1,704	4,637
C. Net cash flow (B - A)	6,606	852	1,279	1,704	4,637
D. FRR :	18 %				

* Without the imputed value of family labour

Table 4.3
Cash Flow for BTW (conventional) alone

(Rs.)

Particulars	Years			
	0	1	2	3-5
I	2	3	4	5
A. Outflow				
Cost of investment	720	-	-	-
B. Inflow				
Incremental income* from crops	-	584	875	1,167
C. Net Cash flow	720	584	875	1,167
D. FRR :	> 50 %			

* Without the imputed cost of family labour.

4.3 A sensitivity analysis was attempted based on (a) 10 per cent increase in the capital cost and (b) 10 per cent decline in the benefits. The results, as presented in Table 4.4 suggest that with assumption (a), the investments in STW with PS, BTW with PS and BTW alone would be viable at FRR of 32 per cent, 15 per cent and more than 50 per cent respectively. The corresponding values of FRR based on assumption (b) would also work out to about 32 per cent, 15 per cent and more than 50 per cent respectively.

Table 4.4
Sensitivity Analysis

Sensitivity test		FRR %		
		STW with PS	BTW with PS	BTW alone
1		2	3	4
a)	10 % increase in capital cost	32	15	> 50
b)	10 % decline in benefits	32	15	> 50

4.4 The popular demand for traditional BTWs alone in the area was evidently on account of very low capital investment in such BTWs and their high profitability. In contrast, the composite BTW investment was only marginally viable under adverse conditions.

CHAPTER V

REPAYMENT PERFORMANCE

5.1 The data pertaining to demand, collection and balance obtained from the sample branches of the BSLDB and those of the RRB, as presented in Table 5.1, revealed that under the selected schemes, the recovery performance of the RRB was better than that of the BSLDB. The relevant data for all accounts under the selected schemes could be collected for 3 branches of the BSLDB. While the overdues in respect of the RRB were 36.5 per cent and 31 per cent of the demand respectively during the two years, viz., 1978-79 and 1979-80 for which data could be obtained. The same were higher at about 62 per cent, 74 per cent and 37 per cent of the demand during 1978-79, 1979-80 and 1980-81 respectively in respect of the sample branches of the BSLDB. The improvement in the recovery performance of the BSLDB branches during 1980-81 was due to the interest subsidy granted by the State Government to the LDB borrowers financed for minor irrigation structures. The State Government had directed the LDB to exempt the interest component of the recovery instalment of that year provided the borrowers repaid the principal component to the bank within the stipulated time. The bank was compensated by the Government by way of granting funds equal to the interest amount thus exempted for that year.

Table 5.1
Overdues Position at the Level of the Sample Branches*

Bank	Year (As on 30 June)	Demand	Collection	Overdues	Overdues as % to demand
1	2	3	4	5	6
BSLDB	1978-79	85.78	32.98	52.80	61.55
	1979-80	93.42	24.33	69.09	73.96
	1980-81	106.92	66.85	40.07	37.48
Kosi RRB**	1978-79	2.71	1.72	0.99	36.53
	1979-80	6.58	4.52	2.06	31.31

* Data provided in the Table pertain to 3 branches of BSLDB, viz., Forbisganj, Araria and Kishanganj, whereas, RRB data relate to all branches in the district implementing the scheme.

** In the case of the RRB branches, the requisite data could not be obtained for the year 1980-81.

5.2 An attempt has been made to assess the repayment performance at the sample beneficiary level as well. It may be seen from Table 5.2 that altogether about 33 per cent, 51 per cent and 76 per cent of the sample beneficiaries respectively under STW with PS, BTW with PS and BTW alone were in default during 1980-81. The remaining sample beneficiaries had repaid fully. The average default per overdue account worked out to Rs. 2,213, Rs. 1,359 and Rs. 473 in the case of STW with PS, BTW with PS and BTW alone, respectively. In other words, the incidence of overdues was 73 per cent, 78 per cent and 92 per cent of the demand for recovery respectively in the case of the defaulting sample beneficiaries having STW with PS, BTW with PS and BTW alone.

Table 5.2
Repayment Performance of Sample
Beneficiaries during 1980-81

Type of investment	Percentage of overdue accounts	Average default per overdue account (Rs.)	Percentage of overdues to demand
1	2	3	4
1. STW with PS	33	2,213	73
2. BTW with PS	51	1,359	78
3. BTW alone	76	473	92*

* The overdues in respect of the sample beneficiaries of the RRB during the earlier two years, viz., 1978-79 and 1979-80, when examined, worked out to 40% and 47% of demand respectively.

5.3 It is surprising to note that the default was highest at the sample beneficiaries level (Table 5.2) in terms of the percentage overdue accounts and percentage overdues to the demand raised during 1980-81 in respect of the single purpose BTW loans financed by the RRB, whose recovery performance at the bank level was found comparatively better than the BSLDB branches during the previous two years, viz., 1978-79 and 1979-80 (Table 5.1). The step taken by the State Government to exempt interest portion of the LDB dues during 1980-81 had created confusion among the RRB borrowers and this was one of the reasons of default. The RRB branches also experienced shortage

of adequate field-staff to launch an effective drive for recovery of loans.

- 5.4 Considering the reference year cost of investment, the annual debt service* would work out to Rs. 1,824 for STW with PS loan (Rs. 1,614 in the case of small farmer beneficiaries), Rs. 1,257 for BTW with PS loan and Rs. 190 for the loan covering the single purpose BTW (traditional) investment. The magnitude of average annual incremental income generated by the three types of investments has been found at Rs. 4,403, Rs. 1,704 and Rs. 1,167 respectively, at the reference year's prices. This demonstrates that the beneficiaries of all the three investments generally had the necessary repaying capacity from out of the incremental income to service the loans. The default was, by and large, wilful, especially in the case of the STW investment loans.

Calculated at 10.25% interest and repayment period of 9 years for STW loans (15 years in the case of small farmers), 9 years for pumpset (for both small and other farmers) and 5 years for BTW loans.

CHAPTER VI

MACRO IMPACT OF TUBEWELLS

6.1 The macro-level impact of the three schemes under review can be assessed in terms of the incremental irrigated area, crop production, farm income and employment in the area. The estimation is obviously to be based on the micro-estimates (Chapter-III) arrived at on the basis of the cross-sectional survey data. Since the sample study was confined to the composite investments in STWs and BTWs, the impact of the investment in single purpose pumpsets has been ignored for the purpose of these macro-level estimations. It may be recalled that in all, 1926 STWs with PS, 1182 BTWs with PS and 942 BTWs alone were financed under the three schemes. However, the field survey revealed that assets were non-existent in respect of 17.5 per cent of the sample beneficiaries[®] under the single purpose BTW investment on account of misutilisation of the entire loan, and all units under the composite STW and BTW investments were completed and found functional. Therefore, the macro-estimates have been worked out for 1926 STWs with PS, 1182 BTWs with PS and 777 BTWs alone. The monetary benefits have been estimated at 1981-82 prices. The relevant estimates are presented in Table 6.1.

Table 6.1
Macro Impact of the STWs and BTWs

Particulars	STW with PS (1926)		BTW with PS (1182)		BTW alone (777)		All Tube- wells
	Per unit	Total	Per unit	Total	Per unit	Total	
1	2	3	4	5	6	7	8
1. Additional area brought under irrigation (Acres)	7.97	15,350	4.15	4,905	2.60	2,020	22,275
2. Value of additional production (Rs.)	11,708	225.50*	5,569	65.83*	3,559	27.65*	318.98*
3. Contribution to GDP (Rs.)	4,403	84.80	1,704	20.14*	1,167	9.07*	114.01*
4. Incremental employment (Mandays)							
i) Non-recurring	104.88	2.02*	23.69	0.28*	20.22	0.16*	2.46*
ii) Recurring per year	215.11	4.14*	114.58	1.35*	63.99	0.50*	5.99*

* Figures in lakhs.

● Such cases were dropped from the sample and additional financial units included in their place.

6.2 Thus, the investments in tubewells under the three selected schemes together resulted into an extension of tubewell irrigation over an additional area of 22,275 acres. The desirable changes in cropping pattern, cropping intensity and crop productivity due to irrigation on account of the scheme-investments resulted into increased farm output and consequently increased the gross value of output substantially. For instance, the aggregate production of major foodgrains alone, viz., paddy and wheat increased by about 2.44 lakh quintals. The value of incremental production of all crops grown by the beneficiaries worked out to Rs. 319 lakhs and the net incremental income accrued to the beneficiaries, i.e., net addition to GDP worked out to Rs.114 lakhs. The macro-impact on human labour employment has been estimated at about 2.46 lakh mandays of the initial non-recurring employment and as many as 6 lakh mandays of recurring annual employment due to the installation of the tubewells financed under the schemes.

ANNEXURE - I

OBJECTIVES, SAMPLE DESIGN AND METHODOLOGY OF THE STUDY

Objectives

1. The study is an attempt to analyse the benefits accruing from minor irrigation investments under the selected schemes. The broad objectives of the study were :-
 - i) to review the implementation of the selected schemes by the financing banks;
 - ii) to study and quantify the financial benefits of both types of investment, i.e., shallow tubewells and bamboo tubewells on beneficiary holdings;
 - iii) to assess the financial viability of the investments; and
 - iv) to examine the repayment performance under the scheme investments.

2. Selection of Schemes

The selection of the three schemes was done purposively, keeping the study requirements in view.

- i) The original scheme sanctioned to BSLDB envisaged financing for construction of shallow tubewells with pumpsets.
- ii) Under the supplementary scheme implemented by BSLDB, bamboo tubewells with pumpsets were financed.
- iii) Since the scheme implemented by Kosi RRB was sanctioned for providing finance for construction of bamboo tubewells with pumpsets, bamboo tubewells alone and pumpsets alone just three years prior to the survey year, this scheme was selected purposively to measure the benefits from bamboo tubewells (traditional) alone.

3. Selection of District/Blocks/Villages

Since the main purpose of the study is to compare the benefits derived from shallow tubewell with the benefits accrued from bamboo tubewell in the scheme area, it was necessary to select those district/districts where large scale financing had been done for both types of investment. Such schemes had been implemented in Purnia and Saharsa districts. However, both the items of investment were concentrated in Purnia district only. Hence, Purnia district was selected purposively. The soil strata and water table are suitable for installation of bamboo tubewells in this district. The district has three sub-divisions, viz., Purniasadar, Araria and Kishanganj. Shallow tubewells were concentrated in Araria and Kishanganj sub-divisions. The scope of the study was extended to cover all the three sub-divisions to get adequate representation for both investments. Bamboo tubewells (traditional) alone were financed by Kosi RRB which were concentrated in Purnia sub-division. Out of 27 blocks in the district, 10 blocks were selected at the first stage of sampling.

4. Study Sample of Beneficiaries

From the selected blocks, 41 villages were selected based on concentration of borrowers. Finally, a list of beneficiaries for each of the selected villages was prepared purpose-wise/investment-wise. From out of such lists, altogether 40 beneficiaries under shallow tubewell with pumpsets, 40 beneficiaries having bamboo tubewell with pumpset and 33 beneficiaries having bamboo tubewell alone were randomly selected to constitute the study sample.

5. Data and Analysis

- i) The relevant primary data were collected by survey method from the sample beneficiaries for the reference year of the study, viz., 1981-82. The necessary additional data were also obtained

from the offices of the selected banks which had implemented the schemes under review. The inputs and output were valued at constant 1981-82 prices. The valuation of crop produce was made at the prevailing post-harvest farm-gate prices.

- ii) The estimation of incremental benefits due to the investments was based on 'with' and 'without' investment comparisons. The 'without' investment situation was represented by the farm activity as observed on the rainfed portions of the beneficiary holdings. An no significant variations were observed as between the rainfed farming elsewhere on non-beneficiary farms and that on beneficiary holdings in the study area, no separate "control" sample was considered necessary. In other words, the incremental benefits due to the investments were studied by comparing the relevant farm business data for irrigated and unirrigated portions of the beneficiaries' holdings.
- iii) The relative economics of the three investments, viz., STW with PS, BTW with PS and BTW alone has been worked out and their financial viability assessed against the back-drop of the obtaining geo-hydrological and farm level conditions in the study area.

6.

Limitation of the study

The field-survey data for the present study related to only one district of Bihar and hence, the study results based on survey findings do not necessarily have the general applicability to the whole region.

ANNEXURE - II

Per Acre Average Yield and Cost of Cultivation of Different Crops (Survey Data)

(Amount in Rs.)

Crops	Yield (Quintals)	Seed	Manure	Fertilizers	Pesticides	Total expenditure on material inputs	Cost AI
IRRIGATED							
Paddy							
(i) STW with Pumpset	10.2	55	31	132	12	230	670
(ii) BTW with Pumpset	9.4	49	45	100	15	209	631
(iii) BTW alone	9.2	48	40	88	9	175	584
Wheat							
(i)	9.5	120	47	175	18	360	830
(ii)	8.6	120	60	140	16	336	806
(iii)	8.8	120	61	132	16	329	822
Pulses & Oilseeds							
(i)	4.5	70	15	40	-	125	400
(ii)	4.0	65	-	30	-	95	348
(iii)	3.5	65	-	35	-	100	306
Jute							
(i)	6.4	16	34	64	8	122	552
(ii)	5.6	15	31	53	10	109	497
(iii)	5.1	15	40	53	15	123	453
RAINFED							
Paddy (L)							
(i)	4.5	22	14	9	-	45	307
(ii)	4.2	25	7	8	-	40	268
(iii)	3.0	23	10	-	-	33	174
Jute							
(i)	2.3	16	11	-	-	27	188
(ii)	2.5	14	24	29	-	67	224
(iii)	2.0	14	20	-	-	34	175

**List of reports published under the Evaluation Study Series
of the National Bank for Agriculture and Rural Development**

Series No.	Title of Evaluation Report	Year of Publication
1.	Minor Irrigation Scheme-Construction of New Wells and Installation of Pumpsets thereon in Sholapur District [Maharashtra]	1977
2.	Minor Irrigation Scheme - Installation of Shallow Tubewells in Karnal District [Haryana]	1977
3.	Bhadra Land Development Project - Scheme for Reclamation and Development of Land [Karnataka]	1977
4.	Land Development under Nagarjuna Sagar Project, Miryalguda Taluka [Andhra Pradesh]	1977
6*.	Dairy Development Scheme in Jagadhri Block of Ambala District [Haryana]	1978
7.	Dairy Development Scheme in Moga Area of Faridkot District [Punjab]	1978
8.	Poultry Development Scheme in Mulkanoor, Karimnagar District [Andhra Pradesh]	1979
9.	Mechanised Fishing Boats in South Kanara District [Karnataka]	1979
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13.	Development of Grape Cultivation in Bijapur District [Karnataka]	1982
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15.	Dairy Development Schemes in Western Uttar Pradesh	1982
16.	River Lift Irrigation Scheme in Kolhapur District [Maharashtra]	1982
17.	Sheep Rearing in Nalgonda District of Andhra Pradesh	1982
18.	Development of Coffee Plantations in Lower Palnis Area, Madurai District [Tamil Nadu]	1983

* One report [Series No. 5] was not published.

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Series No.	Title of Evaluation Report	Year of Publication
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