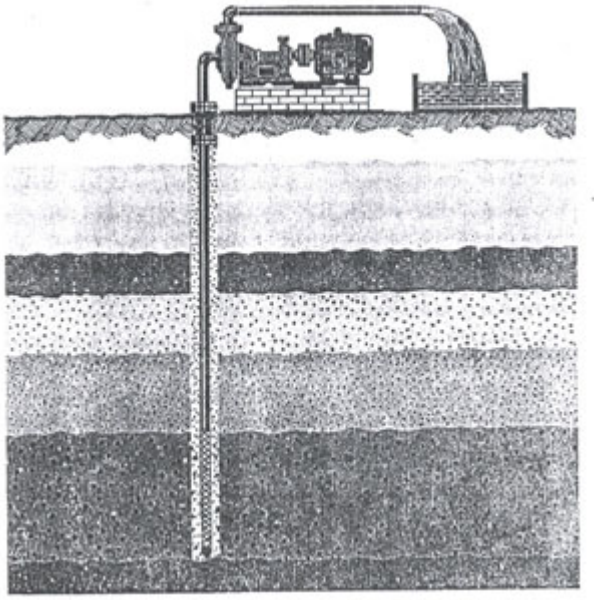
SHALLOW TUBEWELLS WITH PUMPSETS IN ALLUVIAL AREAS



CHAPTER – I

REQUIREMENTS OF A MODEL SCHEME FOR FORMULATION BY BANKS

1.1 General

Given in this document are the salient features which the banks should incorporate while formulating schemes for Shallow Tubewells in Alluvial Formations. Individual items to be included are indicated here. The model also includes essential items of cost and economics. This scheme may be taken as a guide only and modifications/improvements including provision of additional details considered necessary on area specific basis should be given in the schemes formulated by banks.

1.2 Why Scheme Formulation is Desirable

It is always desirable to formulate schemes for minor irrigation development. These should give the design, cost estimates, physical and financial targets, and economics along with a time frame for its completion. Scheme formulation helps in the following ways.

1. Planned development of groundwater resources.
2. Proper planning and fixing targets on block/area specific basis under a fixed time frame.
3. Ensuring quality of lending, systematic development, and assured income to beneficiaries, implied timely repayment and recycling of funds.
4. Quality control of works and equipment.
5. Systematic monitoring.
6. Periodical review about achievements and short falls and timely remedial measures.

In view of the above advantages NABARD always insists on proper scheme formulation and its appraisal before sanction and extending refinance facilities.

1.3 Scheme Requirements

The following items should be included in any scheme for Shallow Tubewells in Alluvial Formations for availing bank finances.

1.3.1 Introduction

This should briefly give the location of the scheme area, its extent and topographical features.

1.3.2 Selection of Area

Guidance of the State Groundwater Department should be followed to select the project area for minor irrigation development through groundwater resources. The area selected should be a compact block / taluka or watershed with adequate groundwater potential, easy accessibility by road and adequate outlets for sale of agricultural produce. The above information can be obtained from the State groundwater department and local district authorities. Brief details about the area selected and the project benefits should be given in the scheme.

1.3.3 Soil

The scheme should give the general type of soils in the scheme area along with the type of crops that can be grown thereon. In general, soils are classified as either Sandy or Loamy or Clayey or Black Cotton type soils. Soils have bearing on irrigation and crops grown. Soils also have bearing on irrigation scheduling and depth of irrigation required to meet the water requirements of crops.

1.3.4 Climate and Rainfall

The climate and rainfall of the scheme area help in estimating the supplemental Irrigation water requirement and the number of minor irrigation units that can be constructed and financed in the scheme area. Under this item the minimum and maximum temperature, seasons and the rainfall period should also be given. The normal yearly rainfall as given by the Indian Meteorological Department (IMD) and the monsoon and non-monsoon rainfall should necessarily be given. If

there is no rain-gauge station in the scheme area, rainfall figures of the nearest (IMD) rain gauge station may be given.

1.3.5 Hydrogeology

Under this heading, different geological formations in the area, aquifers, their thickness and water transmitting capacity average depth to water table and well design suitable for the area should be indicated. Only the top unconfined aquifers in alluvium formations are mostly developed by construction of shallow tubewells. They generally comprise of fine to medium sand intermixed with silt and clay. These formations are lenticular in shape and have limited horizontal and vertical continuity. This information is available with the district geologist of the State groundwater department.

1.3.6 Groundwater Availability

Before any programme of groundwater development is taken up, it is essential to ascertain whether adequate groundwater potential is available in the blocks covered under the scheme. The state groundwater department estimates groundwater resources on a blockwise, taluka wise or watershed wise basis and also keeps a record of the status of groundwater development at a given period of time. The categorisation of blocks as over-exploited, dark (critical), grey (semi-critical) and white (safe) is made on the basis of stage of groundwater development expressed as a ratio of draft to utilisable resources available, as well as trend of groundwater table fluctuations. For overexploited areas, it is greater than 100%, for dark (critical)areas, it is between 90% and 100% ; grey (semi-critical) areas, between 70% and 90% and for white (safe), it is less than 70%. This information is available with the NABARD regional office and state groundwater department. Banks can obtain it from them.

Since long term behaviour of water table is a manifestation of the long duration availability of groundwater resources, it is necessary to ensure that there is no declining trend of water table in the area selected for the scheme. Information on pre-monsoon water table is also necessary to decide the depth of well and to ensure that the yield of well is not affected due to depletion of water table in the area.

Keeping this in view and for sustainability of the structure and the investment, new well investments in dark(critical) and over-exploited areas should not be formulated.

1.3.7 Groundwater Quality

The groundwater quality in a scheme area as indicated by the State groundwater department should be given. Its suitability for irrigation may be indicated in terms of total dissolved solids, sodium adsorption ratio etc. Generally, the groundwater in the scheme area should be of good quality and suitable for all crops grown in the area.

1.3.8 Physical Programme

It is desirable to assess the demand for new wells in the area before formulating the scheme either by interaction with the farmers or the state/district level developmental agencies involved in groundwater development programme. This facilitates fixing the physical targets for wells and pumpsets. If the demand is more and targets assessed are large, the programme could be phased over 2 to 3 years instead of envisaging entire programme for one year. Such a phasing helps in better monitoring and leaves scope for mid term correction wherever required.

Normally single design of well is uniformly followed in the block suitable for the geological formation. However, if different designs of wells are considered necessary for different geological formations, physical programme should be given for each type of well design.

1.3.9 Well Design

The diameter,depth and length of strainer of shallow tubewells should always be given in a scheme.It should also give the discharge expected from the well for the proposed cropping pattern and the corresponding drawdown.The location of the well should be preferably at the center of the command area so that the length of the distribution system is minimum.

1.3.10 Spacing

In absence of any groundwater legislation, institutional agencies enforce technical discipline in the form of spacing between two ground water structures for proper and efficient development of groundwater. The State groundwater deparment conducts pumping tests and recommends optimum spacing between the wells which should be observed in the field.

1.3.11 Unit Cost

Based on the average design of well in the scheme areas, unit cost of the structure should be estimated adopting district schedule of rates and the total financial outlay of the scheme should be worked out for the physical programme envisaged. However, actual cost of well may vary from location to location and loan should be sanctioned for actual cost of well. It is important to avoid under financing of well that may render the investment infructuous.

1.3.12 Pumpset

Proper selection of pumpset in conformity with BIS 10804-1994 is important to achieve maximum output at minimum capital and operation cost. The scheme should give the type of pumpset (diesel/electric), requirement of horsepower of the pumpset, size of suction/delivery pipes for the required discharge and operating head as per average agronomical practices and hydrogeological conditions in the scheme area. If site conditions require construction of a pit for installation of the pumpset or use of belt drive, coupled pumpset, these should also be given in the scheme and its cost provided for. (NABARD model scheme on Selection and Financing of Agricultural Pumpsets may be referred to).

1.3.13 Economics

The economics of investment should be given in detail to justify the loan. The scheme should also give details about subsidies,if any, repayment schedule, rate of interest etc.

1.3.14 Check list

A checklist should always accompany the proposal. This would help to check at a glance whether or not the details of essential items of scheme formulations have been incorporated. A check list is given in **Annexure – I**.

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CHAPTER- II

ILLUSTRATIVE MODEL FOR SCHEME OF 'SHALLOW TUBEWELLS IN ALLUVIAL FORMATIONS'

2.1 Introduction

Formulation of a scheme is explained in the subsequent paragraphs taking the case of a model block.The scheme gives details about availability of groundwater, its present stage of development, existing number and type of minor irrigation works with a view to finance construction of additional shallow tubewells in private sector in the block for development of minor irrigation.

The block is located in the Indo-Gangetic alluvial terrain. The total geographical area of the block is about 16,739 ha. It has a flat topography with elevation ranging from 200m to 220m above mean sea level. Certain parts of the block are already provided irrigation facilities through surface and groundwater sources. A canal of 110 km total length with average wetted perimeter of 8m in the block flows for about 120 days during the non-monsoon period. The canal length in the block is about 48 km.

2.2 Soil

In the scheme area the soil is mostly sandy loam. It also has large patches of clayey loam. Wheat, paddy, maize and gram are generally grown in the area.

2.3 Climate and Rainfall

The climate of the area is typical of the North Indian sub-continent. It is characterised by large seasonal fluctuation in temperatures.A temperature of about 40^0 C is common between April to June and about 8^0 C between December to January. The normal yearly rainfall in the scheme area is about 1060 mm out of which 930 mm (89%) is received from South West monsoon during the monsoon period from June to September and 129 mm during the non-monsoon period (winter rainfall) from November to January.

2.4 Hydrogeology

2.4.1 Exploration Data

Quaternary alluvium of considerable thickness occurs in the area. Exploratory drilling carried down to a depth of 450 metres have not indicated presence of any bed rock. The alluvial complex principally consists of fine to medium sand, silt and clay. Beds of gravel or very coarse sand are uncommon. Kankar, an impure deposit of calcium carbonate of secondary origin, is very often associated with the sediments. The finer parts of alluvium generally consist of sandy or silty clay. Thick horizons of pure clay are uncommon.

The lithology of alluvium, as inferred from the study of lithological and geophysical logs show heterogeneous character of sediments in the transverse and downstream directions. Clay zones are distributed at random. Although there are local concentrations of fine grained sediments of considerable thickness, individual strata are generally lenticular and have little horizontal or vertical continuity.

Two major aquifer systems separated by silty clay are encountered within 100m depth. The first aquifer, developed extensively by private tubewells, occurs in the depth range of 15 to 45 m. It has an average thickness of about 12 m. The second aquifer occurs in the depth range of 50 to 95m. Deep tubewells constructed by the State government tap this unit. The lower aquifer is separated from the upper one by a thick confining clay layer. Shallow tubewells in the top aquifer are capable of giving a discharge of about 8 lps at a drawdown of about 3m. The average hydraulic conductivity of unconfined aquifers as estimated by the SGD is about 30 m per day and the radius of influence is about 100m.

2.5 Groundwater availability

2.5.1 Recharge

The State groundwater department (SGD) has estimated the available annual recharge by water table fluctuation and specific yield method. This includes recharge from monsoon rainfall and from supplementary sources like canals and tanks, re-cycled irrigation water, non-monsoon rainfall etc. The available recharge as estimated by SGD in the block is given below.

Total Annual Groundwater Recharge (ham) 6200

Net annual groundwater availability (ham) 5580.

After allowing for the existing and projected demand for drinking water and industrial use, the net annual groundwater available for irrigation is estimated at 5270 ham.

2.5.2 Draft

The existing gross annual groundwater draft for all uses in the block,as estimated by the state groundwater department is 2742 ham.

2.5.3 Water Balance

Net annual groundwater availability for future irrigation development is estimated by the state groundwater department as 2560 ham.

2.5.4 Stage of Groundwater Development

The stage of groundwater development is defined by ratio of existing gross annual groundwater draft for all uses to net annual groundwater availability and expressed as percentage. From the above groundwater estimates by the state groundwater department, the stage of groundwater development in the block is 49%. Further, the long term behaviour of water levels in the observation wells as recorded by the state groundwater department, does not show any progressive decline during past 10 years. Accordingly, the block is categorised as white (safe) and new well programme in the block is technically feasible.

2.5.5 Physical Programme

A programme of 300 shallow tubewells with pumpsets is proposed under the scheme. The unit gross draft of a shallow tubewell is taken as 1.5 ham per year. The gross draft works out to be 450 ham, against a water balance of 2560 ham. Thus the proposed programme in the block is technically feasible. The stage of groundwater development after financing the proposed programme would be within 70% and the block would remain in the white (safe) category.

2.6 Groundwater Quality

As estimated by the State Groundwater Department the electrical conductivity of groundwater in the scheme area is 1500 micro mhos/cm and the Residual Sodium Carbonate 1.5 ppm. Therefore, groundwater in the scheme area is of good quality and suitable for all crops.

2.7 Spacing

In the area, the spacing norm between two shallow tubewells is 150 m as prescribed by the State Ground Water Department, and the same would be adopted in the scheme area.

2.8 Well Design

In the scheme area, an aquifer thickness of about 12 m in a boring depth of about 45 m is available. Therefore, shallow tubewells of 45m depth with strainer length of 12 m would be provided. The diameter of wells would be 100 mm and they would be capable of giving a discharge of about 8 lps.

2.9 Cropping Pattern and command Area

The irrigated crops in the scheme area are paddy, maize, wheat, potato and gram. The average available command area with the farmers in the scheme area is about 1 ha. The cropping pattern and water requirements for a 1 ha model are given in **Annexure II**. The peak discharge required during the Rabi season is 2.5 lps. This can be adequately met from the well designed for the

scheme area (in fact, as indicated above, it is capable of giving upto 8 lps). The discharge of 2.5 lps is also taken for selection of an appropriate pumpset.

2.10 Pumpset Selection

A centrifugal pumpset would be suitable for installation on shallow tubewells. This type of pumpset is also commonly used in the scheme area. The pumpset has been selected keeping in view the discharge and total pumping head.

a. Required discharge

The discharge required is 2.5 lps for an average daily pumping period of about 6 hrs. on the days of irrigation.

b. Total Pumping Head

The total pumping head including static head, lowering of water level during pumping (drawdown) and friction head losses will be 16.5 m. The friction losses are considered as per norms i.e. not exceeding 10% of the total static head.

For the groundwater regimen prevalent in the area, the total pumping head is calculated as under.

Peak water requirement period	**Rabi**
Total static head (m)	12.5
Drawdown (m)	3.0
Friction losses in pipes, valves etc.(m)	1.0
Total	**16.5**

Therefore a pumpset for a discharge of 2.5 lps and total head of 16.5 m has to be selected.

c. Horse power of the prime mover

The horsepower required after taking into consideration the pump efficiency as 50% and for discharge and head as indicated above is calculated below :

$HP = (Q \times H) / (75 \times e)$

Where
Q = discharge in lps
H = head in meters
e = pump efficiency in fraction

$$HP = \frac{2.5 \times 16.5}{75 \times 0.5} = 1.1$$

add 40% extra cushion for diesel pumpset

HP = 1.1 + 0.4 = 1.5

However, from practical considerations including that of market availability,it is proposed to provide 5 HP diesel pumpset (If electricity is available, a 3 HP electrical pumpset may be provided wherever required).

The specification of complete pumping system selected for the scheme should be as per BIS:10804. The details are as follows

1. Centrifugal pump

Discharge (Q) = 2.5 lps
Total head (m) = 16.5 m
Efficiency = 50%

2. HP of diesel engine = 5

3. Suction pipe = 100mm

Delivery pipe = 100 mm
Reflex valve = 100 mm
other accessories = as per requirement

2.11 Cost Estimates

The cost estimates for the suggested shallow tubewell design are indicated below as per prevalent rates. The unit cost for the shallow tubewell and pumpset works out to Rs.36200.00. The cost of pumphouse may be considered as an optional item.

Diameter (mm) : 100
Depth (m) : 45

Type : PVC Strainer well
Plain pipe : 33 m
Slotted pipe : 12 m

Sr. No.	Item	Quantity	Rate (Rs.)	Amount (Rs.)
1.	Drilling charges *	50m	100/m	5000.00
2.	Plain pipe (100 mm)	33m	100/m	3300.00
3.	Strainer (100 mm)	12m	150/m	1800.00

4.	Pipe accessories and Bail plug			400.00
				10500.00
	Contingency @5%			525.00
				11025.00
			say Rs.	**11000.00**
	* includes development & gravel packing charges			

2. RCC pit for installation of centrifugal pump : 6.5 m depth

(RCC rings 1.25 m dia. x 0.6 m height) @ 800/- per m depth **5200.00**

3. Diesel Pumping system @18000/-
18000.00

Belt, shaft and pully arrangement **2000.00**

Hence, the total cost of Shallow Tubewell with pumpset will be **Rs. 36200.00**

Optional Structure

Pump house (2.5m x 2.5m x 2.1m) @10000/- per unit Rs. 10000.00

2.12 Financial Outlay

The unit cost of a shallow tubewell with 5 HP Diesel pumset is Rs.36200.00. The total financial outlay of the scheme of construction of 300 shallow tubewells with pumpsets would thus be Rs.108.60 lakhs.

2.13 Economic Analysis

The same has been done as per details below.

2.13.1 Interest Rate for Ultimate borrowers

Banks are free to decide the rate of interest within the overall RBI/NABARD guidelines. However, for working out the financial viability and bankability of the model project, we have assumed the rate of interest as 12% p.a.

2.13.2 Repayment Period

The repayment period of loan for pumpset may be kept as 9 years, and for shallow tubewells, 11 to 13 years excluding 11 months grace period. However,for the purpose of this model project, 12 years has been taken.

2.13.3 Security

Banks may take a decision as per the RBI guidelines.

2.13.4 Pre and Post Development Incomes

The annual incremental income works out to be Rs. 12,480/-.The details are indicated in Annexure – III.

2.13.5 Projected Cash Flows

The discounted cash flows are indicated in Annexure – IV , from where the following values of BCR,IRR and DSCR are observed.

BCR	IRR	DSCR
1.78	33%	1.98

2.14 Interest Rate for Refinanace from NABARD

As per circulars of NABARD issued from time to time.

2.15 Supervision and Monitoring Arrangements

The financing bank has the necessary staff to give guidance to farmers in regards to long term and crop loans. Services of the concerned government department would also be availed for successful implementation of the programme.

2.16 Availability of Technical and Extension Services

The bank shall ensure that all technical conditions stipulated by NABARD under the scheme would be followed during the scheme implementation. The services of State groundwater department and state agriculture department are also available as and when required.

Agriculture Extension Officers at block level would provide necessary extension services to farmers through village level workers and gram sevaks by arranging camps and through audiovisual aids. This would include extension services for agronomical practices, crop-calender, fertilizer, pest control and marketing.

The following general guidelines would be followed for selection of site of Shallow Tubewells :

i. The proposed shallow tubewell would be at a safe distance from other shallow tubewells so that there are no interference effects and spacing norms would be followed.

ii. The location of shallow tubewell would preferably be at the center of the command area so that length of underground distribution pipe is minimum.

ANNEXURE – I

Check List

Minor Irrigation

Groundwater Development Schemes

(To be completed by Bank Officer forwarding the Scheme)

Tick (P) in boxes to signify that the relevant information has been furnished under the Scheme.

1.	Name of Scheme	
2.	Scheme Location	
3.	Area Map	
4.	Area-geographical area, cultivated area and area irrigated by different sources	
5.	Soil conditions, cropping pattern and crop water requirement	
6.	IMD Normal Rainfall	
7.	Geological Formations	
8.	Length of canal and distributaries with wetted perimeter and number of running days in the scheme area	
9.	Groundwater availability – groundwater recharge and draft, stage of groundwater development and category of block	
10.	Yearwise physical programme and financial outlay	
11.	Spacing between different type of minor irrigation works	
12.	Chemical quality of groundwater	
13.	Design of minor irrigation works	
14.	Specifications of pumping machinery, diameter of suction and delivery pipes, discharge, total head and HP of pumpset	
15.	Cost Estimates	
16.	Financial returns on investments with reference to representative size of holdings in different climatic zones in the scheme area	
17.	Lending terms i.e. interest rate, down payment, repayment period, extent of subsidy, if available	
18.	Availability and arrangement for procurement and distribution of	

	material	
19.	Agency providing crop loan and its adequacy	
20.	Supervision and monitoring arrangements	
21.	Technical guidance if available and by whom	
22.	Availability of extension services	
23.	Availability of power and diesel	
24.	Availability of seeds, fertilizers and pesticides	

Annexure – II

Cropping Pattern and Water Requirements

(1 ha Farm Model)

Working Period : 6 hrs/day

Season	Crop	Area (ha)	Irrigation Interval (days)	Depth of Irrigation (cm)
Kharif	Paddy	0.75	20	5
	Maize	0.25	24	5
Rabi	Wheat	0.50	15	7.5
	Gram	0.25	15	7.5
	Potato	0.25	10	5

$$\text{Discharge Required (Q)} = 28 \frac{A \times I}{R \times t}$$

Where Q = Discharge in lps
A = Area in ha
l = Depth of Irrigation in cm
R = Irrigation Interval in days
t = Hours of operation of well per day

Kharif

$$Q = 28 \left(\frac{0.75 \times 5}{20 \times 6} + \frac{0.25 \times 5}{24 \times 6} \right)$$

= 1.12 lps

Rabi

$$Q = 28 \left(\frac{0.50 \times 7.5}{15 \times 6} + \frac{0.25 \times 7.5}{15 \times 6} + \frac{0.25 \times 5}{10 \times 6} \right)$$

= 2.33 lps say 2.5 lps

Thus the peak discharge required is during Rabi and is estimated at 2.5 lps which should be available from the shallow tubewell.

Annexure - III PRE AND POST DEVELOPMENT CROPPING PATTERN AND INCOME

CCA	**1 Hectare**								
Pre Development									
SEASON	CROPS	Area	YIELD	TOTAL	PRICE (in	GROSS	COST	Cost	NET INCOME
		(in Ha)	(Qtl per Ha)	YIELD (QTL)	Rs per Qtl)	INCOME	(per Ha)	incurred	(in Rs)
						(in Rs)			
Kharif	Paddy	0.50	14.00	7.00	550.00	3850.00	6340.00	3170.00	680.00
	Maize	0.50	8.00	4.00	500.00	2000.00	2630.00	1315.00	685.00
								Total	1365.00
Rabi									
	Gram	0.75	5.50	4.13	1200.00	4950.00	4350.00	3262.50	1687.50
	Mustard	0.25	5.20	1.30	1200.00	1560.00	4300.00	1075.00	485.00
								Total	2172.5
								Say	2173
					Total Pre development income				3538.00
Post development									
SEASON	CROPS	Area	YIELD	TOTAL	PRICE (in	GROSS	COST	Cost	NET INCOME
		(in Ha)	(Qtl per Ha)	YIELD (QTL)	Rs per Qtl)	INCOME	(per Ha)	incurred	(in Rs)
						(in Rs)			
Kharif	Paddy	0.75	20.00	15.00	550.00	8250.00	6340.00	4755.00	3495.00

	Maize	0.25	11.00	2.75	500.00	1375.00	2630.00	657.50	717.50
								Total	4212.50
								Say	4213
Rabi									
	Wheat	0.50	21.00	10.50	700.00	7350.00	8720.00	4360.00	2990.00
	Gram	0.25	7.50	1.88	1400.00	2625.00	4350.00	1087.50	1537.50
	Potato	0.25	260.00	65.00	150.00	9750.00	9890.00	2472.50	7277.50
								Total	11805.00
					Total Post development income				16018.00
Pre developmental Income (in Rs.)									
Kharif	1365								
Rabi	2173								
Total	3538								
Post Developmental Income (in Rs)									
Kharif	4213								
Rabi	11805								
Total	16018								
Incremental income (in Rs.)			12480						

Annexure IV - Shallow Tubewell with Pumpset

Techno-economic parameters adopted :									
(for 1 hectare model)									
1. Economic life of the project investment(years)*					15				
2. Margin money(%)					5				
3. Rate of interest for borrower(%)					12				
4. Repayment period(years)*					12				
5. Capital recovery Factor					0.1614				
6. Investment Cost (Rs.)					36200				
7. Annual Incremental Income (Rs.)					12480				
8. Discounting rate					15%				
9. Special cash flows pertaining to (a) Other cost & (b) Other income indicated at S. Nos.2 & 5 in the table below as follows .									
(a) Replacement cost of pumpset at 9 years*					20000				

(b)(i) Salvage value at 9 years						2000				
(ii)Salvage value at 15 years						9215				
* Cash flows projected accordingly										
Discounted Cash Flow :										
S.No.	Particulars		0	1	2	3	4	5	6	7
1	Investment Cost	(Rs.)	36200							
2	Other Cost(Replacement)	(Rs.)								
3	Total Cost(A)	(Rs.)	36200	0	0	0	0	0	0	0
4	Incremental Income	(Rs.)		12480	12480	12480	12480	12480	12480	12480
5	Other Income(Salvage)	(Rs.)								
6	Total Benefit(B)	(Rs.)	0	12480	12480	12480	12480	12480	12480	12480
7	Net Benefit(C)	(Rs.)	-36200	12480	12480	12480	12480	12480	12480	12480
8	NPV of Total Costs	(Rs.)	41885.25							
9	NPV of Total Benefits	(Rs.)	74676.18							
10	BCR		1.78							
11	NPV of Net Benefits	(Rs.)	32790.93							
12	IRR	(%)	33%							
13	Equal Annual Repayment	(Rs.)		5551.81	5551.81	5551.81	5551.81	5551.81	5551.81	5551.8
14	DSCR			2.25	2.25	2.25	2.25	2.25	2.25	2.25
15	Average DSCR		1.98							
# the replacement may be done by the farmer out of his own resources										