Financing Watermill Upgrades

The Business Case for Banking Support

Itpower

CHAMOLI
WATERMILL
ASSOCIATION

Financing Watermill Upgrades

CONTENTS

1. INTRODUCTION

This summary report prepared by IT Power presents the business case for supporting the upgrading of traditional watermills ('gharats') with improved technology. The report is directed at the banking community with the aim of encouraging rural and agricultural banks to offer appropriate finance for new projects. The report provides an overview of the technical, financial, social and market characteristics of watermill upgrades.

2. BACKGROUND

The principal use of hydropower in the Himalayas is through traditional watermills for grinding grain. These develop typically less than one kilowatt of mechanical power at low efficiency. Many of the traditional watermills are now being abandoned and the remaining mills face increasing competition from diesel and electric mills.

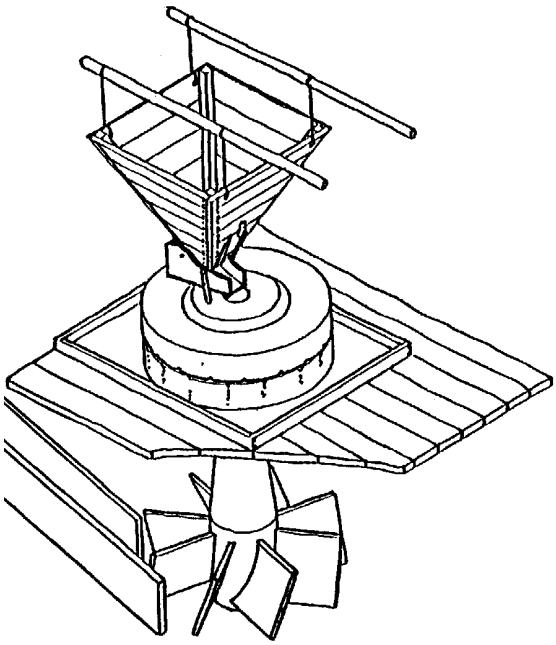
Since 1996, efforts by IT Power in association with the Himalayan Environmental Studies & Conservation Organisation and the Chamoli Watermillers Association have resulted in the successful demonstration of cost-effective solutions for upgrading the traditional watermills. These have been developed with the participation of the watermillers and local manufacturing partners and have now been demonstrated under local conditions since 1999.

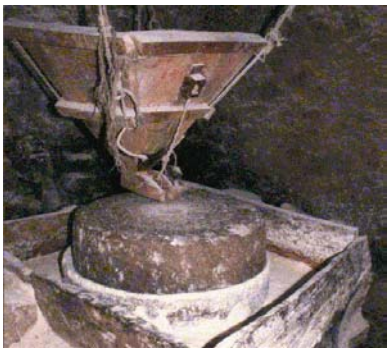
3. TECHNOLOGY

3.1 Traditional Watermills

The concept and main components of a traditional watermill are illustrated in Figure 1, consisting of a grain hopper, millstones, water chute and wooden runner. The grinding capacity of the traditional mills ranges from 5-10 kg of flour per hour, with an efficiency of less than 20%.

Figure 1 Traditional watermill or 'gharat'





3.2 Upgraded Watermill

The improved watermill has been developed to maximise the grinding capacity of the existing mill-stones at an affordable cost, so that the watermills will be able to compete effectively with the diesel mills. The upgraded mills have proven capable of grinding at 20-25 kg/hour, typically a three-fold increase.

The new runner fits under the existing mill-house and can use the same mill-stones. Figure 2 depicts the upgraded watermill and highlights the new components.

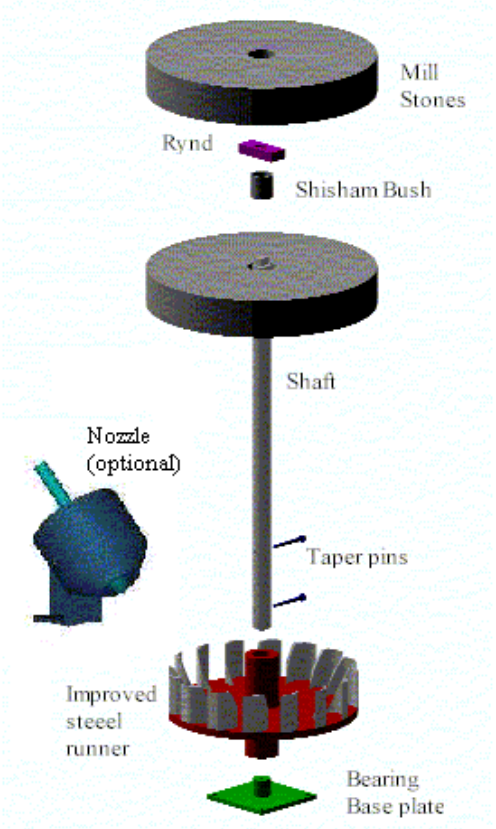
To improve efficiency and durability, the runner is of metal construction and is supplied with a steel shaft and improved bearings. The runner has been designed to achieve an efficiency above 50% and to have a geometry which is suitable either for casting, or fabricating at a local welding shop. The upgraded mill is intended to operate at roughly 200rpm to achieve peak output; the traditional watermills run at less than 100rpm.

The new runner can operate with the existing wooden chute although this is often replaced with a new chute from GI Sheet. An additional improvement is the provision of a PVC pipe and nozzle, which directs a more powerful jet on to the runner, as indicated in Figure 2.

A limited amount of civil work from a mason may be required to make small modifications to the powerhouse, and to ensure the intake canal is in robust condition. A new system also requires some technical assistance to ensure that the equipment is installed for optimum efficiency, and to train the miller in the necessary maintenance tasks. This assistance can be provided by the Chamoli Watermill Association, who have already overseen the installation of more than 100 demonstration units.

Further technical details are provided in Annex A.

Figure 2 Upgraded Watermill



4. COST ESTIMATES

4.1 Investment Costs

The initial expenses for upgrading a traditional watermill are presented in Table 1. An explanation of the cost elements involved is given in Annex B.

Table 1 Watermill Upgrade Costs

No.	Item	Costs (Rs)	Basis of costs
1	Hardware costs	6900	Based on manufacturer's quotations
2	Channel- GI sheet	1000	Based on manufacturer's quotations
3	Top Grinding Stone	1500	Market survey
4	Materials for civil works	720	Market survey of prices
5	Labour for civil works	480	Two man days of effort for a mason
6	Installation & Commissioning	1000	Market survey
7	Technical assistance	3740	Market survey
	Total	**15340**	

4.2 Operation & Maintenance Costs

Operation and Maintenance costs primarily consist of the replacement of parts that are subject to wear and tear. As the life of the components are proportional to the hours of operation of the watermill, the costs given in Table 2 represent an average watermill upgrade and additional explanation on the cost elements is available at Annex B. The cost of labour contributed by the watermiller himself is not considered.

Table 2 Average Operation & Maintenance Costs

No.	Item	Annual Cost (Rs)	Basis of costs
1	Bearing Base Plates	800	Two base plates @ Rs. 400, based on manufacturers quotation
2	Ball Bearing	40	Based on manufacturers quotation
3	Shisham Bushes	300	Cost of two bushes @ Rs. 150 based on manufacturers quotation
4	Grinding Stones	750	Half the cost of one stone @ 1500 based on manufacturers quotation
5	Tool Repair	50	Past operating costs of upgraded watermills
6	Sundries	60	Past operating costs of upgraded watermills
	Total (Rs)	**2000/year**	

4.3 Summary

Hence in order to benefit from this technology, a watermiller has to find at least 15,000 Rs to invest in the upgrade of his mill, plus 2000Rs/year in annual maintenance costs.

The increase in income to justify this investment is discussed in Section 7.

5. MARKET OPPORTUNITIES

In the hilly regions, large quantities of wheat and millet are grown and consumed locally, all of which has to be processed by grinding. This was the exclusive role of the watermill until diesel and electric mills became available to offer a faster (but more expensive) service.

A market survey of 500 households in Chamoli district, within the service area of two upgraded watermills, revealed that the average household produces between 270 and 350 kg/year of wheat (60%) and millet (40%). Since an upgraded mill should aim to process at least 20,000 kg per year to achieve an attractive income, as discussed below, it is apparent that the market opportunity is for upgrading those mills which can service at least 75 and preferably 100 families. A second essential aspect is that the mill has access to sufficient water to maintain its operations throughout the year, even if processing speed is somewhat reduced in the dry season.

As long as the service is quick and reliable enough, local families have shown a strong preference for 'gharat-atta' (watermill flour) which has the best quality and lowest processing cost: typically 0.75 Rs/kg with payment in kind (known locally as *Bhagwari*), compared with 1.5 Rs/kg cash payment at diesel mills.

There are estimated to have been nearly 200,000 watermills at one time, spread across the Himalayan states of India. Hence the possibilities for replicating the pilot schemes are enormous. A 2003 survey in Chamoli district alone has revealed the existence of 2160 watermill sites, of which 1150 (53%) are still in operation.

It is also worth noting that 3 times as much wheat flour is bought from the market as is grown locally. There is therefore a good opportunity for watermillers to import grains from other wheat growing areas of the country and grind them in their mills for local sale of *gharat-atta*.

6. SOCIAL RELEVENCE

A survey to assess the social impacts of watermill upgrades was carried out in Urgam, Gadora and Tangsa villages, Chamoli, in April 2003. This involved village meetings, and interviews with individual millers and their customers.

For the end-users, principally women, upgraded watermills were seen to bring benefits in terms of saving both time and money, as well as better quality flour (compared with a diesel mill). Also, those who had to travel far to the mills had more to gain from a faster service since it could save them a second round-trip to collect the processed flour.

To millers, the benefit has been a major increase in business and hence better earnings, and the ability to operate their mill as their sole source of income.

The only negative aspect has been among millers of traditional mills who feel they have lost customers to the upgraded mills. These millers have been encouraged to invest in upgraded machines themselves.

Village meeting with women of Gadora

Interview with a mill-owner at his mill

7. BUSINESS AND FINANCE ASPECTS

7.1 Financial Analysis

A detailed financial analysis has been carried out on the business viability of watermill upgrade schemes. The analysis was based on the existing experience with watermill upgrades in the hills and the assumptions made are given in Annex C. Analysis of a traditional watermill business without the upgrade was also made to quantify the baseline case. Details of each analysis are given in Annex C. The comparative results are given in Table 3 below:

Table 3 Comparative financial analysis

	Best case Upgrade	Average case Upgrade	Traditional Watermill
Investment Costs (Rs)	15340	15340	2000
Annual O&M costs (Rs)	2060	1580	740
Annual Income (Rs)	22248	17064	3348
IRR (10 years, with 3 year loan at 12.5%)	104%	75%	NA
NPV of cash flow (10 years) (Rs)	57256	38472	8636

The following key results were drawn from the analysis:

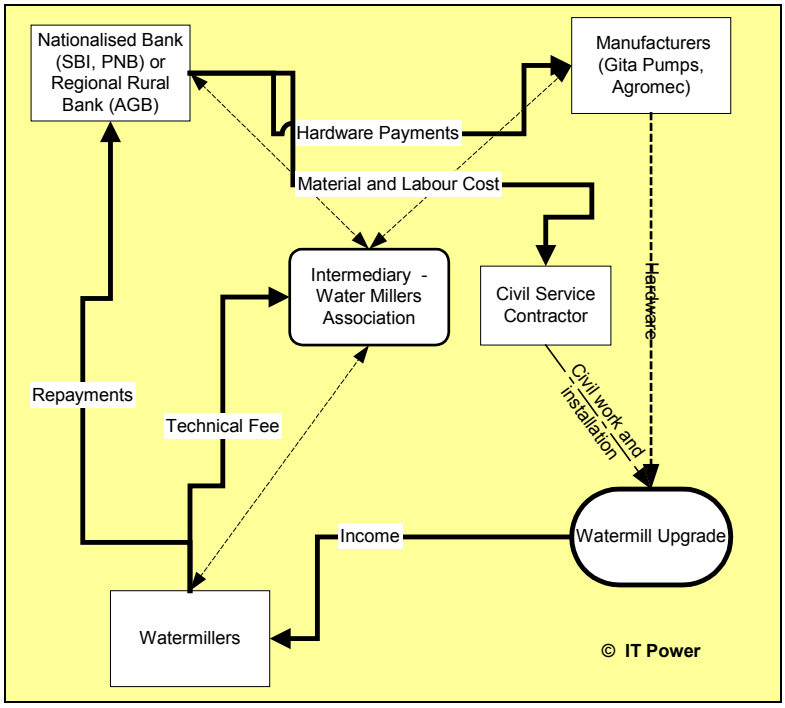
- A six-fold increase in income can be expected for a watermill upgrade compared to a traditional watermill. The income increases from Rs 217/month to Rs1290 /month.
- A watermill upgrade will have a high internal rate of return (over 75%) servicing a loan from a commercial bank. The miller will still have an increased income on a monthly basis after providing for loan repayments;
- The average monthly repayments on a loan of Rs. 10,600 will be Rs 380/month over a three year period. The average repayment represents only 29% of the monthly income generated;

7.2 Business Framework

A possible business framework for watermill upgrades has been developed considering the rural banking system, the current institutional arrangements for watermill upgrades and the social and market aspects. A proposed framework is shown in Figure 2, summarised as follows:

- An intermediary provides the technical services such as site appraisal, procurement, loan application, and supervision of installation, and co-ordinates with the manufacturer and the local banks on behalf of the miller. The Chamoli Watermill Association has agreed that it can play the role of the intermediary at least during the initial phase of market development.
- The millers avail a loan from the local bank to cover the hardware and civil costs of the watermill upgrade. The nationalised banks and the regional rural banks have previously expressed willingness to lend to watermill upgrades as a regular loan. The Regional Rural Banks may seek refinance from NABARD (National Bank for Agricultural and Rural Development).
- The manufacturers who have built watermill upgrades in the past would supply the hardware. The intermediary and a civil contractor carries out the installation and commissioning. The costs are financed through a combination of loan and contribution from the millers.
- The upgraded watermill generates increased business and is able to repay the loan on schedule after providing for the miller's own needs.

Figure 2 Proposed Business Framework for Watermill upgrades



The relevance of the business framework was demonstrated in November 2003 when two millers obtained loans from a nationalised bank and a regional rural bank and upgraded watermills using the WMA as the technical intermediary. A sustained effort is now needed to scale-up the business model so as to bring significant impacts for the many potential beneficiaries.

8. CONCLUSIONS

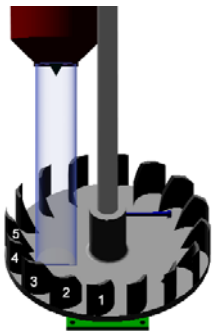
- Upgrading traditional watermills is an effective and sustainable way of meeting essential agro-processing needs in the Himalayan region using an abundant local energy resource.
- The technology for watermill upgrades is now proven, understood and being manufactured locally. Capacity has been developed in the Hills to specify, own and operate these upgraded watermills. Today a critical mass of installations exist as a basis to increase the scale of efforts;
- The number of watermills installed and the years of operating experience so far provides a firm basis to estimate the investment and operating costs of the watermill upgrades. The total investment cost for a watermill upgrade is estimated to be around 15,000 Rs, with annual O&M costs around 2000 Rs/year;
- A large number of watermills in Uttaranchal and other parts of the Himalayas are not functional or use traditional technology and are candidates for upgrades. There exists a market preference for flour ground by watermills, however it is important to have a critical service level of 75-100 families, and a consistent water supply, in order to ensure viability;
- A social impact assessment concluded that upgraded watermills were perceived as a faster and cheaper means of grinding flour. The quality of the flour was also considered to be the best available. The income generated is sufficient for millers to run their business as their sole source of income.
- The upgraded watermill results in a six fold increase in income and can comfortably service a commercial loan. This presents an opportunity for local banks to lend to watermill upgrades.
- A business framework involving the miller, watermill association, manufacturers and local banks needs to be galvanised to facilitate widespread uptake of this technology.

ANNEX A
FURTHER TECHNICAL DETAILS OF THE 'NEW GHARAT'

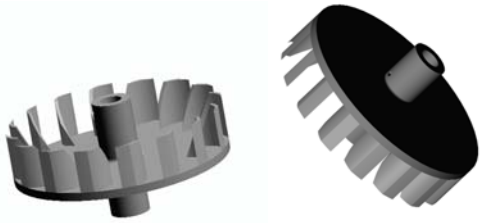
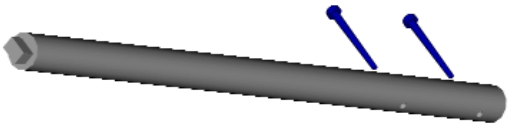
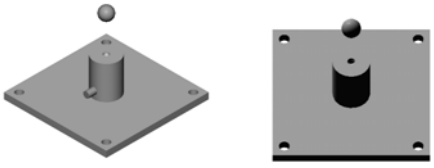
Working Principle
The upgraded watermill works on the principle the runner blades deflect the water jet to create a turning force on the runner. The open flume can be retained for the new watermill design, but needs to be aligned to ensure the jet strikes the runner correctly as shown below (the new runner is smaller than the traditional waterwheel). To operate efficiently, the new runner turns at roughly 200rpm (traditional mills run at less than 100rpm).

The milling performance of the upgraded watermill depends upon the following parameters:

- ❑ head and flow (i.e. gross power available)
- ❑ stone and runner rpm
- ❑ gap between drive-stone and bed-stone
- ❑ feed rate from the hopper
- ❑ weight of top stone
- ❑ stone-dressing detail
- ❑ type of grain



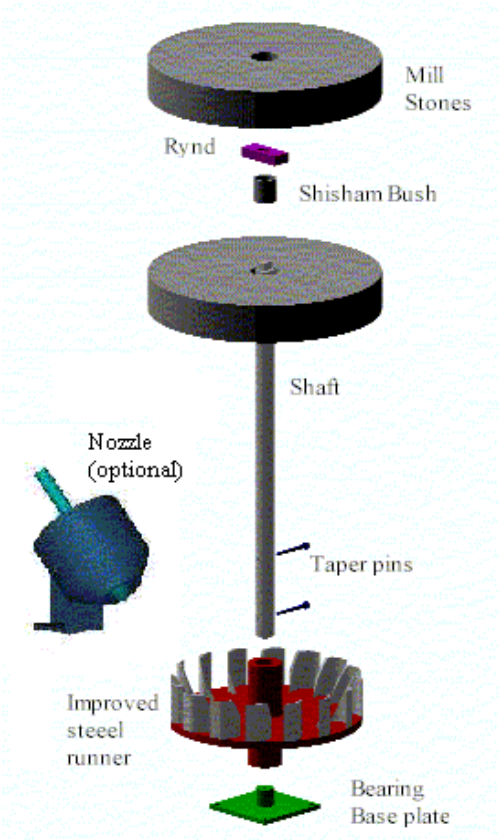
Hardware Components of the Upgraded Watermill
The various components that are required for upgrading the watermill along are shown below.

Runner The runner, with upper and lower bosses, is a single piece made in cast steel.	
Shaft and taper pins The upper end of the shaft is cut in a rectangular form to fit the T-piece (Rynd cam) for driving the upper stone.	
Bottom bearing, with ball and grease cup The 1-inch ball bearing runs on the pin made from hardened steel. The grease cup feeds grease up to the ball through a hole in the pin.	

Shisham bush The bush is preferably soaked in hot oil for 2-3 days.	
T-piece (Rynd cam) A slot must be cut into the top mill-stone to fit the correct size of T-piece.	

Watermill Assembly

The exploded view of an upgraded watermill illustrates how the various components are assembled.



- The runner is fitted to the shaft using the 2 taper pins. These are tapped firmly into place with a hammer.
- The ball bearing is placed into the hole in the bottom of the shaft.
- The top of the shaft is inserted up through the floor of the mill-house and through the hole in the bottom millstone, until it stands vertically.
- By raising the runner and shaft further, the bottom bearing can be located underneath the runner boss.
- The bearing base plate is then fixed to the wooden beam using 4 strong nails and the runner lowered to rest on the bearing.
- The shisham bush is placed over the top of the shaft and tapped into place inside the bottom millstone. It may be necessary to enlarge the hole in the millstone with a chisel until the bush fits.
- The Rynd is fitted onto the end of the shaft and the top stone lowered into position. It may be necessary to enlarge the groove in the millstone with a chisel to fit the new Rynd.

Dressing the Mill Stones

The extra power provided, at least double that of the old watermill, can not be fully absorbed by un-cut mill-stones. The bottom stone needs to be 'dressed' with appropriate grooves to enable the stones to grind effectively at the higher speed. This forms an essential part of the installation process - otherwise the stones will get hot and break. Dressing increases the feed rate of the grain and provides cooling during higher speed milling. Stones have to be re-dressed periodically as the grooves wear down.

Stone-dressing

ANNEX B

DETAILS OF INVESTMENT AND OPERATING COSTS

Investment Cost Components

- **Hardware costs** include the costs of components shown in ANNEX A, which includes cost of single piece cast steel runner with upper & lower bosses, shaft & taper pins, one inch ball bearing of hardened steel with grease cup, shisham bush and rynd cam. The costs include taxes and transportation.
- **Channel cost** includes the cost of galvanised iron sheet (approximately 25 foot long) used for orienting the flow of water to strike the runner.
- **Grinding Stone costs**: include the costs of two new grinding stones including taxes and transportation.
- **Civil works costs** have two components: (i) the construction materials such as cement, sand, steel etc and (ii) the labour costs for the masons and labour for dressing of stones.
- **Installation and Commissioning charges** are the costs for engaging a local civil contractor for installing and commissioning of the watermill upgrade.
- **Technical Assistance costs** include the manpower costs associated with services of a local intermediary who provides the technical services such as site appraisal, procurement, loan application and supervision of installation as well as co-ordinating with the manufacturers and the local banks on behalf of the miller.

Operation and Maintenance Cost Components

- Replacement of base plates are required two times annually;
- Ball Bearings need to be replaced annually.
- Shisham Bushes have to be destroyed while removing base plates, so the replacements are similar to base plates.
- Grinding Stones are to be replaced once in two years
- Tool Repair costs are estimates for maintenance and upkeep of tools
- Miscellaneous costs for operation and maintenance of upgrades.

ANNEX C
FINANCIAL ANALYSIS WORKSHEETS & ASSUMPTIONS

The worksheets on the following pages summarise the business returns that can be expected by investing I new watermill technology. Three scenarios are examined:

(i) the best case among current upgrades is compared with
(ii) an average upgrade case and
(iii) the situation of a traditional watermill.

Table C1 summarises the costs, income and rate of return over ten years for the three scenarios. The detailed cash flow calculation for each case is included afterwards on separate worksheets.

In all cases the following assumptions were made:

Key Assumptions

- Investment and O&M costs have been assumed based on the experience with existing Watermills and cost estimates available as of May 2003;
- Conservative figures of grinding volumes of wheat and millets have been assumed for the upgraded watermills, based on the record of business volume by existing watermill upgrades representing average and best cases.
- Interest rate of 12.5%/year on diminishing balance and a three year loan period is assumed for the loan;
- Monthly repayments have been assumed and no moratorium is provided due to the small gestation period of one week;
- Discount rate is taken as 12.5%, equal to the commercial interest rate;
- A 10 year life of equipment is assumed;

Note:
A barter system (called 'Bhagwari') is prevalent in the region between the millers and the villagers wherein the miller is given a share of the milled flour (approximately 4%) instead of cash payments. The miller then sells his Bhagwari flour locally at the market rate.

Table C1: Business Summary for Three Scenarios

Performance of Upgraded Gharat (Best So Far)

Project Costs		
Project Cost	15340	Rs
Annual O&M costs	2060	Rs/year

Financing Parameters		
Interest rate	12.5%	
Loan term	3	years
Installments/year	12	
Loan coverage	75%	

Business Income			
Total annual Bhagwari		3090	kg/year
Annual Bhagwari Wheat	60%	1854	kg/year
Annual Bhagwari Millet	40%	1236	kg/year
Bhagwari Wheat Price		8	Rs
Bhagwari Millet Price		6	Rs
Annual Income		**22,248**	**Rs**

Milling Output						
Season	*Months*	*Milling kg/day*	*Milling Sub-tot.*	*Bhagwari kg/day*	*Bhagwari Sub-total*	
July-Oct	4	160	19200	12	1440	kg
Nov-Mar	5	107	16000	8	1200	kg
April-June	3	67	6000	5	450	kg
Annual Total			**41200**	**kg/year**	**3090**	**kg/year**

Economic Summary		
IRR (10 years)	104%	
NPV of net cashflow (10 years)	57,256	Rs

Performance of Average Upgraded Gharat

Project Costs		
Project Cost	15340	Rs
Annual O&M costs	1580	Rs/year

Financing Parameters		
Interest rate	12.5%	
Loan term	3	years
Installments/year	12	
Loan coverage	75%	

Business Income			
Total annual Bhagwari		2370	kg/year
Annual Bhagwari Wheat	60%	1422	kg/year
Annual Bhagwari Millet	40%	948	kg/year
Bhagwari Wheat Price		8	Rs
Bhagwari Millet Price		6	Rs
Annual Income		**17,064**	**Rs**

Milling Output						
Season	*Months*	*Milling kg/day*	*Milling Sub-total*	*Bhagwari kg/day*	*Bhagwari Sub-total*	
July-Oct	4	133	16000	10	1200	kg
Nov-Mar	5	80	12000	6	900	kg
April-June	3	40	3600	3	270	kg
Annual Total			**31600**	**kg/year**	**2370**	**kg/year**

Economic Summary		
IRR (10 years)	75%	
NPV of net cashflow (10 years)	38,472	Rs

Traditional Gharat

Project Costs		
Project Cost	2000	Rs
Annual O&M costs	740	Rs/year

Financing Parameters		
Interest rate	12.5%	
Loan term	3	years
Installments/year	12	
Loan coverage	75%	

Business Income			
Total annual Bhagwari		540	kg/year
Annual Bhagwari Wheat	60%	324	kg/year
Annual Bhagwari Millet	40%	216	kg/year
Bhagwari Wheat Price		7	Rs
Bhagwari Millet Price		5	Rs
Annual Income		**3,348**	**Rs**

Economic Summary		
IRR (10 years)	130%	
NPV of net cashflow (10 years)	8,636	Rs

Milling Output						
Season	*Months*	*Milling kg/day*	*Milling Sub-total*	*Bhagwari kg/day*	*Bhagwari Sub-total*	
July-Oct	4	26.7	3200	2	240	kg
Nov-Mar	5	27	4000	2	300	kg
April-June	3	0	0	0	0	kg
Annual Total			**7200**	**kg/year**	**540**	**kg/year**

Performance of Upgraded Gharat (Best So Far)

Project Costs		
Project Cost	15340	Rs
Annual O&M costs	2060	Rs/year

Financing Parameters	
Interest rate	12.5%
Loan term	3 years
Installments/year	12
Loan coverage	75%

Business Income			
Total annual Bhagwari		3090	kg/year
Annual Bhagwari Wheat	60%	1854	kg/year
Annual Bhagwari Millet	40%	1236	kg/year
Bhagwari Wheat Price		8	Rs
Bhagwari Millet Price		6	Rs
Annual Income		**22,248**	**Rs**

Milling Output						
Season	*Months*	*Milling kg/day*	*Milling Sub-tot*	*Bhagwari kg/day*	*Bhagwari Sub-total*	
July-Oct	4	160	19200	12	1440	kg
Nov-Mar	5	107	16000	8	1200	kg
April-June	3	67	6000	5	450	kg
Annual Total			**41200**	**kg/year**	**3090**	**kg/year**

Economic Summary	
IRR (10 years)	104%
NPV of net cashflow (10 years)	57,256 Rs

MONTHLY and 10-YEAR CASH-FLOW CALCULATIONS

Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec							
Days per month		31	28	31	30	31	30	31	31	30	31	30	31	31	28	31	30	31	30	31	31	30	31	30	31	31	28	31	30	31	30	31	31	30	31	30	31							
Year	*0*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Outflows																																											
Project Cost	15340																																										
Operation & Maintenance		172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	2060	2060	2060	2060	2060	2060	2060
Loan repayments (see below)		436	433	430	427	424	421	418	415	412	409	406	403	396	393	390	387	384	381	378	375	372	369	366	363	356	353	350	347	344	341	338	335	332	329	326	323	0	0	0	0	0	0	0
Monthly outflows		608	605	602	599	596	593	590	587	584	581	578	574	568	565	562	559	556	553	550	547	544	541	538	535	528	525	522	519	516	513	510	507	504	501	498	495							
Annual outflows	*15340*												*7095*												*6616*												*6136*	*2060*	*2060*	*2060*	*2060*	*2060*	*2060*	*2060*
Inflows																																											
Bank Loan	11505																																										
Millers Contribution	3835																																										
Monthly Income from milling		1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854	1854							
Annual Income													*22248*												*22248*												*22248*	*22248*	*22248*	*22248*	*22248*	*22248*	*22248*	*22248*
Net Flows (monthly)		1246	1249	1252	1255	1258	1261	1264	1267	1270	1273	1276	1280	1286	1289	1292	1295	1298	1301	1304	1307	1310	1313	1316	1319	1326	1329	1332	1335	1338	1341	1344	1347	1350	1353	1356	1359							
Net Flows (annual)	*-15340*												*15153*												*15632*												*16112*	*20188*	*20188*	*20188*	*20188*	*20188*	*20188*	*20188*
Loan Repayment																																											
Loan amount	11505	Rs																																									
Opening Balance		11505	11185	10866	10546	10227	9907	9588	9268	8948	8629	8309	7990	7670	7350	7031	6711	6392	6072	5753	5433	5113	4794	4474	4155	3835	3515	3196	2876	2557	2237	1918	1598	1278	959	639	320							
Principal Repayments		320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320							
Interest Repayments		117	114	111	108	105	102	98	95	92	89	86	83	77	74	71	68	65	62	59	55	52	49	46	43	37	34	31	28	25	22	19	16	12	9	6	3							
Total Payments		436	433	430	427	424	421	418	415	412	409	406	403	396	393	390	387	384	381	378	375	372	369	366	363	356	353	350	347	344	341	338	335	332	329	326	323							
Payable over the term	13667	Rs																																										

Performance of Average Upgraded Gharat

Project Costs		
Project Cost	15340	Rs
Annual O&M costs	1580	Rs/year

Financing Parameters	
Interest rate	12.5%
Loan term	3 years
Installments/year	12
Loan coverage	75%

Business Income		
Total annual Bhagwari	2370	kg/year
Annual Bhagwari Wheat	60% 1422	kg/year
Annual Bhagwari Millet	40% 948	kg/year
Bhagwari Wheat Price	8	Rs
Bhagwari Millet Price	6	Rs
Annual Income	**17,064**	**Rs**

Milling Output					
Season	*Months*	*Milling kg/day*	*Milling Sub-total*	*Bhagwari kg/day*	*Bhagwari Sub-total*
July-Oct	4	133	16000	10	1200 kg
Nov-Mar	5	80	12000	6	900 kg
April-June	3	40	3600	3	270 kg
Annual Total			**31600 kg/year**		**2370 kg/year**

Economic Summary	
IRR (10 years)	75%
NPV of net cashflow (10 years)	38,472 Rs

MONTHLY and 10-YEAR CASH-FLOW CALCULATIONS

Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec							
Days per month		31	28	31	30	31	30	31	31	30	31	30	31	31	28	31	30	31	30	31	31	30	31	30	31	31	28	31	30	31	30	31	31	30	31	30	31							
Year	*0*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Outflows																																											
Project Cost	15340																																										
Operation & Maintenance		132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	1580	1580	1580	1580	1580	1580	1580
Loan repayments (see below)		436	433	430	427	424	421	418	415	412	409	406	403	396	393	390	387	384	381	378	375	372	369	366	363	356	353	350	347	344	341	338	335	332	329	326	323	0	0	0	0	0	0	0
Monthly outflows		568	565	562	559	556	553	550	547	544	541	538	534	528	525	522	519	516	513	510	507	504	501	498	495	488	485	482	479	476	473	470	467	464	461	458	455							
Annual outflows	*15340*												*6615*												*6136*												*5656*	*1580*	*1580*	*1580*	*1580*	*1580*	*1580*	*1580*
Inflows																																											
Bank Loan	11505																																										
Millers Contribution	3835																																										
Monthly Income from milling		1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422	1422							
Annual Income													*17064*												*17064*												*17064*	*17064*	*17064*	*17064*	*17064*	*17064*	*17064*	*17064*
Net Flows (monthly)		854	857	860	863	866	869	872	875	878	881	884	888	894	897	900	903	906	909	912	915	918	921	924	927	934	937	940	943	946	949	952	955	958	961	964	967							
Net Flows (annual)	*-15340*												*10449*												*10928*												*11408*	*15484*	*15484*	*15484*	*15484*	*15484*	*15484*	*15484*
Loan Repayment																																											
Loan amount	11505 Rs																																										
Opening Balance		11505	11185	10866	10546	10227	9907	9588	9268	8948	8629	8309	7990	7670	7350	7031	6711	6392	6072	5753	5433	5113	4794	4474	4155	3835	3515	3196	2876	2557	2237	1918	1598	1278	959	639	320							
Principal Repayments		320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320							
Interest Repayments		117	114	111	108	105	102	98	95	92	89	86	83	77	74	71	68	65	62	59	55	52	49	46	43	37	34	31	28	25	22	19	16	12	9	6	3							
Total Payments		436	433	430	427	424	421	418	415	412	409	406	403	396	393	390	387	384	381	378	375	372	369	366	363	356	353	350	347	344	341	338	335	332	329	326	323							
Payable over the term	13667 Rs																																										

Traditional Gharat

Project Costs	
Project Cost	2000 Rs
Annual O&M costs	740 Rs/year

Financing Parameters	
Interest rate	12.5%
Loan term	3 years
Installments/year	12
Loan coverage	75%

Business Income		
Total annual Bhagwari		540 kg/year
Annual Bhagwari Wheat	60%	324 kg/year
Annual Bhagwari Millet	40%	216 kg/year
Bhagwari Wheat Price		7 Rs
Bhagwari Millet Price		5 Rs
Annual Income		**3,348 Rs**

Milling Output					
Season	*Months*	*Milling kg/day*	*Milling Sub-total*	*Bhagwari kg/day*	*Bhagwari Sub-total*
July-Oct	4	26.7	3200	2	240 kg
Nov-Mar	5	27	4000	2	300 kg
April-June	3	0	0	0	0 kg
Annual Total			**7200 kg/year**		**540 kg/year**

Economic Summary		
IRR (10 years)	130%	
NPV of net cashflow (10 years)	8,636 Rs	

MONTHLY and 10-YEAR CASH-FLOW CALCULATIONS

Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec							
Days per month		31	28	31	30	31	30	31	31	30	31	30	31	31	28	31	30	31	30	31	31	30	31	30	31	31	28	31	30	31	30	31	31	30	31	30	31							
Year	*0*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Outflows																																											
Project Cost	2000																																										
Operation & Maintenance		62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	740	740	740	740	740	740	740
Loan repayments (see below)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monthly outflows		62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62							
Annual outflows	*2000*												*740*												*740*												*740*	*740*	*740*	*740*	*740*	*740*	*740*	*740*
Inflows																																											
Bank Loan	0																																										
Millers Contribution	2000																																										
Monthly Income from milling		279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279	279							
Annual Income													*3348*												*3348*												*3348*	*3348*	*3348*	*3348*	*3348*	*3348*	*3348*	*3348*
Net Flows (monthly)		217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217							
Net Flows (annual)	*-2000*												*2608*												*2608*												*2608*	*2608*	*2608*	*2608*	*2608*	*2608*	*2608*	*2608*
Loan Repayment																																											
Loan amount	0 Rs																																										
Opening Balance		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
Principal Repayments		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
Interest Repayments		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
Total Payments		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
Payable over the term	0 Rs																																										