ENERGY SURVEY STUDY
REPORT FOR MALSHIRAS IREP BLOCK

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Chapter 1
Executive Summary

1.1 Introduction

Humans in all walks of life use energy. In the domestic sphere, energy is required in cooking, lighting and heating; in agriculture and industries it is used in production related activities. However, the present rural energy scenario in terms of access to energy is quite dismal. Also, along with the issue of availability of energy, the other issues like tapping of renewable energy sources, energy efficient devices and sustainable energy use through integrated planning have also become very crucial to meet the livelihood requirements of the rural population and also to move towards sustainable prosperity. The IREP initiated by MEDA partially addresses this issue and as part of this programme the study of Malshiras IREP block was given to Society for Promoting Participative Ecosystem Development (SOPPECOM), Pune.

1.2 Malshiras block -- the study area

Malshiras block is situated in Solapur district. It is divided into seven revenue circles for the purpose of administration. Its total geographical area is 1068 sq. km. The trends in land use indicate that the area under the commons and forests, etc., is fast declining and as a result the per household availability of common land in the block is very limited.

The block, which is entirely rural, comprises of 110 villages. As per the 1991 census, the total population of the block is about 3,50,000 with a total number of 63,000 households. Almost 19% of its total population belong to the scheduled castes. The main occupation of the people of Malshiras is agriculture with almost 77.5% of the total main workers being engaged in agriculture related activities.

Jowar, *bajra*, wheat and maize are the main cereal crops grown in the district. The main pulses grown are *matki*, *tur* and *harbara*. Sugarcane and cotton are the main cash crops in the block. The net cropped area of the block has been increasing gradually and there has been a subsequent decline in the area under fallows. In 1995-96 almost 40% of the gross cropped area has come under irrigation and about 60% of this is under well irrigation.

1.3 Methodology of the study

A two stage sampling procedure was adopted to select the sample. At the first stage 12 villages were selected through a systematic stratified random sampling method and at the second stage 25 households from each of the sample villages were selected, again, through a systematic stratified random sampling method.

Resource index and proportion of Scheduled Caste population were the key variables considered for the purpose of selection of the 12 sample villages. Based on these key variables, six strata of villages were formed. It was very difficult to form any clusters or zones, which were contiguous, and homogenous on the key variables identified. It was, therefore, decided to present the data and the analysis on the basis of these seven revenue circles. The sample size for the household survey was 306 and the estimations of the domestic energy consumption has been done based on the survey findings.

Rural establishments were also studied to understand the energy use pattern in the non-domestic sector in the block. There were about 30 different types of establishments in all these villages together. These fell in 7 broad categories as per their energy use and requirements. Simple random sampling was done within each category to select the sample.

1.4 IREP coverage in Malshiras block

Malshiras has been covered extensively under the MEDA programme. Coverage of the programme in the block for the period between 1995-96 to 1999-2000 is given below in Table 1.1. The data shows that the programme, to a great extent, has been able to meet the targets it had set.

***Table 1.1**: Year-wise Distribution of Energy saving devices in Malshiras block*

Schemes	95-96	96-97	97-98	98-99	99-2000
Biogas	45	44	64	58	-
Pressure Cookers	96	59	93	23	-
Improved Lanterns	291	1,228	582	1,220	430
Iron *Chulhas*	1,000	300	-	35	-
Mud *Chulhas*	-	-	430	-	-

1.5 Survey findings and projections for the block

Firewood, fodder and the pressure on the commons

The main source of fuel for cooking purposes in the block is firewood. The annual firewood use per family comes to 3.25 T and much of this comes from their own land. The total firewood drawn from the commons is very marginal as it comes to only about 2% of the total requirement. The projections for the block indicate that in the years 2000, 2005 and 2010 the total domestic firewood requirement would be 2,01,680 T, 2,24,580 T and 2,50,090 T respectively assuming the proportionate availability of other fuels such as dungcake, kerosene, etc., as per present composition of fuel use.

The study shows that the households meet most of their fodder requirements from the production on their own lands and there is very little dependence on the commons. The availability of dry fodder in the form of crop residue is much higher than the reported consumption. The estimated free grazing component per animal unit comes to about 25% of the total fodder and feed requirement. The projections for the block indicate that in the years 2000, 2005 and 2010 the total estimated fodder consumption in terms of dry weight would be about 2,45,060 T, 2,56,310 T and 2,65,240 T respectively.

The estimated pressure on the commons presently is to the tune of 4.35 T/ha (dry weight). This would increase to 5.5 T/ha in the next 10 years. The estimations show that we are cutting into the accumulated biomass stock from the commons at the rate of 2.5 T/ha that is indicative of a crisis that needs to be addressed. The main reason for this is that the commons is very limited as compared to the number of households in the block. The Table 1.2 below indicates the pressure on the commons for the years 2000, 2005 and 2010.

***Table 1.2* : Projected estimate of pressure on the forest, commons and wastelands for Malshiras block**

Year	Firewood dry wt ('000T)	Free grazing dry wt ('000T)	Total extraction dry wt ('000T)	Estimated area of commons (ha)	Extraction rate dry wt (T/ha)
2000	86.19	48.79	134.98	31,000	4.35
2005	100.48	51.03	151.51	31,005	4.89
2010	116.98	52.81	169.79	31,010	5.48

Dung availability and use

The total dung production and its various uses are given in Table 1.3. The table shows that out of the 540 T (dry weight) dung produced, about 64 T (about 12%) is used for making dungcake, about 43 T (about 8%) for biogas and the remaining 434 T (about 80%) dung is used as manure. Of the different types of fuels used for domestic purposes, dung forms only a minor part. The study shows that, of the total annual domestic fuel use, in terms of fuel value, dungcake forms just 3.5% and biogas forms only 2.4%.

***Table 1.3**: Estimated annual dung use for the sample households*

All values in tons

Circle	Animal units	Dung production		Dung used for Dungcake (dry weight)	Dung used for biogas (dry weight)	Estimated dung use for manure (dry weight)
		gross weight	dry weight			
Akluj	253	249.08	99.63	12.87	23.36	63.40
		(0.99)	(0.41)	(0.05)	(0.09)	(0.25)
Dahigaon	202	223.27	89.31	3.88	10.51	74.92
		(1.10)	(0.44)	(0.02)	(0.05)	(0.37)
Mahalung	198	264.70	105.88	20.88	4.42	80.59
		(1.34)	(0.53)	(0.11)	(0.02)	(0.41)
Malshiras	61	78.69	31.48	4.56	--	26.92
		(1.28)	(0.51)	(0.07)	--	(0.44)
Natepute	198	221.81	88.72	3.74	--	84.98
		(1.12)	(0.45)	(0.02)	--	(0.53)
Piliv	189	167.57	67.03	10.00	--	57.03
		(0.89)	(0.36)	(0.05)	--	(0.30)
Velapur	115	146.22	58.49	8.21	4.38	45.90
		(1.27)	(0.51)	(0.07)	(0.04)	(0.40)
Total	1,216	1351.34	540.54	64.14	42.67	433.73
		(1.11)	(0.44)	(0.05)	(0.04)	(0.36)

Figures in parentheses denote per animal unit values for that zone.

Kerosene

The daily per household kerosene use for domestic purposes for the sample households is about 0.20 litre. Of the different types of fuels used for domestic purposes, kerosene forms only a minor part. The study shows that, of the total annual domestic fuel use, in terms of fuel value, kerosene forms just about 4%. The estimated demand for kerosene shows that at the end of the year 2000 the total annual consumption of kerosene would be 4,580 kl.

Composition of different fuels used for domestic purposes (except electricity) for the sample households

Table 1.4, given below, gives the annual fuel value of different types of fuels used for domestic purposes. The table indicates that firewood forms the single largest source in meeting the domestic fuel requirement of a household.

***Table 1.4** : Annual fuel value of domestic fuel used (except electricity) for the sample households*

All figures are in '000 kcal/year

Circle	Firewood	Dungcake	Kerosene	LPG	Biogas	Total

Akluj	835,558.00	32,165.63	29,346.00	9,526.50	54,896.00	961,492.13
	(1,903.32)	(73.27)	(66.85)	(21.70)	(125.05)	(2,190.19)
Dahigaon	652,620.00	9,695.31	20,878.00	9,163.59	24,703.20	717,060.10
	(1,778.26)	(26.42)	(56.89)	(24.97)	(67.31)	(1,953.84)
Mahalung	540,638.00	52,195.00	31,013.32	4,234.00	18,527.40	646,607.72
	(1,721.78)	(166.23)	(98.77)	(13.48)	(59.00)	(2,059.26)
Malshiras	276,670.00	11,406.25	26,036.67	10,020.47	--	324,133.38
	(1,740.06)	(71.74)	(163.75)	(63.02)	--	(2,038.57)
Natepute	805,190.00	9,353.13	28,032.00	1,199.63	--	843,774.76
	(2,048.83)	(23.80)	(71.33)	(3.05)	--	(2,147.01)
Piliv	563,560.00	25,002.50	29,784.00	--	--	618,346.50
	(2,126.64)	(94.35)	(112.39)	--	--	(2,333.38)
Velapur	302,658.00	20,531.25	15,719.33	2,117.00	10,293.00	351,318.58
	(1,903.51)	(129.13)	(98.86)	(13.31)	(64.74)	(2,209.55)
Total	3,976,894.00	160,349.06	180,809.32	36,261.19	108,419.60	4,462,733.17
	(1,897.37)	(76.50)	(86.26)	(17.30)	(51.73)	(2,129.17)

Figures in parentheses are average values per capita for that circle.

Electricity

The study shows that, of the total number of sample households, about 34% have reported no electric connections. The data indicates a very high use of bulbs. Per household annual electricity consumption comes to about 340 kWh. The total annual electricity consumption for all the 68 establishments surveyed come to about 1,15,040 kWh. The total electrical energy used for pumping water is 4,69,274 kWh which, on an average, comes to 2,878 kWh per pumpset.

The estimated total annual electrical energy requirement for the block for the years 2000, 2005 and 2010 is shown in Table 1.5. The total estimated supply need has been worked out with 20% T&D losses.

<u>Table 1.5</u>: Projected annual electricity supply need for Malshiras block (2000, 2005 and 2010)

All values in kWh

Year	Rural household consumption	Small rural establishment consumption	Semi-urban sector consumption	Agricultural pumpset consumption	Estimated supply need with 20% T&D losses
2000	21,086,943	15,442,372	1,675,261	13,133,907	64,175,604
2005	25,722,537	17,195,898	3,684,746	14,419,471	76,280,821
2010	31,377,183	19,148,541	6,322,344	15,439,824	90,362,378

Source-wise energy use in the block

The source-wise energy use pattern for the block is given in Table 1.6. The table shows that firewood accounts for about 85% of the total energy use in the block.

<u>Table 1.6</u> : Summary for various kinds of energy use for Malshiras block (2000)

Kinds of energy use	Units	Total Annual Consumption	Energy equivalent		Percentage
			'000 Mkcal	'000 GJ	
Firewood	'000 T	201.68	806.73	3,372.14	84.77
Dungcake	'000 T	13.01	32.53	135.97	3.42
Kerosene	'000 kl	4.58	3.67	15.33	0.39
LPG	'000 T	0.61	7.36	30.75	0.77
Biogas	MNm3	4.68	21.99	91.93	2.31
Diesel	'000 kl	2.03	16.24	67.88	1.71
Electricity	MU	51.34	44.14	184.53	4.64
Bullocks	'000 days	3,070.00	11.86	49.57	1.25
Total			**951.72**	**3948.11**	**100.00**

1.6 People's responses and their purchasing power

A vast majority of the people are very positive about the introduction of the NRSE devices. However, people have voiced the problems they face in utilising these devices effectively and also have given certain suggestions to overcome the constraints. Some of these problems and suggestions for the various gadgets are given below.

Suggestions about energy efficient devices

As expected a vast majority of the respondents have said that the government should increase the subsidy component of the schemes (in their words they should get economic help from the government) so that many more people would start using devices like improved *chulhas*, biogas, lanterns, solar cookers, etc. Most of them also suggested that the distribution of these devices should not be limited to only those who live in the main village; but should be distributed in the *wadis* also. Most of them also felt that the government officials are corrupt and hence there are irregularities in distribution. They also felt that a wider spread of energy saving devices would ultimately save energy. Many others felt that the information should reach the people in all the *wadis* and *vastis*. The use of solar energy should also be propagated. A few of the respondents felt that the cost of these devices should be reduced. Propagation of solar energy should also be made in order to save energy.

Responses and suggestions with regard to the MEDA schemes

Most of the respondents expressed the need to get detailed and correct information about MEDA schemes. The respondents from the remote villages in the block complained that these schemes do not get implemented in these areas. Many of them also complained about the delay in getting the government schemes sanctioned. Generally there is a perception among the people that any government scheme, and MEDA schemes are not exceptions to this, takes an enormous amount of time to get it sanctioned. Another reaction was that very often these schemes get monopolised by the richer and influential sections of the village and the needy and poorer people do not get the benefits of these schemes. Hence many of them pointed out the need to make these schemes affordable to the poorer sections in the rural areas. There were also isolated responses like community biogas schemes based on night soil should be introduced in the villages.

Suggestions to solve the energy problem

Invariably almost all the respondents have complained against the frequent power breakdowns and failures and have very strongly expressed the need for continuous power supply and that too without much of voltage fluctuations. Another equally important suggestion is about kerosene. Most of the respondents have very strongly expressed their view that they should get access to different schemes coming under MEDA. Sufficient quantities of kerosene through the public distribution system should be given and that too at an affordable cost. Their suggestion was that the government should provide for saplings to enhance the biomass plantation

The suggestions and responses of the respondents also show that most of them are aware of the energy problem. In fact, many of them have given suggestions to overcome the energy crisis and some of these suggestions include (a) the dependence on firewood could be reduced if the government makes arrangements for more number of biogas plants in the rural areas so that more and more people switch to biogas for cooking and this would arrest the depletion of forests, (b) the government should supply more number of devices which run on solar energy at an affordable cost so that there would be saving of firewood, kerosene, etc., (c) LPG cylinders should be provided which would also help in reducing the use of firewood, (d) there should be systematic efforts at afforestation, (e) people should be educated as how to efficiently use fuels and thus save fuels, (f) energy problem at the village level can be solved by collecting and storing more cowdung and fuelwood and the *Gram Panchayat* should make the necessary arrangements or design appropriate schemes for this and implement them, and (g) government should provide subsidy for distribution of saplings and take up plantation programmes.

1.7 Recommendations of the study for IREP and beyond

The study while recognising the importance and the need for increasing the spread of energy saving gadgets and other NRSE systems also suggests the need for moving beyond the IREP. It advocates an alternative energy plan, which takes into account the availability of renewable resources and the potential they have for generation of energy. A holistic approach, rather than a piecemeal one, is suggested to bring about a change in the current energy scenario. This includes planning for watershed development and large-scale plantations of trees to enhance the availability of biomass basically to meet fuel and fodder needs and also generate surplus biomass, which can be used for power generation. Along with the technical plans there is also a need to involve the users for a judicious and sustainable use of energy. Several institutional arrangements therefore become necessary to make a success of the alternative strategy.

Suggested programme for IREP

Firewood, fodder and the pressure on the commons

In respect of biofuels programme which has an impact on the pressure on the commons, the study suggests a modified programme comprising of improved *chulhas* aimed at half fuel replacement, optimised Deenbandhu family biogas plants, similarly nightsoil and dung based community biogas plants and an experimental scale programme for a Pura-style community biogas plant based on dung, nightsoil as well as leaf litter for different sections. The impact on the pressure on the commons of the biofuel programme at different levels of the estimated potential coverage for the block is given below in Table 1.7 and the potential fuel saving at 100% coverage of the entire programme is given in Table 1.8.

It may be seen that even though these programmes give substantial savings in fuel, nevertheless it is only when the programme reaches 100% of potential coverage that the extraction rate from the commons comes within the level of expected annual increments, i.e., within sustainable levels. From another point of view, it is important to estimate at what percent of potential coverage the programme succeeds in arresting the extraction rate at current levels, i.e., does not at least worsen the situation any further.

Table 1.7 : Impact of entire biofuel programme on the pressure on the commons at different levels of achievement of potential

Programme coverage as %	Projected 2010 dry biomass	Estimated firewood saving	Dry weight of estimated	Estimated area of forests and	Extraction rate from commons	Reduction in extraction rate

of potential	extraction from the commons ('000 T)	from the entire programme ('000 T)	firewood saving from the entire programme ('000 T)	commons ('000 ha)	(T dry biomass per ha)	due to programme (T dry biomass per ha)
100%	169.79	174.10	139.28	31.01	0.77	4.50
50%	169.79	87.05	69.64	31.01	2.54	2.25
25%	169.79	43.53	34.82	31.01	3.42	1.12
10%	169.79	17.41	13.93	31.01	3.95	0.45

Table 1.8 : Projected fuel savings for the entire programme at 100% potential

	Firewood ('000 T)	Dungcake ('000 T)	Kerosene cooking fuel ('000 kl)	Kerosene lighting fuel ('000 kl)	Electricity ('000 kWh)
Improved *chulha*	48.75	3.15	--	--	
Family biogas plants	97.50	6.30	1.47	--	
Improved kerosene stove	--	--	0.81	--	
Community biogas plant (night soil and dung)	23.10	1.50		--	
Community biogas plant (night soil and dung with litter/biowaste)	5.36	0.35	0.08	--	
Improved kerosene lantern	--	--	--	0.27	
Electronic choke and tube	--	--	--	--	2,207.85
CFL					4,237.05
Total	174.71	11.30	2.36	0.27	6,444.90

One of the conclusions of the above is that the IREP biofuels programme alone cannot be expected to bring down the extraction rate to sustainable levels and that there must be a convergence with other supply augmenting programmes like wasteland development, watershed development, social forestry and other similar programmes.

Suggested level of potential coverage for improved *chulha* and family and community biogas plants

Choosing a suggested level of programme is thus dependent on a consideration of cost and of other programmes. The objective has been to at least have a coverage where the programme succeeds in arresting any increase in extraction rate from the commons while other supply augmenting programmes ease the pressure and bring it within sustainable limits. In this respect the study strongly recommends that, in the Ist phase, the programme of improved *chulha* be taken up at 50% of potential coverage and Deenbandhu family biogas and community biogas programmes at 10% of potential coverage.

Kerosene

Although the recommendation would still be to move away from non-renewable to renewable energy resources, the need of the hour is to make a judicious increase in the kerosene quota for several reasons. The landless labourers are a section most vulnerable to fuel shortage. They have no access to firewood resources of their own and their dependence on kerosene is high.

The smaller farmers have a somewhat better access to firewood and biofuels but they too face practically the same situation. For these sections therefore there is a twofold need in respect of kerosene: a) they should be the first target for dissemination of kerosene saving devices at a higher rate of subsidy, and b) they should have expanded access to kerosene supply. Introduction of improved stoves and improved lanterns is therefore strongly recommended at a coverage potential of 10% in the initial phase. This would still mean a fuel saving of 650 Mkcal due to introduction of improved stoves and 220 Mkcal due to introduction of improved kerosene lanterns.

Electricity and lighting

Although there does not seem to be an apparent gap in the electricity demand and supply, the introduction of gadgets like CFL's and electronic chokes and tubelights would result in saving in electrical energy which can be used for other production related activities.

The recommendation for the Ist phase is the introduction of electronic chokes and tubelights and CFL's at 25% coverage potential. In the 2nd phase the number of electronic chokes and tubelights could be reduced to increase the coverage of CFLs which are more energy efficient. The introduction of these schemes presupposes a regular electric supply at normal voltage.

The tables below show the expected fuel savings by introduction of electronic chokes and tubelights and CFL's at different coverage levels.

Table 1.9: ***Projected fuel savings for the programme for replacement of filament lamps by electronic choke and tubelights***

Coverage of the programme	Lamps	Cost ('000 Rs.)	Electricity saved (kWh)
100% potential	90,000	36,000	2,207,850.83
50% potential	45,000	18,000	1,103,925.42
25% potential	22,500	9,000	551,962.71
10% potential	9,000	3,600	220,785.08
Annual energy saved per Re (kWh/Re)			
			0.08

Table 1.10: ***Projected fuel savings for the programme for replacement of filament lamps by CFL***

Coverage of the programme	Lamps	Cost ('000 Rs.)	Electricity saved (kWh)
100% potential	1,60,000	52,000	4,237,049.28
50% potential	80,000	26,000	2,118,524.64
25% potential	40,000	13,000	1,059,262.32
10% potential	16,000	5,200	423,704.93

Annual energy saved per Re (kWh/Re)			
			0.11

Impact of the programme on fuel saving

The fuel saving that would accrue from the suggested programme over a period of 10 years from 2000-2010 is given in the table below.

***Table 1.11* : Fuel saving form the suggested programme**

Programme	Coverage (%)	Firewood ('000 T)	Dungcake ('000 T)	Kerosene cooking fuel ('000 kl)	Kerosene lighting fuel ('000 kl)	Electricity ('000 kWh)
Improved *chulha*	50	24.38	1.58	--	--	--
Family biogas plants	10	9.75	0.63	0.15	--	--
Improved kerosene stove	10	--	--	0.08	--	--
Community biogas plant (night soil and dung)	10	2.31	0.15	0.04	--	--
Community biogas plant (night soil and dung with litter/biowaste)	--	5.36	0.35	0.08	--	--
Improved kerosene lantern	10	--	--	--	0.03	--
Electronic chokes and tubelights	25	--	--	--	--	551.96
CFL	25	--	--	--	--	1,059.26
Total		41.8	2.71	0.35	0.03	1,611.22

Investment Required

It is suggested that IREP programme components should be included in other related programmes like wasteland development, watershed development, health programmes, etc., and part of the funds of the IREP programme should be allocated from such allied schemes. The cost therefore is assumed to be divided between users, IREP funds and other Government scheme funds. For electrical components, at present, only IREP and user funds are assumed, though it is possible to work out a contribution to these from MSEB and allied sources.

The investment required for the recommended programme is given in Table 1.11 below. The distinction is essentially made on two aspects. The first set of schemes directly relates to the pressure created on the commons and forestlands. This investment therefore means that the impact will be seen on the environment at large. The pressure on commons would be reduced considerably.

The second component is the energy required for lighting. The investment made here will have an impact on the total electrical energy saved. The MSEB and the IREP could jointly decide the investment pattern but there is a recommendation for the programme to go ahead at the coverage potential discussed above.

Apart from this, investment on personnel too has to be made to ensure the proper implementation and monitoring of the programme. This has been outlined in the last chapter.

Table 1.11: ***Investment required for the suggested programme for the period 2001 to 2010***

Sr. No.	NRSE gadgets	Coverage (%)	Investment from different sources ('000 Rs.)			
			IREP	**Government**	**Users**	**Total**
1.	Improved *chulha*	50	1,500	1,500	1,500	4,500
2.	Deenbandhu biogas	10	5,000	5,000	5,000	15,000
3.	Improved kerosene stoves	10	463	--	463	925
4	Community biogas	10	1,000	1,000	1,000	3,000
5	Community biogas plant (night soil and dung with litter/biowaste)	--	1,650	1,650	1,650	4,950
6	Improved lanterns	10	263	--	263	525
7	Electric chokes and tubelights	25	4,500	--	4,500	9,000
8	CFLs	25	6,500	--	6,500	13,000
Total			**20,876**	**9,150**	**20,876**	**50,900**

Table 1.12: ***Investment required for the suggested programme at 100% coverage***

Sr. No.	NRSE gadgets	Investment from different sources ('000 Rs.)			
		IREP	**Government**	**Users**	**Total**
1.	Improved *chulha*	3,000	3,000	3,000	9,000
2.	Deenbandhu biogas	50,000	50,000	50,000	150,000
3.	Improved kerosene stoves	4,625	--	4,625	9,250
4	Community biogas	10,000	10,000	10,000	30,000
5	Community biogas plant (night soil and dung with litter/biowaste)	1,650	1,650	1,650	4,950
6	Improved lanterns	2,625	--	2,625	5,250
7	Electronic chokes and tubelights	18,000	--	18,000	36,000
8	Cfl'S	26,000	--	26,000	52,000
Total		**115,900**	**64,650**	**115,900**	**296,450**

Solar cookers, solar water heaters, solar photo voltaic devices

Solar cookers, solar water heaters, solar photo voltaic devices are the three main groups of solar devices being propagated under the IREP. The study finds that in rural areas they have received lukewarm response, and at best have a demonstration and awareness value because of a host of problems associated with domestic solar devices. For this reason it is suggested that they should be taken up on a demonstration scale, for example, as part of Urja Grams. SPV street lighting is also one of the possible demonstration devices, provided there is a service back up.

Crop wastes and biomass for energy generation

At present crop wastes surpluses as well as other utilisable biomass surpluses are not readily available. Also given the immense pressure on the commons, it is not considered advisable to withdraw biomass for power generation at this stage.

Wind, Hydro, and micro hydel explorations

Solar energy

Solar energy has not been monitored anywhere in Malshiras block. The closest figures available are for the Pune region and the data shows that, except for July and August, values for global radiation are above 5kWh/sq.m./day, which shows that there is good potential for solar energy. The mean daily hours of sunshine, however, are not very well distributed and are consistently low for the four monsoon months.

Wind energy

Wind energy is not being monitored at any site in Malshiras as part of the study of wind energy sites being taken up all over Maharashtra. So there is no data available to assess the potential for wind energy in the block. Even if any future study indicates wind energy potential or partial potential for the block (on any site in the block) we would advocate a hybridisation approach in harnessing that potential. For this, see Datye (1997) and Paranjape and Joy (1995).

Hydro power

Malshiras block being situated in the drought-prone region, the annual rainfall is only about 500 mm. Analysis of the rainfall series data shows that there would not be significant dependable flows within the block. The terrain of the block is also relatively flat. Thus, Malshiras block will not have a significant hydro potential.

Mass utillisation of renewable energy as basis for sustainable prosperity

Many of the possibilities of mass utillisation of renewable energy as basis for sustainable prosperity are examined in greater detail in Datye (1997) and Paranjape and Joy (1995). At present crop wastes surpluses as well as other utilisable biomass surpluses are not readily available. If IREP is treated as a supplementary part of associated convergent schemes for sustainable productivity enhancement, biomass surpluses will be generated and can be integrated into sustainable energy systems described in the annexed note. Most of the programmes flowing out of these fall outside the current scope and nature of IREP. Moreover, without supplementing IREP with a programme on that scale, IREP might only prove to be symptomatic relief; but joined with it, it can become a part of a synergetic energy system that ensures an enhanced quality of life for the rural population without compromising on sustainability and equity. That however requires a separate study focussed on evolving a pilot project for this purpose.

Role of NGOs, women's groups and village institutions with support from MEDA/Government

The issue of energy has not yet become a key issue of involvement for most of the NGOs and organisations working in rural areas. So, although many of these NGOs and organisations have a base among the people in the rural areas, they do not have much of experience in dealing with issues related to energy. Thus, first of all, there is a need for the NGOs and organisations to consciously decide to make energy-related programmes as part of their overall developmental work. There should be also initiative from the side of the government, and specially MEDA, to get the involvement of NGOs and organisations in the rural energy programme. It is proposed that the recommended programme be taken up jointly where the strengths of all the organisations involved such as MEDA, NGOs, village institutions, user groups, women's self help groups (SHGs), etc., be put together to achieve the targets set. The proposed programme therefore assumes participation of all the concerned organisations.

Institutional issues

Besides its technical component, any programme must take into account the social mechanisms through which the programme objectives are to be achieved. Presently, government personnel who are already burdened with their own departmental responsibilities administer the programmes. They are not in a position to fulfil the multifarious functions that such a comprehensive programme demands. Moreover for far too long they have been used to one-way communication (best described in the term -- delivery system) and are not adequately equipped to handle the needs of two-way communication. For this reason, the study proposes an alternative institutional mechanism for handling the multifarious needs that an IREP programme demands. The two main elements in it are the user groups and the service organisation/group. The role of NGO's becomes very crucial in the formation of user groups.

User Groups

User groups are now a well recognised institutional measure for ensuring participation. User groups should be formed village-wise around each component as the programme progresses. For example, in the case of biogas and improved *chulhas* the users are women. It would therefore be appropriate to form women's user groups to deal with the implementation of the programme. Wherever possible, the programmes should feed into SHG activities and the SHGs themselves can become user groups for the programme. This will help achieve convergent community action (CCA) which is one of the important shortfalls of government programmes.

Support services

Any programme, as detailed in this report, cannot be taken up on a mass scale without ensuring effective support service mechanisms. There are three main types of support services that are needed: a) awareness creation, information dissemination and motivation, b) provision of technical services and c) preparation of guidelines, recommendations and improvements.

Team of para-professionals

It is proposed that MEDA should take up the task of forming and training a team of para-professionals at the block level, somewhat along the lines of village health workers. The local NGOs could be also involved in the process of identifying the para-professionals. They need to be trained in the devices propagated under the IREP. They should also receive training for making an appropriate choice of devices, constructing/installing the devices, and in handling routine repairs and advise on maintenance and monitor performance.

The para professionals will receive on-job as well as separate training. It is suggested that the person get a stipend of Rs. 750 p.m. during the first year which shall be considered a training period. However, the person will have to begin the work of organising around ongoing programmes immediately on induction.

After training, the person will be entitled to a stipend of Rs. 1000 p.m. for another four years, during which he or she shall be responsible for the targets to be achieved within the person's designated area/group. Since as emphasised earlier, the programme should not disperse its efforts but should concentrate on covering an area progressively but intensively, it is assumed that the para-professionals are inducted in a phased manner. Thus every year for the first six years, 30 para- professionals will be inducted and trained. They should also be able to act as the conduit for a two way communication between users and the government as well as support scientific institutions.

1.8 List of NGOs and their addresses

Given below is a list of NGOs and organisations, along with their addresses, working in Solapur district and the nearby areas who could be associated with the energy programme in the block.

a) ***Mahatma Phule Samaj Seva Mandal***
Niyojan nagar
Jamkhed Road P.B.No 9
Karmala

District Solapur 413203
Contact person: Shri Pramod Zinjade
Tel. No. 02182-20609

b) ***Model Action for Rural Change***
'Nimbonichamala' At post Kem
Taluka Karmala
District Solapur 413223
Contact person: Shri Shivaji Talekar
Tel. No. 02182-40760/40778

c) ***Nisarg Yatri***
20, Pundaliknagar,
Pandharpur
District Solapur 413304
Contact person: Shri R. Govind Sabnis
Tel. No. 020-6870957, 6878243

d) ***Vanashthali Rural Development Centre***
318/19 B Canal Road
Shivajinagar
Pune, 411016
Contact person: Prof. Nirmala Purandare
Phone 020-5651550

Chapter 2
Introduction

2.1 Background of the study

Access to sufficient quantities of energy, like water, is a prerequisite for the sustainable prosperity of any society. Energy is used in every walk of human life -- domestic lighting, cooking, agriculture, irrigation, industry, transportation, establishments and offices all need or use energy in one form or the other. It is said that energy is the key to all production, including agricultural production; but nowhere is it as important as in non-agricultural, industrial production, which has the potential to generate significant non-farm incomes to the vast sections of the rural resource poor. Thus, energy is a critical resource for subsistence, livelihood assurance, and in turn the quality of life, of the rural population. No wonder prosperity and quality of life very often get equated with access to energy.

However, the present Indian rural scenario in terms of access to energy is quite dismal. It is estimated that the energy availability in India is of the order of 500 kgce (kilograms of coal equivalent) per capita, and for the rural areas, this value is likely to be of the order of 200 kgce. The pre-Second World War levels of energy consumption of the advanced countries were of the order of 5000 kgce. It is true that more than half of this consumption is accounted for domestic heating and transportation and so for comparison we can take that the per capita energy consumption of the order of 2500 kgce. This means that in pre-Second World War times the people of advanced countries had access to energy to the tune of 12.5 times as compared to the present rural scenario in India. The gap between the developed and developing countries in terms of per capita access to energy has further widened with the latest estimates that in many of the developed countries the per capita availability of energy is to the tune of 6000 to 10,000 kgce.

The problem is not only with the quantum of energy. With environmental concerns and sustainability issues coming to occupy an important place in the mainstream discourse on development, the quality of energy and its source has also become very important. Coupled with this there are also studies to show that the fossil fuels are also fast getting depleted and it is predicted that with the present levels and trends in energy consumption, especially of the developed countries, the fossil fuel deposits would get depleted within the next 20 to 25 years. The protests against large, centralised projects like hydro power plants (and big dams), thermal powers plants, atomic power plants, etc., are also becoming quite wide-spread on many counts like the displacement, pollution, health hazards, unsafe nature, etc. Over the last couple of decades there is also a renewed interest in renewable and dispersed sources of energy like solar, wind, small-hydro, biomass, etc., and because of this there are already many technologies and gadgets available to harvest these renewable sources of energy and efforts are being made to achieve new breakthroughs in this field.

All these call for a new and innovative approach to the issue of energy with the ultimate goal being energy self reliance of rural communities. Though it implies a long term strategy and policy initiatives from the state, one of the immediate things one can do is to shift to energy efficient devices so that the same activities and functions can be carried out with less energy. Let us not forget that energy saved is equivalent to new energy generated. Along with this it is also important to promote non-conventional and renewable sources of energy (NRSE) systems so that the dependence on fossil fuel based energy could be gradually reduced. In fact the main objective of state level co-ordinating agencies like Maharashtra Energy Development Agency (MEDA) is to develop such integrated energy plans and also to promote energy efficient devices, technologies and NRSE systems.

It is also true that to efficiently intervene in the present rural energy scene it is important to understand the micro-level situation especially in terms of the present energy use pattern -- both from the supply and demand side. This would help in identifying the gaps and also indicate areas where optimisations and interventions are possible. It also gives a feedback on the energy efficient devices that are being promoted by MEDA so that MEDA can make the necessary changes in the overall programme as well as make perspective plans and work out an action agenda.

It is with this idea in mind that MEDA commissioned studies of the various IREP blocks in Maraharashtra. The study of Malshiras IREP block in Solapur district was given to Society for Promoting Participative Eco-system Management (SOPPECOM) -- a non-governmental organisation working in the field of natural resource management with participation, sustainable productivity enhancement, equity and energy self-reliance as its major concerns. And it is this concern which prompted SOPPECOM to take up this study.

2.2 Scope of work

The scope of work as per the `work order' issued by MEDA includes:

a) To select sample villages in Malshiras block, which represent its geographical, social, cultural and energy use pattern characteristics.

b) To estimate present energy use pattern utilising the existing sources of energy.

c) To make an assessment of all existing energy resources, namely, conventional, non-conventional, commercial, non-conventional, renewable and non-renewable.

d) To make a judicious estimation of projected energy demand for the next five and ten years based on suitable assumptions.

e) To identify and quantify any apparent and disguised energy gap between demand and supply based on the studies of rate of utilisation and rate of consumption.

f) To propose realistic approach towards planning the energy programme which can help to bridge the gap of demand and supply to a great extent considering the energy impact, physical achievement and financial implication.

g) To make an assessment on the performance and popularity of various energy saving devices supplied by MEDA to beneficiaries in the block and give recommendations.

h) To make an assessment of the requirement of various NRSE systems, energy efficient systems like improved kerosene lantern, stove and energy efficient lights by various sectors.

i) To make an assessment of requirement of conventional bulbs in households and the scope of their replacement by energy efficient lamps.

2.3 Organisation of the report

The report is organised and presented in seven chapters. The first chapter gives the executive summary of the report. After the second chapter, which is introductory in nature, we have the third chapter, which gives a brief profile of Malshiras block. Chapter 4 deals with the methodology of the study. The survey findings of the sample villages are presented in Chapter 5. Chapter 6 presents the block level estimations and projections for the years 2000 to 2010. Finally the seventh chapter presents an alternative energy programme for Malshiras block. Tables, figures and annexures (including the questuionnairs used for primary data collection) relevant for each chapter are given at the end of the very same chapters.

Chapter 3
Profile the Area

3.1 Geographical location

Malshiras is one of the 11 blocks of Solapur district and it extends approximately between latitudes 17°36' N and 18°2' N and between longitudes 74°41'E and 76°18' E. The block is on the Western side of the district. Pandharpur, the abode of the famous temple of *Vithoba and Rakhmai*, is about 51 kms to the East of Malshiras. On its Southern boundary lies Sangola block and to its East is Pandharpur. Malshiras is subdivided in seven revenue circles. Malshiras block has no urban areas. Akluj is one of its most prominent and prosperous villages.

Malshiras is one of the few blocks in the district, which has some hilly areas. The district is otherwise flat and waving. The chief hill in Malshiras is the Gurvad hill, which lies on its Western side. The rest of the block is flat and devoid of trees.

The major rivers are the Nira and the Bhima. The Nira runs from the West to the East on the northern border of the block and later joins the Bhima in the NorthEast of the district close to Tembhurni town. The Eastern side of Malshiras lies in the Bhima valley. The Bhima runs from North to South on the eastern border. The rivers are mostly dry in the hot season.

3.2 Rainfall and climate

The climate of the block is generally dry and hot and the rains are scanty and uncertain. The SouthWest monsoons commence around June and last till September. October and November constitute the post monsoon or the retreating monsoon season. Almost 70% of the rainfall is received through the South-West monsoons. The average rainfall of the block is around 500 mm.

The winter season starts around December and lasts up to February. The summer season starts around March and lasts till May. In fact May is the hottest month of the year with temperatures rising to about 42°- 45° C.

3.3 Demographic profile

According to the 1991 Census the total population of the block is about 3,50,000 with 63,000 households and has a population density of 230. The block has 110 inhabited villages. About 18 % of the population in the block belong to Scheduled Castes. The literacy rate of the block is 44% and female literacy is about 35%. Agriculture is the main occupation of the people. About 77.5% of the total main workers in the block work in the agricultural sector (Tables 3.1 and 3.1a).

3.4 Land use pattern

The total geographical area of the block is 1608 sq. km. The time series data shows that there is no significant change in the land use pattern over the ten years period from 1984-85 to 1995-96 except in the case of area under forest. In the case of forest, the area has been declining. In 1984-85 it was about 3.66% of the total geographical area and the 1995-96 data shows that it has declined to about 0.18%. The net cropped area has been increasing gradually since 1984-85. In fact there is a decline in the area from 84-85 to 88-89. But there has been a gradual increase from about 59% in 1988-89 to 66% in 1995-96.

Area under grazing land has declined from 8.45% in 1984-85 to just 0.18% in 1994-95. A similar trend is observed for area under groves and trees. This trend generally seems to indicate a decline in the availability of common property resources, forest lands, etc. (Table 3.2).

3.5 Cropping pattern

The soils of Malshiras block are generally shallow and light in colour and not retentive of moisture. Some parts are stony too. However, fertile black soils of sufficient depth are also found in some parts of the block thereby allowing cropping of *jowar*, *bajra*, wheat, *kardai* and cotton. *Rabbi jowar* is the principal crop of the block accounting for about 59% of the gross cropped area in 1995-96. The time series data, however, shows that the area under rabbi *jowar* has increased only marginally -- from 56.67% in 1993-94 to 58% in 1995-96. The area under pulses has been decreasing as the area under pulses has come down from 6.68% in 1984-85 to 4.1% in 1995-96. *Harbara* is the main pulse taken in the area. The area under coconut seems to be on the rise as no area under coconut was reported prior to 1994-95.

Of the total irrigated area, *jowar* accounts for about 29.79% in 1995-96. The irrigated area under all cereals is about 56.51% and there has been very marginal change in this over a period of 10 years. The area of sugarcane, which accounts for only about 10% of the gross cropped area, is 30%. This has, more or less, remained the trend for the period 1984-85 to 1995-96. The irrigated area under *harbara* has gone up marginally from 2.17% in 1984-85 to about 3.25% in 1995-96 (Tables 3.4 and 3.4a). The data for crop production and productivity in the district is given in Table 3.7.

3.6 Irrigation status

The gross irrigated area from all sources for the year 1999-96 is 37,861 ha, which is about 39.38% of the gross cropped area. This has increased from 34.98% in 1984-85 with a sharp increase in the year 1993-94 when it was about 42%. The area irrigated by wells has increased from 17,342 ha in 1984-85 to 22,414 ha in 1995-96. The percentage of area irrigated by wells is about 51% in 1984-85 and this has been increasing and for the year 1995-96 it is about 60% of the total irrigated area (Table 3.6). The data for the total number of irrigation wells and electric motors installed on them is shown in Table 3.6a. Estimations for the years 2005-2010 for pumping energy have been made on the basis of data for electric motors installed for the year 1988-89. The data for the subsequent years seemed rather incongruent and hence has not been used for projections for pumping energy.

3.7 Domestic animals

The total cattle population -- bullocks and cows both of the crossbred and pure breed varieties -- is about 1,05,950. Malshiras has a higher population of indigenous cattle as about 57% of the total cattle population belong to this. Of the total crossbred and pure breed cows, 35% yield milk. Of the indigenous varieties about 29% are milk yielding cows. The total number of crossbred and pure breed working bullocks is about 1950. The number for indigenous bullocks is about 16,500. Of the total crossbred and pure breed varieties of bullocks, 58% are working bullocks. The figure for indigenous bullocks is 91%.

The total number of buffaloes in the block are 34,770 and of these 30% are milk yielding ones. The other domestic animals in the region include sheep and goat, which are there in large numbers accounting for almost 60% of the total animal population. The total animal population of the block is 3,59,180 (Tables 3.8 and 3.8a).

3.8 Electricity use

The total electricity use for Malshiras block for the year 1999-2000 has been 6,04,22,000 kWh. Of this, about 45% is domestic use and agricultural use accounts for about 24%. The average annual domestic electrical energy available for each household in the block is about 429.80 kWh (Tables 3.9 and 3.9a).

3.9 Use of kerosene/LPG

Table 3.10 indicates the monthly quota of kerosene for the months of June and July 2000. The quota for the month of July amounts to about 9.5 litres for each household. There seems to be a marginal increase in the quota from the previous month. The average monthly quota per household is 7.9 litres.

There are about 18,165 LPG connections in the block. This means that about 25% of the households of the block have access to LPG to meet their cooking and other needs (Table 3.11).

3.10 Rural commercial establishments and industries

The data for the district shows that there are about 67,870 rural enterprises in the district. Almost 88% of these falls in the private sector and the remaining 12% comprise of the cooperative and public sector. About 17% of the total enterprises are run on electrical power (Table 3.13).

3.11 MEDA schemes

Malshiras block is one of the blocks taken up under the IREP programme. The main thrust of the programme seems to be on distribution of improved lanterns and installation of biogas plants. The distribution of pressure cookers has decreased from 96 in 1995-96 to just 23 in 1998-99. The distribution of iron *chulha*s too seems to have decreased considerably from 1000 in 1995-96 to a mere 35 in 1998-99. There seems to be hardly any data available for other schemes of MEDA such as improved stoves, euro lights, CFL's, solar cookers or the improved crematoria introduced recently (Table 3.14).

***Table 3.1* : Demographic profile of Malshiras block 1991 census**

Categories	
Area (sq km.)	1,608
Density(population/sq. km area	230
Habited villages	110
Inhabited villages	0
Towns/cities	0
Total number of Households(000)	63,000
Population (000)	
SC Male	33
SC Female	31
SC Total	64
ST Male	1
ST female	1
ST total	2
Total Male	182
Total Female	168
Total	350

Source:Jilha Samajik va Arthik Samalochan, District Solapur 1998-99

***Table 3.1a* : Decennial Variation in Malshiras block**

Year	**Total Population ('000)**	**% increase**
1991	350	24.10
1981	282	24.65
1971	226	36.01
1961	167	35.57
1951	123	--

Source:Jilha Samajik va Arthik Samalochan, District Solapur 1998-99

Table 3.2 ***: Land use pattern for Malshiras block***

Area in '00 ha

Categories	84-85	88-89	93-94	94-95	95-96
Total Geographical area	1,608 (100)	1,608 (100)	1,608 (100)	1,608 (100)	1,608 (100)
Forest	59 (3.66)	59 (3.66)	3 (0.18)	3 (0.18)	3 (0.18)
Land put to non-agri use	4 (0.24)	4 (0.24)	3 (0.18)	3 (0.18)	5 (0.31)
Non Cultivable waste	158 (9.82)	158 (9.82)	52 (3.23)	52 (3.23)	50 (3.10)
Cultivable waste	88 (5.47)	-	198 (12.31)	197 (12.25)	198 (12.31)
Grazing land & pastures	136 (8.45)	136 (8.45)	3 (0.18)	3 (0.18)	7 (0.43)
Land under trees/groves	1 (0.06)	-	-	-	-
Current Fallows	5 (0.31)	291 (18.09)	228 (14.17)	217 (13.49)	211 (13.12)
Other Fallows	125 (7.77)	-	171 (10.63)	143 (8.89)	57 (3.54)
Net Cropped Area	1,032 (64.17)	960 (59.70)	947 (58.89)	986 (61.31)	1,075 (66.85)
Double Cropped Area	50	100	123	129	123
Gross Cropped area	1,072	1,060	1,070	1,116	1,198
Total Cultivable Land	1,251	1,251	1,544	1,543	1,541

Figures in parentheses denote percentages
Source: Source:*Jilha Samajik va Arthik Samalochan*, District Solapur .
1.1990-91
2.1997-98
3.1998-99

***Table 3.3* : Cropping pattern Malshiras block**

Area in ha

Crops	1984-85	1988-89	1993-94	1994-95	1995-96
Rice	200 (0.18)	60 (0.06)	50 (0.05)	143 (0.13)	56 (0.05)
Wheat	8,203 (7.58)	400 (0.38)	7,771 (7.26)	9,093 (8.14)	7,772 (6.49)
K.Jowar	322 (0.3)	204 (0.19)	384 (0.36)	372 (0.33)	105 (0.09)
R. Jowar	69,354 (64.1)	69,500 (65.57)	60,642 (56.67)	62,865 (56.28)	69,571 (58.09)
Total Jowar	69,676 (64.4)	69,704 (65.76)	61,026 (57.03)	63,237 (56.62)	69,676 (58.17)
Bajri	1,872 (1.73)	10,600 (10)	9,252 (8.65)	10,251 (9.18)	12,930 (10.8)
Maize	2,263 (2.09)	1,863 (1.76)	--	3,300 (2.95)	3,672 (3.07)
Other Cereals	--	57 (0.05)	7 (0.01)	81 (0.07)	--
Total Cereals	82,214 (75.99)	82,684 (78.01)	78,490 (73.35)	86,105 (77.09)	94,106 (78.57)
Harbara	2,272 (2.1)	285 (0.27)	1,850 (1.73)	2,828 (2.53)	2,531 (2.11)
Tur	1,059 (0.98)	495 (0.47)	1,287 (1.2)	1,063 (0.95)	731 (0.61)
Mung	442 (0.41)	76 (0.07)	525 (0.49)	14 (0.01)	11 (0.01)
Kulith	--	--	--	429 (0.38)	912 (0.76)
Matki	--	--	--	--	717 (0.6)
Hulga	--	--	--	--	--
Other pulses	3,450 (3.19)	6,730 (6.35)	9 (0.01)	21 (0.02)	2 (0.0)
Total Pulses	7,223 (6.68)	7,586 (7.16)	4,948 (4.62)	5,103 (4.57)	4,908 (4.1)
Total food crops	89,437 (82.67)	90,270 (85.17)	83,047 (77.61)	91,208 (81.66)	99,414 (83)

Table 3.3 continued

Crops	1984-85	1988-89	1993-94	1994-95	1995-96
Sugarcane	11,652 (10.77)	10,570 (9.97)	13,035 (12.18)	10,796 (9.67)	13,020 (10.87)
Total Spices	92 (0.09)	154 (0.15)	103 (0.1)	94 (0.08)	95 (0.08)
Total Fruit & vegetables	441 (0.41)	1,122 (1.06)	4,194 (3.92)	2,821 (2.53)	2,336 (1.95)
Total edible crops	101,622 (93.93)	102,116 (96.34)	100,379 (93.81)	104,919 (93.90)	114,865 (95.90)
Cotton	1,494 (1.38)	123 (0.12)	215 (0.2)	237 (0.21)	218 (0.18)
Total Fibre crops	1,494 (1.38)	130 (0.12)	348 (0.33)	331 (0.3)	225 (0.19)
Groundnut	1,281 (1.18)	1,673 (1.58)	1,864 (1.74)	1,863 (1.67)	2,033 (1.7)
Jawas	--	--	4 (0.003)	1 (0.0)	1 (0.0)
Kardai	3,777 (3.49)	642 (0.61)	1,626 (1.52)	42 (0.04)	123 (0.1)
Coconut	--	--	--	89 (0.08)	75 (0.06)
Sunflower	--	--	--	--	--
Til	--	--	--	--	69 (0.06)
Soyabean	--	--	--	--	--
Other oilseeds	16 (0.01)	785 (0.74)	677 (0.63)	--	1,203 (1)
Total oilseeeds	5,074 (4.69)	3,100 (2.92)	4,683 (4.38)	2,729 (2.44)	3,504 (2.93)
Total medicinal	--	--	4 (0.003)	--	--
Fodder Crops	--	646 (0.61)	1,591 (1.49)	2,390 (2.14)	1,580 (1.32)
Other crops	--	--	--	--	--
Total Non-edible crops	6,568 (6.07)	3,876 (3.66)	6,626 (6.19)	5,647 (5.06)	5,309 (4.43)
Gross Cropped Area	108,190 (100)	105,992 (100)	107,005 (100)	111,696 (100)	119,774 (100)
Double cropped area	4,969	10,000	12,281	12,998	12,303
Net cropped area	103,221	95,992	94,724	98,698	107,471

Figures in parentheses denote percentages
Source:*Jilha Samajik va Arthik Samalochan*, District Solapur.
1.1990-91; 2.1997-98; 3.1998-99

***Table 3.4* : Crop wise Irrigated area for Malshiras block**

Area in ha

Crops	84-85	88-89	93-94	94-95	95-96
Rice	200 (0.53)	60 (0.17)	5 (0.01)	143 (0.36)	56 (0.12)
Wheat	7,166 (18.93)	348 (0.96)	7,471 (18.67)	7,092 (17.63)	7,772 (16.48)
K.Jowar	259 (0.68)	163 (0.45)	84 (0.21)	72 (0.18)	--
R. Jowar	10,062 (26.58)	9,730 (26.83)	9,143 (22.85)	9,070 (22.55)	14,052 (29.79)
Total Jowar	10,321 (27.27)	9,893 (27.28)	9,227 (23.06)	9,142 (22.73)	14,052 (29.79)
Bajri	1,872 (4.95)	10,600 (29.23)	2,298 (5.74)	6,249 (15.54)	2,930 (6.21)
Maize	1,829 (4.83)	1,490 (4.11)	--	973 (2.42)	1,372 (2.91)
Nachni	--	--	--	--	--
Other Cereals	2 (0.01)	--	--	--	--
Total Cereals	21,390 (56.51)	22,391 (61.75)	18,999 (47.48)	20,599 (51.22)	26,182 (55.51)
Harbara	820 (2.17)	102 (0.28)	850 (2.12)	828 (2.06)	1,531 (3.25)
Tur	521 (1.38)	243 (0.67)	--	262 (0.65)	531 (1.13)
Mung	142 (0.38)	24 (0.07)	--	--	--
Vatana	--	--	--	--	4 (0.01)
Other Pulses	--	--	--	--	--
Total Pulses	1,490 (3.94)	370 (1.02)	850 (2.12)	1,090 (2.71)	2,066 (4.38)
Total Food crops	22,880 (60.45)	22,761 (62.77)	19,849 (49.6)	21,689 (53.93)	28,248 (59.89)
Sugarcane	11,652 (30.78)	10,570 (29.15)	13,035 (32.58)	10,796 (26.84)	13,020 (27.61)

Table 3.4 Continued

Crops	84-85	88-89	93-94	94-95	95-96
Total Spices	70 (0.18)	117 (0.32)	103 (0.26)	93 (0.23)	95 (0.2)
Total Fruits	193 (0.51)	78 (0.22)	2879 (7.19)	2701 (6.72)	1426 (3.02)
Total vegetables	268 (0.71)	940 (2.59)	1151 (2.88)	522 (1.3)	460 (0.98)
Total edible crops	35,063 (92.63)	34,466 (95.05)	37,017 (92.51)	35,801 (89.01)	43,249 (91.7)
Cotton	1,494 (3.95)	123 (0.34)	215 (0.54)	237 (0.59)	218 (0.46)
Total Fibre crops	1,494 (3.95)	123 (0.34)	348 (0.87)	331 (0.82)	225 (0.48)
Groundnut	1,281 (3.38)	1,673 (4.61)	1,226 (3.06)	1,883 (4.68)	2,033 (4.31)
Sunflower	--	--	4 (0.01)	560 (1.39)	--
Kardai	--	--	--	--	--
Other oilseeds	14 (0.04)	--	111 (0.28)	89 (0.22)	75 (0.16)
Total oilseeeds	1,295 (3.42)	1,673 (4.61)	1,453 (3.63)	2,545 (6.33)	3,110 (6.59)
Total medicinal	--	--	4 (0.01)	--	--
Fodder Crops	--	--	1,193 (2.98)	1,348 (3.35)	580 (1.23)
Total Non-edible crops	2,789 (7.37)	1,796 (4.95)	2,998 (7.49)	4,419 (10.99)	3,915 (8.3)
Total Irrigated area	37,852 (100)	36,262 (100)	40,015 (100)	40,220 (100)	47,164 (100)

Figures in parentheses denote percentages
Source:Jilha Samajik va Arthik Samalochan, District Solapur .
1.1990-91
2.1997-98
3.1998-99

***Table 3.4a* : Crop and source-wise irrigated area for 1998-99 for Malshiras Block**

Area in ha

Crop	Canal	Well	Total irrigation (canal and well)
Jowar	10,179	12,949.33	23,128.33
Bajra	2,932.5	7,126.95	10,059.45
Rice	7.4	267.75	275.15
Wheat	4,139.24	5,867.56	10,006.8
Maize	2,491.35	4,925.65	7,417
Other cereals	5,730.92	203.28	5,934.2
Tur	362.64	709.27	1071.91
Harbara	284.59	699.62	984.21
Mung	14.81	8.58	23.39
Hulga	--	--	--
Matki	--	--	--
Sugarcane	7,313.04	9,859.4	17,172.44
Groundnut	713.37	286.36	999.73
Sunflower	289.78	62.81	352.59
Soyabean	148.67	56.23	204.9
Cotton	509.67	101.92	611.59
Total Fruit and vegetables	--	--	5,073.24

Source: Tehsil office Malshiras

***Table 3.5* : Rainfall data**

Year	Rainfall (mm)
June-Oct 96	412
1997	525
1998	1667
1999	693

Source Panchayat Samiti, Malshiras

***Table 3.6* : Area irrigated by source for Malshiras Tehsil**

Area in ha

Categories	84-85	88-89	93-94	94-95	95-96
Surface irrigated	16,541	22,881	17,732	16,356	15,447
Well Irrigated	17,342	3,381	13,149	14,151	22,414
Net irrigated area	33,883	26,262	30,881	30,507	37,861
Gross irrigated area	37,852	36,262	40,015	40,220	47,164
Gross Cropped area	108,190	105,992	94,724	111,696	119,774
%of gross irrigated area to gross cropped area	34.98	34.21	42.24	36.09	39.38

Source:Jilha Samajik va Arthik Samalochan, District Solapur.
1.1990-91
2.1997-98
3.1998-99

***Table 3.6a* : Irrigation wells and other wells in Malshiras Block**

Category	84-85	88-89
Total no of Irrigated wells	5,345	5,345
No: of Diesel pumps on irrigated wells in use	3,010	160
No: of Electric Motors on irrigated wells in use	2,045	3,075

Source:Jilha Samajik va Arthik Samalochan, District Solapur.
1.1990-91
2.1997-98
3.1998-99

***Table 3.7* : Total Crop Production and Productivity of Main Crops District Solapur**

Crops	90-91		97-98		98-99	
	Product-ivity/ha in kgs	**Total Production (00metric tons)**	**Product-ivity/ha in kgs**	**Total Production (00metric tons)**	**Product-ivity/ha in kgs**	**Total Production (00metric tons)**
Rice	880	44	1,095	23	1,138	33
Wheat	1,067	476	800	379	1,200	851
Jowar	537	3,806	217	1,580	467	2,257
Bajra	383	113	511	115	505	189
Barley	667	2	1,000	1	1,000	1
Maize	1,213	251	1,427	314	1,748	535
Nachni	--	--	--	--	--	--
Other Cereals	--	--	500	3	947	89
Total Cereals	580	4,692	294	2,416	624	3,955
Harbara	497	169	352	113	557	286
Tur	243	96	109	29	307	84
Udid	182	4	486	17	443	15
Mung	257	9	333	10	434	17
Masoor	--	--	--	--	--	--
Other pulses	--	--	313	61	424	86
Total Pulses	353	398	270	230	462	488
Jawas	219	7	111	1	339	--
Ground-nut	1,688	854	887	196	1,784	--
Til	231	3	217	5	307	--
Sugarcane	85,315	33,017	79,985	43,112	88	5,480
Cotton	1,000	24	282	73	237	--
Mesta (Ambadi)	192	16	180	8	180	--
Tobacco	1,000	1	1,000	1	1,000	--
Ginger	--	--	--	--	--	--
Chillies	778	28	794	27	784	--
Turmeric	1,246	896	6,000	1,734	1,351	--
Potato	5,025	201	--	--	--	--
Mohri	--	--	250	1	250	--
Castor	--	--	1,091	12	410	--

Source:Jilha Samajik va Arthik Samalochan, District Solapur
1.[1990-91] 2.[1997-98] 3.[1998-99]

Table 3.8 ***: Cattle Population***

Crossbred/Pure breed Cattle	
Bullocks above 2.5 years of age	
Working bullocks	1,953
Working and breeding purposes	803
Others	582
Total	***3,338***
Cows above 2.5 years	
Milch cows	14,819
Others	7,729
Total cows above 2.5 years	22,548
Cows upto 2.5 years	18,904
Total cows	*41,452*
Total Pure breed cows and bullocks	***44,790***
Indigenous Bullocks above 3 years	
Working Bullocks	16,461
For breeding and working	950
Others	631
Total	***18,042***
Indigenous Cows above 3 years	
Milk Cows	12,606
Others	9,974
Total Cows	22,580
Indigenous calves below 3 years of age	20,536
Total cows and calves	*43,116*
Total Indigenous cows and bullocks	***61,158***
Total Pure breed and Indigenous cows and bullocks	**105,948**

Source: Jilha Samajik vaArthik samalochan District Solapur1997-98

Table 3.8 continued : Other Cattle and Domestic Animals

He buffaloes above 3 years	
Working	1,255
Others	1,044
Total	2,299
She buffaloes above 3years	
Milking Buffaloes	10,777
Others	6,732
Total	17,959
He buffaloes upto 3 years	14,512
Total Buffaloes	**34,770**
Other Domestic Animals	
Sheep	108,889
Goat	105,888
Horses and ponies	564
Other animals	3,323
TOTAL DOMESTIC ANIMALS	**359,382**
Hens	1,015,540
Total Fowls	***1,015,741***

Source:Jilha samajik va arthik samalochan, district Solapur, 1997-98

Table 3.9 : Electricity Use For Malshiras Taluka for the year 1999-2000

000kWh

Type of electricity use	Natepute division	Akluj division	Total
Domestic Connections	11,259	15,819	27,078
Commercial	15,267	2,741	18,008
Industries	302	507	809
Agriculture	14,200	1,327	15,527

Source : Deputy Engineer,MSEB,Malshiras

Table 3.9 a :Total Number of Borewells, Handpumps in use and electric motors

Categories	90-91	97-98
Successful Borewells	1,062	1,707
HandPumps	987	1,644
Electric motors installed	75	100

Source:Jilha Samajik va Arthik Samalochan, District Solapur.
1.1990-91
2.1997-98
3.1998-99

***Table 3.10* : Kerosene use in Malshiras Block**

Categories	Details
June 2000 kerosene quota (kl)	492
July 2000 kerosene quota (kl)	600
No. of Licenced dealers	139

Supply Section Tehsil office, Malshiras.

***Table 3.11* : LPG Connections**

Category	Numbers
No. with single cylinder	11,339
No. with two cylinders	6,827
No. of total connections	18,165

Source : Tehsil Office, Supply Section, Malshiras

***Table 3.12* : Data on vehicles upto 31st of March 2000**

Category	Number
Motor cycles	10,101
Scooters	2,300
Mopeds	2,834
Jeeps	1,370
Station wagons	781
Taxicabs	22
Auto rickshaws	89
Contract Carriages	5
School bus	1
Private service vehicles	2
Trucks	588
Tankers	5
Fourwheelers	211
Three wheelers	53
Tractors	992
Trailers	1,631
Total	20,991

Source:RTO Solapur

***Table 3.13* : Rural Agricultural and Non-agricultural Enterprises in Solapur District for the year 1990**

Categories	Numbers
Total Enterprises	
Family based	51,497
Establishments	16,373
Total	67,870
Numbers as per ownership type	
Co-operative	1,490
Public sector	6,622
Private	59,758

Source: *Jilha Samajik Va arthik Samalochan, Pune District 1997-98*

***Table 3.14* : Year-wise Distribution of Energy saving devices in Malshiras tehsil**

Schemes	95-96	96-97	97-98	98-99	99-2000
Biogas	45	44	64	58	--
Pressure Cookers	96	59	93	23	--
Improved Lanterns	291	1,228	582	1,220	430
Iron Chulhas	1,000	300	--	35	--
Mud Chulhas	--	--	430	--	--

Source : Panchayat Samiti Agriculture Extension Officer Mr. A B Patil

Chapter 4
Methodology and Approach

4.1 Sampling method

The purpose of the study is to make an assessment of the energy balance for Malshiras block of Solapur district. Based on this, projections of an energy scenario for the years 2005 and 2010 would be made. Suggestions for an alternative energy scenario, which would address the current energy crisis, are to be made. The study included an estimation of the current energy consumption pattern to understand the energy needs and procurement patterns of the people of Malshiras block. For this purpose it was important to collect relevant data at various levels.

- At the primary level it is important to look at the energy consumption pattern at domestic, agricultural, rural industries and artisans levels.
- At the secondary level it is important to look at the available energy sources at the block level.
- Data collected at the block level is important to make estimations based on the primary data findings. These estimations will allow us to make projections for the future energy scenario and suggestions regarding alternatives.

Most of the secondary data is available either at the block or district level or available in the form of census handbooks or district statistical abstracts. However, the primary data to be collected from various households and rural enterprises needs a detailed survey. Malshiras block has 110 villages with a population of about 3,50,000 with the total number of households being 63,000. It is, therefore, impossible and unnecessary to do a survey of the entire universe, which comprises of 110 villages. However, a planned sampling methodology that would help select a representative sample becomes necessary. A two stage sampling procedure was adopted to select the sample. At the first stage 12 villages were selected through a systematic stratified random sampling method ensuring that they represent all the features and variations in the block. At the second stage 25 households from each of the selected villages were selected again through a systematic stratified random sampling method. Rural establishments that were studied were selected through a simple random sampling method.

4.2 Selection of sample villages

Th following was the process adopted for the selection of the 12 sample villages.

- The first stage was based on a systematic study of the village level census data for the block from the 1991 Solapur District Census Handbook.

- For the second stage the factors that are likely to affect the energy consumption pattern were listed out and studied. These were as follows:

  1. Physiography
  2. Forest cover per household
  3. Population density
  4. Irrigation intensity
  5. Per capita cultivated area
  6. Cattle population per household
  7. Electrification status
  8. Distance from urban areas

- Based on the understanding of the above factors and their likely effects on energy use in the context of Malshiras block two variables were identified as being the key variables affecting the energy use for the block. These two variables were:

  a) Resource index
  b) Proportion of Scheduled Caste population

Resource index

The term resource index combines three associated factors affecting rural energy consumption pattern. These are as follows:

a) Per household availability of forest area
b) Per household availability of cultivated area
c) Per household availability of irrigated area

A resource index indicates the per household availability of forest, cultivated and irrigated area. The higher the resource index greater is the availability on the above three resources. Single weightage was given to per household availability of forest area and cultivated area and a double weightage was given to per household availability of irrigated area.

Based on the above variables, the universe of 110 villages was divided into three classes. These were A, B & C. The class A ranked low on the resource index while B ranked medium on the resource index and C was the class of villages with a very high resource index.

Proportion of Scheduled Caste Population

The second key variable affecting the energy use pattern was considered to be the proportion of scheduled caste population in the villages. Two classes were formed around this variable -- class A and class B. Class A represented a low proportion of SC population and class B represented a high proportion of SC population.

- Based on the above classification of resource index and proportion of SC population the universe of 110 villages was divided into six strata showing the position of each of the villages on both the variables. The six strata were AA, AB, CA, CB, BA, and BB. Stratum AA ranked low on the resource index and also low on the proportion of SC population. AB is low on the resource index but high on the proportion of SC population. CA ranks very high on the resource index but low on proportion of SC population. Stratum CB ranks very high on the resource index as well as the SC population proportion. BA has a medium resource index but is low on the proportion of SC population. BB ranks medium on resource index and high on proportion of SC population.

- Within each of the six strata there was homogeneity on the key variables identified. Table 4.1 gives a detailed listing of all the villages according to the strata (Table 4.1 and Figure 4.1).

- Simple random sampling method was adopted within each stratum to select the villages. The sample in each stratum was proportional to the size of that stratum. A computerised random number was generated to avoid any kind of biases. As can be seen from Table 4.1, stratum AA comprised of 14 villages from which a single village was selected. From stratum AB, which comprised of 31 villages, three villages have been selected. Stratum BA, which has 26 villages, a sample of three was drawn. BB comprises of 24 villages from which three were chosen for the sample. One village each was selected from CA and CB, which comprised of 10 and 5 villages respectively. A total sample of 12 villages was thus drawn in a systematic stratified random sampling method (Table 4.2). The block has 7 revenue divisions referred to as the Circles. The sampling method ensured that the villages from each of these 7 Circles are chosen to be part of the sample.

- The representativeness of the sample was verified by the following method. The arithmetic mean and Standard Deviation for selected variables (Table 4.3) was calculated for the sample villages. The same parameters were calculated for these variables for the universe, that is, all the villages of the block. The parameters for the sample were found to be comparable with those for the universe for all the variables.

4.3 Revenue Circles as the category for analysis

The block could not be divided into contiguous zones or clusters on the basis of the six strata. It was seen that all the six strata were spread across the entire block and hence it was difficult to form clear-cut clusters or zones in the block. The 7 Circles formed for revenue purposes have, therefore, been used as the basis for presenting and analysing the data.

4.4 Sampling of households

This was the second stage in the two stage sampling method. In the first stage 12 villages were selected out of the universe of 110. In the second stage a certain number of households had to be selected from these 12 villages. The total number of households from these 12 villages is 6208 and of which about 300 were to be selected. Here too the method of stratified sampling was adopted. For each of the villages three kinds of lists were obtained. They were as follows:

a) List of all the household in the village

b) List of BPL families

c) List of beneficiaries of MEDA schemes

These three lists were treated as three different strata and simple random sampling method was used to select households from each of the three lists. It was decided that a 5% sample would be drawn for the households, which meant a selection of about 25 households per village. It was decided that a minimum of five households from each of the BPL and beneficiary lists would be selected leaving the remaining 15 to be selected from the general household list. The sample households for BPL and MEDA beneficiaries, however, would vary from village to village as per the total numbers for those categories in each of the villages. As Table 4.4 indicates, of the total BPL households in the 12 villages selected, 3.06% are part of the sample. Of the total households for the 12 villages, 5% households form part of the sample. Of the total sample households, about 24% belong to BPL

4.5 Sampling for rural establishments

In the preliminary visits to the selected villages a detailed listing of the establishments in each of the villages was made. There were about 32 different types of establishments in all these villages together. These fell in 7 broad categories as per their energy use and requirements. Simple random sampling was done within each category to select the sample.

4.6 Survey process

Questionnaires

The stage of preparing the household schedules was completed by end of April. There were three different kinds of questionnaires that were used for the purpose of the energy survey.

1) The first was the household schedule to be addressed to the individual households.
2) The second set was the schedule to be addressed to beneficiaries of biogas and improved *chulha*s.
3) The third was to be addressed to rural establishments.

Household schedule

The household schedule could be divided into four sections. The first section comprised of the socio-economic and demographic profile of the family. The second section included the information related to agricultural operations and the use of energy. The third section was related to domestic consumption of energy. This included energy used for cooking and lighting and related purposes. The fourth section comprised of information on energy saving devices supplied by MEDA and peoples opinion on the use of these devices. An attempt was made to address the women of the household specifically for the information related to energy consumed for domestic purposes. (Annexure 4.1).

Biogas and improved *chulha*

The second set of schedules was addressed to beneficiaries of biogas and improved *chulha* schemes implemented by MEDA and the *Zilla Parishad*. The questions were largely related to the use and maintenance of the appliances and people's opinions on the use and difficulties for each of them. Peoples suggestions for improvements were also taken up in this set of schedules (Annexure 4.1).

Schedule for rural establishments

This schedule addressed the energy use in the rural artisanal and establishment sector. The first part of the schedule dealt with general information related to the establishment, that is, seasonality of operation, the number of workers, turnover, annual production, etc. The second section more specifically deals with the tools and equipment used, type of energy use for the concerned activity, etc. The final section looks at the plans for expansion of the establishment to assess the likely impact on the energy use (Annexure 4.1).

Training of the team

The survey process began in the middle of May. A team of 8 people was trained to administer the schedules in the sample villages of Malshiras block**.** A one-day training session was conducted to familiarise the data collection team with the questionnaires and the issues to be addressed. Mock interviews were conducted during the training programme. This helped the team to understand the problems they are likely to encounter while administering the schedules.

Actual survey

The programme was planned in such a way that one village (25 households) would be covered in one day. The whole team of 8 people along with two supervisors would go to the village and complete the data collection by the end of the day and move on to the next village the next day. Sufficient contacts were established by the supervisors with the *gramsevaks, surpanches, talathis,* etc., during their preliminary visits to the area. This facilitated the management of the programme as per the plan. In each of the villages there would be sufficient preparation before hand which enabled the team to complete the 25 households in the stipulated time.

The lists of households to be surveyed were prepared well in advance. Hence the main task after reaching the village was to identify the locations of each of the sample households and divide the work accordingly. Administering each questionnaire used to take about 40-45 minutes.

Some of the information that could not be covered through the questionnaire was collected through informal discussions with different people in the village. This was noted down in diaries given to each of the team members.

Weights and measurements

The team members were instructed to write the actual responses of the people for weights and measures to avoid any subjective interpretation of actual data. These were later converted to either kgs or quintals based on the required time frame. Two spring balances were given to the team to take the weights of the fuels used by a household.

Method of fuelwood measurement

People's responses for fuelwood used for cooking and heating were largely expressed in terms of head-loads (*bhara, moli*) or *mann,* etc. The responses for those collecting fuelwood from either commons or own land was expressed in *bharas* and *molis.* For those purchasing fuelwood the responses were expressed in *mann* which is broadly equivalent to 40 kgs. The daily consumption of the family was retained as kgs/day and the purchases were converted into quintals/annum.

Method of dung measurement

The response for weight of dung was largely expressed in *patis*. The team was asked to weigh a *pati* to get the measure for actual dung collected. This was found to be about 10 kgs. This was converted into kg/day of dung produced, which was later related to the fodder consumption pattern of the cattle.

Method of measurement of kerosene

Kerosene use was calculated on a monthly basis in litres as that was how people responded. The monthly ration quota was one way of knowing the possible availability of kerosene with a household/month.

4.7 Block level data

The overall secondary information regarding the demographic characteristics, land use pattern, cropping pattern, livestock details, irrigation facilities, introduction of energy saving devices, etc., was largely obtained from various government departments at the block, district as well as the regional level through published and unpublished reports, census handbooks, personal information, etc.

4.8 Methodology of assessment

The survey findings have been used for estimations at the block level. The seven Circles form the basis for analysis of the survey findings as well as for all the block level estimations.

- Fuel used for cooking, heating and lighting has been converted into average daily use in kg/household and also in terms of average annual use in tons/household for that Circle.
- For agricultural operations the basis has been average values per cropped area for the concerned Circle. For example use of draught power has been estimated on the basis of animal hours/cropped area for the Circle. Similarly mechanical power like tractor and thresher too is estimated on equipment hours/cropped area of that particular Circle.
- Energy drawn for pumping of water is based on per pump energy drawn in kWh.
- Domestic electrical energy use is based on energy consumed per gadget in kWh for that Circle. On the basis of total number of gadgets in each Circle an average use of electrical energy in kWh per household has been calculated for that particular Circle. The domestic electrical consumption has been calculated taking into consideration the weekly incidence of power failure as reported by the respondents.

- Dry weights of fodder and dung have been calculated for precision for estimations.
- The incidence of reporting of crop residue as fuel from sugarcane has been very low. However, during informal group discussions with people it was clear that residue from sugarcane was used as fuel. Based on these discussions 5% of the total cane production has been taken as residue used for fuel for that particular Circle.

***Table 4.1* : List of villages according to Resource Index Class and SC Population Class**

Location code	Village	Circle	Resource Index Class	SC Popula-tion Class	Village Area (ha)	No. of house-holds	Total Popula-tion
Resource Index Class A, SC Population Class A							
4	Hanumanwadi NV	Dahigaon	A	A	358.70	145	1,016
36	Purandawade	Malshiras	A	A	707.93	971	4,100
38	Jadhavwadi	Malshiras	A	A	804.80	252	1,684
43	Goradwadi	Malshiras	A	A	1,983.38	386	2,300
52	Zanjevasti(N.V.)	Piliv	A	A	235.00	355	2,160
55	Bacheri	Piliv	A	A	2,577.63	283	1,636
66	Vizori	Velapur	A	A	733.00	401	2,243
72	Dasur	Velapur	A	A	599.00	275	1,474
90	Savatgavhan	Akluj	A	A	447.67	448	2,398
91	Bijwadi*	Akluj	A	A	354.19	166	883
101	Rautgat (N.V) (100)	Mahalung	A	A	816.78	479	2,574
103	Malewadi (N.V.)(102)	Mahalung	A	A	304.12	221	1,276
106	Kondarpatta(N.V.) (107)	Mahalung	A	A	464.00	220	1,092
107	Neware	Mahalung	A	A	957.00	439	2,188

Location code	Village	Circle	Resource Index Class	SC Popula-tion Class	Village Area (ha)	No. of house-holds	Total Popula-tion
Resource Index Class A, SC Population Class B							
5	Kurbavi	Dahigaon	A	B	703.34	346	2,121
6	Tambewadi*	Dahigaon	A	B	590.77	264	1,341
7	Ekshiv	Dahigaon	A	B	930.88	691	4,039
16	Gursale	Dahigaon	A	B	1,437.09	705	3,982
17	Dharmpuri	Natepute	A	B	2,188.00	645	3,740
19	Morochi	Natepute	A	B	1,404.09	590	3,554
20	Natepute	Natepute	A	B	2,525.00	2,162	12,285
33	Medad	Malshiras	A	B	1,290.91	666	3,649
34	Malshiras*	Malshiras	A	B	3,544.00	2,722	14,941
35	Yeliv	Malshiras	A	B	415.02	246	1,473
37	Chitalenagar	Malshiras	A	B	495.15	686	3,559
39	Bhamburdi	Malshiras	A	B	1,522.89	594	3,514
44	Mandaki	Malshiras	A	B	924.81	346	2,065
47	Pathanevasti	Piliv	A	B	1,096.73	260	1,407
53	Pilliv	Piliv	A	B	3,029.96	1,198	6,235
70	Malkambi	Velapur	A	B	833.00	416	2,257
73	Bondale	Velapur	A	B	711.00	321	1,497
82	Anandnagar	Akluj	A	B	770.17	466	2,443
83	Bagechiwadi	Akluj	A	B	72.86	530	2,953
84	Girzani	Akluj	A	B	750.00	431	2,553
85	Yashawantnagar	Akluj	A	B	753.00	1,925	9,560
87	Malewadi	Akluj	A	B	1,089.00	643	3,506

Location code	Village	Circle	Resource Index Class	SC Popula-tion Class	Village Area (ha)	No. of house-holds	Total Popula-tion
88	Akluj	Akluj	A	B	1,361.00	5,792	31,432
89	Malinagar	Akluj	A	B	948.13	1,852	9,283
97	Wagholi	Mahalung	A	B	1,050.00	553	2,912
98	Lawang	Mahalung	A	B	1,524.00	860	4,713
99	Mahalung	Mahalung	A	B	3,435.86	3,208	16,486
102	Borgaon	Mahalung	A	B	643.88	947	5,237
104	Mire*	Mahalung	A	B	814.00	315	1,671
108	Jambud	Mahalung	A	B	1,857.00	672	3,766
110	Vijaywadi (N.V.)(65)	Velapur	A	B	335.84	240	1,339
Resource Index Class B, SC Population Class A							
9	Bangarde	Dahigaon	B	A	757.10	209	1,469
14	Pirale	Dahigaon	B	A	1,409.44	431	2,512
21	Mandave	Natepute	B	A	3,030.30	782	4,919
22	Pimpari*	Natepute	B	A	2,631.00	364	2,377
23	Kothale	Natepute	B	A	1,766.00	187	1,075
24	Fadtari	Natepute	B	A	3,144.00	477	3,192
25	Londhe Mohitewadi	Natepute	B	A	716.00	161	911
27	Giravi	Natepute	B	A	2,297.04	420	2,451
29	Rede	Natepute	B	A	1,748.19	297	1,653
30	Tamsiwadi	Malshiras	B	A	1,324.67	415	2,712
40	Kanher	Malshiras	B	A	1,699.39	436	2,600
46	Garwad	Piliv	B	A	4,067.54	408	2,522
51	Salmukhwadi*	Piliv	B	A	335.00	64	418

Location code	Village	Circle	Resource Index Class	SC Popula-tion Class	Village Area (ha)	No. of house-holds	Total Popula-tion
Resource Index Class B, SC Population Class A							
54	Sulewadi	Piliv	B	A	27.30	370	2,473
57	Kalamawadi	Piliv	B	A	444.00	162	950
59	Kolegaon	Piliv	B	A	1,429.87	633	3,580
62	Zunjewadi	Velapur	B	A	510.91	100	622
63	Dombalwadi	Velapur	B	A	348.80	136	821
67	Pisewadi	Velapur	B	A	1,458.55	394	2,503
77	Tandulwadi	Velapur	B	A	3,484.32	1,143	5,844
79	Tirwandi	Akluj	B	A	3,977.00	423	2,614
80	Chakore*	Akluj	B	A	1,132.00	411	2,121
81	Kondabavi	Akluj	B	A	1,366.00	595	2,848
93	Sangam	Akluj	B	A	1,335.00	370	1,623
96	Ganeshgaon	Mahalung	B	A	442.00	138	848
105	Umbare (Velapur)	Mahalung	B	A	1,250.00	328	1,621
Resource Index Class B, SC Population Class B							
1	Shindewadi	Dahigaon	B	B	1,917.13	633	3,420
8	Kalamboli*	Dahigaon	B	B	709.00	238	1,210
12	Kadamwadi	Dahigaon	B	B	352.43	138	836
13	Fondshiras	Dahigaon	B	B	3,040.51	1,142	6,936
18	Karunde*	Natepute	B	B	1,778.02	413	2,456
26	Lonand	Natepute	B	B	2,488.10	339	2,092
28	Bhamb	Natepute	B	B	1,690.90	174	975
32	Umbare Dahigaon	Malshiras	B	B	1,011.00	323	1,971
41	Islampur	Malshiras	B	B	1,419.52	409	2,579

Location code	Village	Circle	Resource Index Class	SC Popula-tion Class	Village Area (ha)	No. of house-holds	Total Popula-tion
Resource Index Class B, SC Population Class B							
48	Nimgaon	Piliv	B	B	4,187.39	1,054	5,667
49	Chandapuri	Piliv	B	B	1,431.00	220	1,337
56	Shingorni	Piliv	B	B	2,658.12	336	2,279
58	Falwani	Piliv	B	B	1,509.62	515	2,689
61	Tarangfal	Velapur	B	B	808.00	328	1,599
64	Khudus	Velapur	B	B	1,936.00	673	3,955
65	Paniv	Velapur	B	B	951.26	366	2,126
68	Velapur	Velapur	B	B	4,592.00	2,206	11,962
75	Dhanore	Velapur	B	B	492.00	187	1,120
76	Maloli	Velapur	B	B	3,367.00	939	5,004

Location code	Village	Circle	Resource Index Class	SC Population Class	Village Area (ha)	No. of households	Total Population
86	Chaundeshwarwadi	Akluj	B	B	1,031.00	524	2,841
92	Tambave	Akluj	B	B	1,439.00	450	2,739
94	Babulgaon	Akluj	B	B	720.00	280	1,535
95	Wafegaon	Mahalung	B	B	848.00	195	1,065
100	Khandali*	Mahalung	B	B	1,780.44	581	3,437

Location code	Village	Circle	Resource Index Class	SC Popula-tion Class	Village Area (ha)	No. of house-holds	Total Popula-tion
Resource Index Class C, SC Population Class A							
2	Deshmukhwadi	Dahigaon	C	A	788.12	181	1,292
3	Dombalwadi	Dahigaon	C	A	777.33	211	1,289
10	Palasmandal	Dahigaon	C	A	1,373.61	256	1,541
11	Motewadi	Dahigaon	C	A	1,709.11	83	511
31	Markadwadi	Malshiras	C	A	1,421.27	295	1,686
45	Jalbhavi	Malshiras	C	A	2,111.00	158	826
50	Kusmod*	Piliv	C	A	2,234.00	254	1,248
60	Shendechinch	Piliv	C	A	680.00	163	895
78	Kacharewadi	Akluj	C	A	1,070.00	247	1,822
109	Vitthalwadi	Mahalung	C	A	563.44	95	538
Resource Index Class C, SC Population Class B							
15	Dahigaon	Dahigaon	C	B	4,541.00	1,035	6,634
42	Motewadi	Malshiras	C	B	2,252.81	176	1,082
69	Ughadewadi	Velapur	C	B	1,461.82	406	2,192
71	Khalawe	Velapur	C	B	1,031.00	175	959
74	Tondale*	Velapur	C	B	711.00	146	2,185

<u>Table 4.2</u>* : *List of villages selected for primary data collection

Sr. No.	**Name of village**	**Location code**	**Circle**
1	Tambewadi	6	Dahigaon
2	Kalamboli	8	Dahigaon
3	Karunde	18	Natepute
4	Pimpari	22	Natepute
5	Malshiras	34	Malshiras
6	Kusmod	50	Piliv
7	Salmukhwadi	51	Piliv
8	Tondale	74	Velapur
9	Chakore	80	Akluj
10	Bijwadi	91	Akluj
11	Khandali	100	Mahalung
12	Mire	104	Mahalung

***Table 4.3* : Comparison of All Villages and Selected Villages: Selected Indicators**

	All Villages				**Selected Villages**				**Difference in Average as % of range**	**% difference in Std. Deviation**
	Total	**No. of villages**	**Average Value**	**Std. Deviation**	**Total**	**No. of villages**	**Average Value**	**Std. Deviation**		
Geographical Area	157,404.95	110	1,430.95	1,026.71	16,613.42	12	1,384.45	1,015.45	-1.02	-1.10
No. of Households	62,731	110	570	720.51	5,938	12	495	715.01	-1.32	-0.76
Forest area	5,099.03	110	46.35	129.35	494.87	12	41.24	133.90	-0.55	3.52
Irrigated Area	61,300.72	110	557.28	565.41	8,453.17	12	704.43	871.89	4.36	54.21
Unirrigated Area	49,895.36	110	453.59	453.51	4,312.05	12	359.34	369.77	-4.32	-18.47
Culturable Wastes	20,705.73	110	188.23	284.44	1,972.11	12	164.34	207.36	-1.48	-27.10
Area Not Available for Cultivation	20,116.58	110	182.88	246.90	1,648.82	12	137.40	161.30	-4.08	-34.67
Total Population	350,346	110	3,185	3,850.73	34,288	12	2,857	3,891.67	-1.06	1.06
Total Males	182,099	110	1,655	2,014.31	17,966	12	1,497	2,077.63	-0.98	3.14
Total Females	168,247	110	1,530	1,837.27	16,322	12	1,360	1,814.55	-1.14	-1.24
SC -- Males	32,745	110	298	435.61	3,070	12	256	391.55	-1.23	-10.11
SC -- Females	30,596	110	278	399.63	2,865	12	239	343.10	-1.26	-14.14
ST -- Males	924	110	8	30.02	122	12	10	24.51	0.70	-18.36
ST -- Females	877	110	8	27.90	98	12	8	19.73	0.08	-29.28

***Table 4.4* : List of BPL households**

		Total Households		**BPL Households**	
Circle	**Name of village**	**In the village**	**In the sample**	**In the village**	**In the sample**
Dahigaon	Tambewadi	264	25	113	5
Dahigaon	Kalamboli	238	23	138	7
Natepute	Karunde	413	25	154	5
Natepute	Pimpari	364	25	130	0
Malshiras	Malshiras	2,722	26	1,259	9
Piliv	Kusmod	254	27	0	5
Piliv	Salmukhwadi	64	25	57	10
Velapur	Tondale	416	26	113	5
Akluj	Chakore	411	27	257	5
Akluj	Bijwadi	166	26	107	10
Mahalung	Khandali	581	26	0	5
Mahalung	Mire	315	25	150	10
		6,208	306	2,478	76

Chapter 5
Survey Findings

5.1 Household profile of the survey households

Household profile attempts to contextualise the survey households by giving detailed information of the households in terms of their demographic profile (which includes household size, the proportion of Scheduled Caste (SC) and Scheduled Tribe (ST) population, age, educational status), occupation and non-agricultural income.

Households, population and sex ratio

As explained in the chapter on methodology the data of the survey are mainly presented according to the different Circles in the block. Out of the total sample of 306 households, 53 households are from Akluj Circle, 48 households are from Dahigaon Circle, 51 households are from Mahalung Circle, 26 households are from Malshiras Circle, 50 households are from Natepute Circle, 52 households are from Piliv Circle and 26 households are from Velapur Circle. The total population covered in the survey is 2096. Of this, 1084 are males and 987 are females, which gives a sex ratio of 911 females for 1000 males (Table 5.1).

Household size

Data on household size shows that a vast majority of the sample households, accounting for more than 85%, fall in the two household size categories of 1 to 5 and 6 to 10. Though the average family size for all the Circles together is 6.85, there is also considerable variation between Circles. For example the average family size for Akluj, Malshiras and Dahigaon Circles comes to 8.28, 7.86 and 7.65 where as in Piliv Circle the average family size is only 6.11 (Table 5.1).

Proportion of SC, ST population

The SC and ST population together forms about 15% and out of this SC population alone accounts for nearly 15.25% of the total population. Thus the ST population is very negligible. About 85% population falling in the other caste category predominantly includes communities like *Maratha*, *Mali*, *Dhangar* and *Wadar*. The proportion of ST population amongst the sample households is particularly high in Circles like Akluj (25.53%), Mahalung (23.53%) and Velapur (23.08%) and in Malshiras Circle it is much lower (11.54%) as compared to the all Circles average (Table 5.2).

Age composition

About 58% of the population fall in the productive age group of 16 to 60 years. Children up to the age of 15 account for about 35% and the remaining 7% consists of old people above the age of 60. In terms of the proportion of people within the age group of 16 to 60 Malshiras ranks the highest with nearly 63% and Akluj ranks the lowest with about 54%. The data does not show any significant variation between males and females in terms of age class except in the age category of above 60 years where 8.12% of the total male population falls in this category where as only 5.67% of women comes in this age group (Table 5. 3).

Educational status

Out of the total population, 12.36% consists of non-school going age group children, 25.41% are illiterate, 1.29% are neo-literate, 52.53% have studied up to matriculation and 9.11% have gone above matriculation. The literacy rate is about 72% (if we exclude non-school going age group children) and about 75% if we consider the entire population which means about 25% are illiterate. However, there is variation across Circles and more significantly between males and females. For example in Piliv Circle about 33.5% are illiterate. There is significant variation in educational status between males and females across the Circles. For example the illiteracy rate of females is about 33% as compared to about 17% of the males. This variation across Circles and between males and females could be noticed in the case of higher education also (Table 5.4).

Occupational status

Out of the total population, nearly 40% belong to the non-applicable category comprising small children, students, old people and disabled. Agriculture constitutes the single largest occupation with about 22% of the responses. Other occupations like agricultural and other wage labour accounts for about 14%, salaried employment accounts for 2.85% and other types of work accounts for 3.32%. The artisanal activity is very minimal with about 1% responses. Women, as in other areas, do a double duty -- housework and agricultural work and/or wage labour. Data also show that the percentage of people engaged in agriculture is slightly lower in Akluj and Malshiras Circles as compared to other Circles. This variation is partly taken care of by the fact that in occupations like salaried employment these Circles report a slightly higher proportion of people as compared to other Circles. This is very prominent in Malshiras Circle as salaried employment and other work together account for about 12.5% of the responses. This to some extent indicates that the respondents from Malshiras and Akluj Circles are at a comparatively advantageous position in terms of access to non-agricultural occupations. The data also indicate that the participation of women in occupations like salaried employment, artisanal activities and other type of work with access to cash income are very minimal as compared to the men (Table 5.5).

Access to non-agricultural income

Table 5.6 shows that about 20% of the survey households do not have access to Non-Agricultural Income (NAI), about 19% of the households get NAI up to Rs. 10,000 per year, about 25.50% of the households falls in the category of ten to twenty thousand and about 37% of the households get NAI above Rs. 20,000. The average annual NAI for the reporting households is about Rs. 24,265. The data indicates that there is significant variation across the Circles with Circles like Akluj and Malshiras Circles leading in average annual NAI with Rs. 33,233 and Rs. 31,700 respectively. Where as in Piliv Circle the average annual NAI comes to only Rs.16.040. This also corroborates the earlier observation that Circles like Malshiras and Akluj are comparatively better placed in terms of non-farm occupations (Table 5.6).

5.2 Land holding, crop pattern and irrigation

Land holding

Out of the total sample of 306 households, 103 households (about 33.60%) are landless and this is particularly high in Malshiras Circle (53.85%). Out of he total number of households, about 7% of the households have less than 0.5 ha holding, about 30% have holdings between 0.5 to 2 ha, 12.75% have holdings between 2 to 4 ha and about 17% of the households have a holding size above 4 ha. The average size of the holding per family for all the Circles together comes to 2.32 ha. However, the per household landholding reported by Malshiras and Akluj Circles is only about half of the all Circle average. In terms of average size of the holding Mahalung Circle seems to be comparatively better placed with 3.77 ha average holding per household (Table 5.7).

Crop pattern

Though there is significant crop diversity amongst the sample households, the major crops are *jowar* (23.30% of the cropped area), *bajra* (19.2%), sugarcane (16.68%), *wheat* (10.95 %), pulses (7.18%), fodder crops (5.60%), maize (5.90%) and fruits (3.74%). Some of the other reported cash crops include cotton (0.85%) and onion (1.62%). The crop pattern for the sample households shows that about 6.70% of the total cultivated area is kept as fallow as part of the crop rotation. There is also quite a bit of variation between Circles in relation to the percentage of area under different crops. For example in the case of *Jowar* though the all Circle average is 23.30%, in Natepute Circle it is as high as 31.80% and in Dahigaon Circle it is only 13.8%. In the case of *Bajra* the data shows a range between 7.31% in Velapur to 29.85% in Piliv Circle.

In the case of sugarcane area also there is a wide variation. For example in Piliv and Natepute Circles the reported area under sugarcane comes to only 1.19% and 2.4% respectively. Whereas in Circles like Velapur and Mahalung it is as high as 35.7% and 27.5% respectively (Table 5. 8).

Irrigation status

For all the seven Circles together the reported cropped area is 609.37 ha and out of this about 60.98% is irrigated. Here it would be noted that the main reason for this high proportion of irrigated land is that we have included even lands with a couple of waterings during dry spells, especially in kharif season, in the irrigated category.

The data show that there is also variation between the different Circles in terms of the area irrigated. For example in Dahigaon and Mahalung Circles the reported irrigated area comes to about 72.10% and 70.10% respectively. Whereas in Piliv Circle it is only 40.76%. Flow irrigation by the government canals and lift irrigation from wells is the main mode of irrigation.

The important irrigated crops are *jowar* (29.97% of the total irrigated area), followed by sugarcane (27.09%) and wheat (17.55%). Amongst these irrigated crops sugarcane is the most water intensive crop and thus in terms of water use it would be taking up most of the water that is used for irrigation (Table 5.8).

5.3 Agricultural biomass production and use

The biomass produced on cropland is taken into account here. Biomass in this context includes everything, say grain, seeds, flowers, stalks, leaves, roots, etc., that are produced on the crop land and not restricted to the main production, say only grain, which is often associated with terms like `crop production' or `agricultural production'.

Table 5.9 presents the data related to annual biomass production from crop land and biomass use for the sample households. The table gives both the main production as well as the residue which consists of fodder and fuel. Taking all the Circles together, the main production comes to about 10,707.25 T. Residue used as fodder and fuel comes to about 2,162.23 T and about 355.51 T respectively. However, it should be noted here that the figures for residue do not denote actual production but use as fodder and fuel. Thus the figures in the table do not indicate the total availability of residues as a part of the residue is burned in situ. For example the stalks of crops like *bajara*, wheat, sugarcane lopping, etc. are very often burned in the field itself. (Table 5.9)

5.4 Trees and biomass utilisation from non-crop land

The annual biomass utilisation from non-crop land for the sample households consists of two main uses, namely, fodder and fuel. The respondents could not estimate use of timber as timber, mainly used for construction, is extracted only once in a couple of years and does not fall in the annual cycle. For all the seven Circles together the average per household annual utilisation of biomass in terms of fodder and fuel from non-crop land comes to about 0.83 T. Out of this, fuel use accounts for as high a share as 0.50T and fodder use comes to only 0.33T. There is also quite a bit of variation amongst the Circles in terms of biomass utilisation from non-crop area. In Velapur and Dahigaon Circles the biomass utilisation comes to only 0.12T and 0.20T respectively, whereas in Mahalung Circle it comes to about 1.38 T (Table 5.10).

Table 5.11 gives the number of trees owned by the sample households in terms of (a) fodder, timber and fuel yielding trees, (b) fruit trees (fruit trees which are grown as regular horticulture crops are not included in this), and (c) other trees like ornamental plants, etc.

5.5 Animal composition, fodder and feed consumption and dung production

Animal composition

The data related to the animals owned by sample households is presented in Table 5.12. In the table we have given both the total number of each of the animals for each Circle as well as the number of animal units. We have tried to standardise animals owned by the sample households by working out the number of animal units for each Circle by using the same norms as given in MANAGE Manual on Watershed Development.

The table shows that the all the sample households together own 1,216 animal units and per household it comes to 3.97 animal units. However, the data also shows certain variation across the Circles. At one end of the range we have Malshiras Circle with only 2.36 animal units per household and on the other end we have Akluj, Velapur and Dahigaon Circles with 4.47, 4.43 and 4.21 animal units respectively. The major reason for this seems to be that the proportion of crossbred milch cows is much higher in these Circles as compared to other Circles. This becomes clearer in the discussion below about the animal composition for each Circle.

In terms of composition of the animal units the data shows that for all the sample households together the single largest category is crossbred milch cows which accounts for 417.50 animal units (about 34%), followed by milch buffaloes (17.85%) and bullocks (about 11%). The data also very clearly show that the incidence of small ruminants like goat and sheep is very marginal.

There are also some variations in the animal composition of the seven Circles. Though in almost all Circles with the exception of Mahalung Circle, the proportion of crossbred milch cows is higher than the other animals, this proportion is particularly high in Circles like Akluj and Dahigaon.

Fodder and feed consumption

Table 5.13 gives the data related to annual fodder and feed consumption for the sample households according to Circles. The table gives both the gross weight (wet weight) and dry weight for green fodder, dry fodder and animal feeds and concentrates. The annual per animal unit consumption of green fodder, dry fodder and feeds and concentrates have been also worked out in the table. Taking all the Circles together the annual per animal unit consumption (in terms of dry weight) of green fodder comes to 0.41 T, dry fodder comes to 0.34 T and the consumption of feeds and concentrates comes to 0.15 T. One of the significant variations between Circles is that in terms of the consumption of feeds and concentrates in Mahalung Circle where the per animal unit consumption is as low as 0.08 T. In the rest of the Circles there is very little variation in terms of consumption of animal feed.. There seems to be little variation across Circles in the green fodder and dry fodder consumption per animal unit. The green fodder consumption mentioned here does not include the free grazing component. During the data collection it has been observed that green fodder is generally given in the four monsoon months of the year.

Dung Production

The annual dung production per animal unit is also shown in the same table. The data across Circles do not show much variation and this is in line with little variation in fodder consumption pattern across Circles. In terms of dry weight the average per animal unit dung production for all Circles is 0.45. The variation across Circles is not very high. The range is between 0.36 in Piliv to 0.53 in Mahalung.

5.6 Use of draught power

Draught power used by sample households has been estimated for the two basic agricultural operations and as a means of transport (Table 5.14). The survey has shown that no draught power is used amongst the sample households for lifting water. The table also gives the average number of animal days per ha cropped area and also the division between owned and rented animals supplying draught power out of the total draught power used.

The total draught power used per ha cropped area for all the Circles together comes to about 22 animal days in a year. Out of this about 69.77% of the draught power is used for agricultural operations, primarily tilling of the land. Thus the use of draught power as a means of transport is very negligible. The data clearly indicate that most of the draught power used by the sample households (about 69.2% of the total number animal days used per ha cropped area) is owned by them.

The above mentioned table shows certain variations between the Circles. For example the number of animal days used per ha cropped area is 30.23 animal days for Natepute which is nearly double that of Akluj Circle where it is only 16.32 animal days per ha cropped area. One reason for this is that the sample households in Natepute (Table 5.12) are much better placed as compared to other Circles in terms of the bullocks that they own. The second reason is that there is much more mechanisation in the agricultural operations in the other Circles especially in Akluj. This would become clear from the data presented in the next table on annual use of mechanical equipment for the sample households.

5.7 Use of mechanical power

The major mechanical equipment considered here is tractors and threshers. Table 5.15 gives details of the number of tractors owned by the sample households, the number of hours of tractor use for agricultural operations and for transport, and the number of hours of thresher use. It also gives data about the average values per ha cropped area. The use of mechanical power is estimated in terms of equipment hours.

The sample households have reported that they own 23 tractors. All the 23 tractors together use 709 hours for agricultural operations and per ha cropped area use of this comes to 1 hour. The respondents have also reported a total of about 867 hours as rented in, which comes to 1.22 hours per ha cropped area. The data also show that the use of tractors for transport is on par with use for agricultural operations. About 1,413 hours of thresher use is reported. Of this 98 hours is owned and the rest is rented. There are 14 threshers owned in the area. The table also brings out the Circle-wise variation in mechanical power use. Piliv and Velapur Circles do not report any ownership of tractor.

5.8 Annual pumping energy

Table 5.16 gives the annual pumping energy for the sample households. It has details like the number of pumpsets owned, capacity of the pumpsets, annual hours of use and the energy used. Data for electrical pumpsets diesel pumpsets are given separately. Based on this data, the per pumpset use has been estimated.

From the table it is very clear that the use of diesel pumpsets is very minimal (about 5,120 hours of use and 18667.90 kWh energy use) as compared to electric pumpsets (12,1230 hours of use and 469275.28 kWh energy use). The table also shows the variations between the Circles. For example Akluj, which is the most prosperous Circle, reports 24,857 annual hours of use and Piliv reports only 6,069 annual hours of use. The higher use of pumping energy can be clearly seen in sugarcane growing areas. The total number of electric pumpsets owned in all the Circles is 163. The average per pump hours of use for all Circles is 743.74 and the total energy use per pump amounts to 2,878.98 kWh

5.9 Domestic non-electrical fuel use

The data regarding the domestic non-electrical fuel use are presented in terms of daily domestic fuel use for sample households, annual domestic fuel use, fuel value of daily domestic fuel used, and delivered heat of daily domestic fuel used. Use of electricity is treated separately and given later.

Daily domestic fuel use

The non-electrical fuels reported are firewood, dungcake, kerosene, LPG, vegetable oil, biogas and coal. Table 5.17 gives data about the daily Circle-wise use of each of these fuels and also the per household use for each Circle. Domestic use includes cooking, heating bathing water and lighting. The daily use of LPG is very minimal (0.03 kg/household) The respondents have reported that kerosene is used for cooking, heating bath water and lighting. Similarly firewood and dungcake are used for cooking and heating bath water. The data show that the major non-electrical fuels used for domestic uses are firewood (8.9 kg per household per day) and dungcake (0.57 kg per household per day). It can be seen that Malshiras reports a higher use of kerosene (0.34) as compared to the other Circles, which use kerosene in the range of 0.15 to 0.21 per day. This can easily be explained by the fact that there is much more availability of kerosene in town like villages. The reach of biogas plants seems to be the highest in Akluj Circle [0.60 Nm3/household as compared to Mahalung where it is only 0.21 Nm3] (Table 5.17). Table 5.17 a shows the per capita use of domestic fuel which essentially reflects the explanations given above.

Annual domestic fuel use

Table 5.17 b estimates the annual domestic fuel use for each of the fuels according to Circles. The table also gives the annual per household use of these fuels. The annual per household domestic use comes to 3.25 T of firewood, 0.21 T of dungcake, 0.07 kl of kerosene, 0.01 T of LPG, and 0.08 Nm3 of biogas. (Table 5.17b). For he annual domestic per capita fuel use see table 5.17c.

Fuel value of Annual domestic fuel used

Table 5.18 gives the estimated fuel value for all the fuels that are used as domestic fuels. The daily per capita fuel value for all the fuels together comes to 2,12,9170 kcal and there does not seem to be much of variation across the Circles The table clearly brings out that in terms of fuel value firewood continues to be the main provider of domestic fuel as it provides 18,97,370 kcal (per capita per day) which comes to about 89% of the total fuel value. Then comes dungcake and kerosene with values of 76,500 kcal (3.59%) and 86,260 kcal (5.03%) respectively.

Delivered heat of annual domestic fuel used

Table 5.19 presents the estimated delivered heat for different fuels, which also shows the relative efficiency of these fuels. The table shows that out of the total delivered heat of 27,8490 kcal/capita 18,9740 kcal (about 68%) comes from firewood, 38,820 kcal (about 13.9% from kerosene, 31,040 kcal (about 11.1%) from biogas and 7,650 kcal (about 2.7%) comes from dungcake. Thus from the point of view of delivered heat the role of dungcake is very marginal. (Table 5.19)

5.10 Annual flows and balances

Green fodder balance for the sample households

The estimated annual green fodder balance for the sample households is given in Table 5.20. The table gives Circle-wise details of the green fodder consumption and the quantum of green fodder procured from different sources. The table also gives the estimated shortfall, which is collected from the commons. Thus the table tries to estimate the extent of the pressure on commons to meet the green fodder requirement of the sample households.

For all the Circles taken together the annual consumption of green fodder for total animal units comes to 997.27 T. There is no shortfall which means that green fodder needs are met from owned lands and that there is no dependence on the commons for green fodder. There seems to be a surplus in the availability of green fodder. The reason why this sort of a picture emerges is because the availability of commons too is not very high in this region. Only Akluj, Natepute and Piliv Circles seem to depend on the commons to meet there green fodder needs. The table also gives average values per animal unit for the Circles (Table 5.20).

Dry fodder balance for the sample households

Table 5.21 shows that in terms of dry fodder requirement the sample households do not depend on the commons. This means that the needs are met form fodder, which is either purchased, or that which is available as crop residue and from non-crop land. Of the total fodder, fodder from crop residue forms the largest share. The table shows that there is no shortfall in procuring dry fodder and in fact there seems to be a surplus in the dry fodder balance.(Table 5.22)

Annual free grazing component

Since reliable data cannot be obtained directly from the respondents about the free grazing component, we have tried to make an estimate of this component by making an estimation of the total fodder and feed consumption required for production of the dung, which is reported by the sample households. Since we already know the fodder component, which is collected or procured by the sample households, we could estimate the shortfall, which is taken to have come from free grazing.

Table 5.22 shows that the annual dung production reported by the sample households is about 1,351.34 T (and about 540 T dry weight). To produce this the estimated fodder required is about 1,351 T (dry weight). The total collected/procured green fodder, dry fodder and feed and concentrates together account for about 1,082.28 T (dry weight) which comes to about 80% of the estimated fodder consumption. Thus the remaining fodder of about 269 T (about 20%) comes as the free grazing component. (Table 5.22)

Annual dung use for the sample households

Table 5.23 gives the details related to the various uses of dung. Since we know what is the total dung produced and the quantum of dung used for making dungcake and use in biogas plants it has been possible to estimate the quantum of dung used as manure. The table shows that out of the 540 T (dry weight) dung produced, about 65.14 T (about 11.8%) is used for making dungcake, about 42.47 T is used for biogas (about 7.8%) and the remaining 433.73 T (about 80%) dung is used as manure (Table 5.23).

Annual firewood balance for the sample households

Table 5.24 gives the estimated firewood collection from commons and forests. For all the Circles together the annual firewood consumption is about 995.22 T and firewood procured from non-crop land, crop residues used as firewood and firewood purchased all add up to about 985.01 T (about 98% of the total consumption). Thus the estimated firewood collected from commons and forests come to about 8.17 T (dry weight) which is about 2% of the total firewood consumption. This means that there is very little pressure on the commons for meeting firewood needs. The table does not show much variation across Circles. Natepute Circle seems to extract the largest share from the commons of all the Circles.

5.11 Domestic electricity use

Out of the total 306 sample households, 104 households (33.9%) have reported that they do not have electricity connection. Piliv and Akluj Circles account for the highest number of houses without electric connections. (Table 5.25). The high incidence of reporting of no electricity in households seems to be largely due to the fact that there was under reporting by the respondents. The data collection team observed during data collection that people were using various kinds of electrical equipment and yet reporting for no electric connection.

Table 5.26 gives a detailed account of all the electrical equipment and gadgets used by the sample households. The details include number of each equipment, total wattage and annual electricity use according to Circles. Out of the total 10,3,950.89 kWh annual electricity use for all the sample households together, bulbs account for as much as 55.8%, followed by TV's (13.67%) fans (7.82%), refrigerators (5.41%) electric stoves (5.43%) and tube lights (5.36%). The use of other electric gadgets like energy saving lamps, irons, radios, electric stoves, fans, mixers, etc. is very minimal. Out of the total domestic electricity use, lighting accounts for about 60.17%. In Akluj Circle the annual electricity use per household is 367 kWh. There does not seem to be a very wide variation between Circles. The total annual electricity use per household amounts to 339 kWh.

5.12 Use of pressure cookers, biogas plants and improved *chulhas*

Table 5.27 gives village-wise data with regard to pressure cookers, biogas plants and improved *chulhas* in the sample households. According to this table there are 70 pressure cookers, 25 biogas plants and 10 improved *chulhas* in the sample households. Velapur and Akluj Circles do not report any Improved *chulhas*.

Status of biogas plants

Out of the total number of 26 biogas plants, 15 plants are in use. The 15 plants (out of the total 26) which have reported a capacity have a combined capacity of 125.5 Nm3. The reported cost of bringing the 11 plants not in use to use is Rs. 31,000. Out of this the users are ready to bear Rs. 11,200 which comes to about 36% of the expected cost (Table 5.28).

Status of improved chulhas

The total number of improved *chulhas* reported are 10 and of these 4 are in use (Table 5.29). The user response to improved *chulhas* in terms of change in smoke, change in fuel use and change in cooking time on a 5 point scale of large increase, small increase, no change, small decrease, and large decrease is presented in Table 5.30. This table shows that out of the 4 *chulhas*, which are in use, all have responded to the user response. On the question of change in smoke, 1 has marked large decrease in smoke, 2 have marked small decrease, and 1 has opted for large increase. When it comes to change in fuel use, there is one response for large increase, 1 for small decrease, one for no change and one for small increase. Responses to change in cooking time shows that two have opted for large decrease, 1 has opted for small decrease and one for large increase. Overall one can say from these responses that majority of them feel that there has been decrease in smoke, in fuel use and in cooking time.

The respondents have also reported some of the problems associated with the improved *chulhas* and which have contributed for their disuse. Some of these problems include (a) firewood has to be small in size, (b) the mouth of the *chulha* is too large, (c) the stand is broken, (d) inadequate information on its use, (e) the stove was not fixed properly, (f) not sufficient for the cooking needs of the family, and (g) increase in the consumption of firewood.

5.13 Status and use pattern of the MEDA energy saving devices used in the sample households

Table 5.31 gives the status of the various energy saving devices like improved lantern, pressure cooker, solar cooker, energy saving lamp, wick stove and solar batteries. The table gives Circle wise data about the total number of each of the gadgets and the number in use. There are no solar cookers reported amongst the sample households. Out of total number, only one energy saving device has been reported in the sample households and that is in use. The table shows that in the sample households there has been a very limited reach of the MEDA schemes. The selection of sample households and villages was done through a stratified random sampling method. The sample was also tested for its representativeness. This therefore indicates that the reach of the MEDA schemes in Malshiras block has been very limited and this was corroborated by people's response during the survey. It was seen that people were not very satisfied with the mode of operation of distribution of MEDA schemes. People's main complaint was that the schemes should come through the Gram Panchayat rather than through the Panchayat Samiti as is currently done.(Table 5.31).The use pattern of these gadgets is given in Table 5.32. According to this table, out of the 3 improved lanterns in use, 2 are used only when there is electricity failure. Only 1 is reported to be in constant use. In the case of the other gadgets all the ones in use are in constant use.

5.14 Perception of the respondents to energy saving devices and energy use

Use of pressure cookers

A vast majority of the respondents do not own pressure cookers. Non-affordability is quoted as the main reason for not using pressure cookers. Many have also said that they have not bought cookers because they do not know how to use them. A few of the non-users have also given reasons like (a) they have not felt the need for pressure cookers, (b) they feel afraid to use them, and (c) they do not know anything about them and (d) they do not see the need for using pressure cookers.

Suggestions about energy efficient devices

As expected a vast majority of the respondents have said that the government should increase the subsidy component of the schemes (in their words they should get economic help from the government) so that many more people would start using devices like improved *chulhas*, biogas, lanterns, solar cookers, etc. Most of them also suggested that the distribution of these devices should not be limited to only those who live in the main village; but should be distributed in the *wadis* also. Most of them also felt that the government officials are corrupt and hence there are irregularities in distribution. They also felt that a wider spread of energy saving devices would ultimately save energy. Many others felt that the information should reach the people in all the *wadis* and *vastis*. The use of solar energy should also be propagated. A few of the respondents felt that the cost of these devices should be reduced. The schemes should not reach only the few leaders of the village. Propagation of solar energy should also be made in order to save energy.

Responses and suggestions with regard to the MEDA schemes

Most of the respondents expressed the need to get detailed and correct information about MEDA schemes. The respondents from the remote villages in the block complained that these schemes do not get implemented in these areas. Many of them also complained about the delay in getting the government schemes sanctioned. Generally there is a perception among the people that any government scheme, and MEDA schemes are not exceptions to this, takes an enormous amount of time to get it sanctioned. Another reaction to these schemes was that very often these schemes got monopolised by the richer and influential sections of the village and the needy and poorer people do not get the benefits of these schemes. Hence many of them pointed out the need to make these schemes affordable to the poorer sections in the rural areas. There were also isolated responses like community biogas schemes based on night soil should be introduced in the villages

Some of the responses were of very general nature like (a) the government machinery is very corrupt and because of this it is very difficult to get these schemes sanctioned, (b) the politicians do not allow the schemes to reach the needy people, and (c) the government officials do not provide sufficient information about these schemes to the people.

Suggestions to solve the energy problem:

Invariably almost all the respondents have complained against the frequent power breakdowns and failures and have very strongly expressed the need for continuous power supply and that too without much of voltage fluctuations. Another equally important suggestion is about kerosene. Most of the respondents have very strongly expressed their view that they should get access to different schemes coming under MEDA. Sufficient quantities of kerosene through the public distribution system should be given and that too at an affordable cost. Their suggestion was that government should provide for saplings to enhance the biomass plantation they also suggested that the government should increase the kerosene quota.

The suggestions and responses of the respondents also show that most of them are aware of the energy problem. In fact, many of them have given suggestions to overcome the energy crisis and some of these suggestions include (a) the dependence on firewood could be reduced if the government makes arrangements for more number of biogas plants in the rural areas so that more and more people switch to biogas for cooking and this would arrest the depletion of forests, (b) the government should supply more number of devices which run on solar energy at an affordable cost so that there would be saving of firewood, kerosene, etc., (though one respondent has mentioned that solar devices may not work in this block because of climatic reasons), (c) LPG cylinders should be provided which would also help in reducing the use of firewood, (d) there should be systematic efforts at afforestation, (e) people should be educated as to how to efficiently use fuels and thus save on them.(f) energy problem at the village level can be solved by collecting and storing more cowdung and fuelwood and the Gram Panchayat should make the necessary arrangements or design appropriate schemes for this and implement them, and (g) government should provide subsidy for distribution of saplings and take up plantation programmes.

5.15 Village establishments and their energy use

Type of establishments

Table 5.33 gives the number of establishments under each category or type of establishment in the selected villages and in the sample for survey. The types of establishments are broadly classified into seven categories, namely, artisanal establishments, brick kilns, flour and *masala* mill food products, small industrial establishments, poultry and goatery, and shops and other small establishments. Artisanal establishments include *kumhar, lohar*, handloom, etc. Food products would include teashops and hotels, sugarcane and other juice joints, bakeries, etc. Establishments like fabrication units, garage, tailoring shops, etc. are grouped together under small industrial establishments. The last category of shops and small establishments includes provision shops, schools, offices of the gram panchayat cooperative society, clinics (PHCs), post office, balwadi, bank, etc. According to this table out of the 762 total establishments reported in the sample villages, 68 have been included in the survey sample, which comes to nearly 8.9%.

Employment pattern in sample establishments

Table 5.34 gives the employment pattern existing in the sample establishments. The data give details like whether the employment is of permanent nature or temporary and in each of them what is the division between household members and non-household members. The table gives number of persons and person days for each of the type of establishment. This table is helpful to understand the seasonality of the operations (whether the establishment operates through out the year or only for a number of months in the year) and also to some extent the size or quantum of operations.

Annual fuel (non-electrical) use in sample establishments

Table 5.35 gives the details of annual fuel use by different types of establishments. The fuel use is also given as per different fuel sources like coal, diesel, firewood, crop residue, dungcake, LPG and kerosene. The reported annual coal use is about 1.69 T and nearly most of it (1.63 T) is used by brick kilns. The reported annual diesel use is of 21.9 kliters and shops and small establishments use all of it. About 206.98 T of firewood is annually used and almost 77% of it is used by artisanal establishments like the *kumhars, lohars* etc. and 16.9% is used by establishments which cover food products, basically bakeries. Brick kilns account for the entire crop residue (15 T) used as fuel. The table shows that the use of LPG is very marginal. Out of the 5.9 kl kerosene that is used for establishments a high share goes into flour and masala mills.

Fuel value of annual fuel use

The fuel value of the different fuel uses for the sample establishments is given Table 5.36. In terms of the fuel value firewood accounts for the highest use of 8,27,920 ('000 kcal), followed by dungcake 2,89,500 ('000 kcal), and diesel 1,75,296 ('000 kcal) in that order . The other fuels like coal and LPG are quite marginal in terms of their fuel value in terms of their proportionate share in the total fuel value used by the sample establishments.

Annual electricity use in sample establishments

The total electricity use of all the sample establishments together in a year comes to about 1,15,040 kWh. Out of this, flour and *masala* mills account for about 50% of the total electricity use, followed by shops and establishments, which account for about 33% and small industrial establishments which accounts for 8.8%. The electricity consumption of all other types of establishments is quite marginal. In terms of type of equipment, motors account for about 63% of the total electricity use, followed by bulbs (11.45%), and fans (7.7%). Electricity used by other gadgets like CFL, TVs, refrigerators, tape recorders, battery chargers and blacksmith grinders is not very significant (Table 5.37)

Table 5.1 ***: Demographic profile of sample households according to household size and circles***

Circle	Hh size 1 to 5				Hh size 11 and above				Hh size 6 to 10				Total			
	No. of Hh	Males	Females	Total	No. of Hh	Males	Females	Total	No. of Hh	Males	Females	Total	No. of Hh	Males	Females	Total
Akluj	14	37	25	62	26	98	94	192	13	99	86	185	53	234	205	439
	(26.42)	(15.81)	(12.20)	(14.12)	(49.06)	(41.88)	(45.85)	(43.74)	(24.53)	(42.31)	(41.95)	(42.14)	(100.00)	(100.00)	(100.00)	(100.00)
Dahigaon	19	42	35	77	18	70	62	132	11	79	79	158	48	191	176	367
	(39.58)	(21.99)	(19.89)	(20.98)	(37.50)	(36.65)	(35.23)	(35.97)	(22.92)	(41.36)	(44.89)	(43.05)	(100.00)	(100.00)	(100.00)	(100.00)
Mahalung	31	76	54	132	13	49	41	90	7	47	45	92	51	172	140	314
	(60.78)	(44.19)	(38.57)	(42.04)	(25.49)	(28.49)	(29.29)	(28.66)	(13.73)	(27.33)	(32.14)	(29.30)	(100.00)	(100.00)	(100.00)	(100.00)
Malshiras	15	33	32	65	10	35	39	74	1	8	12	20	26	76	83	159
	(57.69)	(43.42)	(38.55)	(40.88)	(38.46)	(46.05)	(46.99)	(46.54)	(3.85)	(10.53)	(14.46)	(12.58)	(100.00)	(100.00)	(100.00)	(100.00)
Natepute	19	44	36	80	23	86	79	165	8	69	59	148	50	199	174	393
	(38.00)	(22.11)	(20.69)	(20.36)	(46.00)	(43.22)	(45.40)	(41.98)	(16.00)	(34.67)	(33.91)	(37.66)	(100.00)	(100.00)	(100.00)	(100.00)
Piliv	31	55	56	113	20	64	76	140	1	7	5	12	52	126	137	265
	(59.62)	(43.65)	(40.88)	(42.64)	(38.46)	(50.79)	(55.47)	(52.83)	(1.92)	(5.56)	(3.65)	(4.53)	(100.00)	(100.00)	(100.00)	(100.00)
Velapur	14	37	24	62	9	28	33	61	3	21	15	36	26	86	72	159
	(53.85)	(43.02)	(33.33)	(38.99)	(34.62)	(32.56)	(45.83)	(38.36)	(11.54)	(24.42)	(20.83)	(22.64)	(100.00)	(100.00)	(100.00)	(100.00)
Total	143	324	262	591	119	430	424	854	44	330	301	651	306	1084	987	2096
	(46.73)	(29.89)	(26.55)	(28.20)	(38.89)	(39.67)	(42.96)	(40.74)	(14.38)	(30.44)	(30.50)	(31.06)	(100.00)	(100.00)	(100.00)	(100.00)

Figures in parentheses denote percentages.

***Table 5.2* : Demographic profile of sample households according to SC/ST population and circles**

Circle	SC		ST		Others		Total	
	No. of Hh	Population	No. of Hh	Population	No. of Hh	Population	No. of Hh	Population
Akluj	13	94	--	--	40	345	53	439
	(24.53)	(21.41)	--	--	(75.47)	(78.59)	(100.00)	(100.00)
Dahigaon	9	45	--	--	39	322	48	367
	(18.75)	(12.26)	--	--	(81.25)	(87.74)	(100.00)	(100.00)
Mahalung	12	57	1	4	38	253	51	314
	(23.53)	(18.15)	(1.96)	(1.27)	(74.51)	(80.57)	(100.00)	(100.00)
Malshiras	3	15	1	5	22	139	26	159
	(11.54)	(9.43)	(3.85)	(3.14)	(84.62)	(87.42)	(100.00)	(100.00)
Natepute	7	40	--	--	43	353	50	393
	(14.00)	(10.18)	--	--	(86.00)	(89.82)	(100.00)	(100.00)
Piliv	1	7	--	--	51	258	52	265
	(1.92)	(2.64)	--	--	(98.08)	(97.36)	(100.00)	(100.00)
Velapur	6	40	1	6	19	113	26	159
	(23.08)	(25.16)	(3.85)	(3.77)	(73.08)	(71.07)	(100.00)	(100.00)
Total	51	298	3	15	252	1,783	306	2,096
	(16.67)	(14.22)	(0.98)	(0.72)	(82.35)	(85.07)	(100.00)	(100.00)

Figures in parentheses denote percentages.

<u>Table 5.3</u> : Demographic profile of sample households according to age and zones

Circle	Age above 60			Age between 16 and 60			Age less than 15			Total		
	Males	**Females**	**Total**	**Males**	**Females**	**Total**	**Males**	**Females**	**Total**	**Males**	**Females**	**Total**
Akluj	25	9	34	125	111	236	84	85	169	234	205	439
	(10.68)	(4.39)	(7.74)	(53.42)	(54.15)	(53.76)	(35.90)	(41.46)	(38.50)	(100.00)	(100.00)	(100.00)
Dahigaon	13	7	20	115.00	107	222	63	62	125	191	176	367
	(6.81)	(3.98)	(5.45)	(60.21)	(60.80)	(60.49)	(32.98)	(35.23)	(34.06)	(100.00)	(100.00)	(100.00)
Mahalung	10	5	15	100	86	186	62	49	113	172	140	314
	(5.81)	(3.57)	(4.78)	(58.14)	(61.43)	(59.24)	(36.05)	(35.00)	(35.99)	(100.00)	(100.00)	(100.00)
Malshiras	6	7	13	48	52	100	22	24	46	76	83	159
	(7.89)	(8.43)	(8.18)	(63.16)	(62.65)	(62.89)	(28.95)	(28.92)	(28.93)	(100.00)	(100.00)	(100.00)
Natepute	16	15	31	109	98	217	74	61	145	199	174	393
	(8.04)	(8.62)	(7.89)	(54.77)	(56.32)	(55.22)	(37.19)	(35.06)	(36.90)	(100.00)	(100.00)	(100.00)
Piliv	10	7	17	77	80	159	39	50	89	126	137	265
	(7.94)	(5.11)	(6.42)	(61.11)	(58.39)	(60.00)	(30.95)	(36.50)	(33.58)	(100.00)	(100.00)	(100.00)
Velapur	8	6	14	54	43	98	24	23	47	86	72	159
	(9.30)	(8.33)	(8.81)	(62.79)	(59.72)	(61.64)	(27.91)	(31.94)	(29.56)	(100.00)	(100.00)	(100.00)
Total	88	56	144	628	577	1218	368	354	734	1084	987	2096
	(8.12)	(5.67)	(6.87)	(57.93)	(58.46)	(58.11)	(33.95)	(35.87)	(35.02)	(100.00)	(100.00)	(100.00)

Figures in parentheses denote percentages.

***Table 5.4* : Demographic profile of sample households according to educational status**

Circle	Illiterate			Neo-literate			Educated up to matriculation			Eleventh and above			Not Applicable			Total		
	M	**F**	**T**	**M**	**F**	**T**	**M**	**F**	**T**	**M**	**F**	**T**	**M**	**F**	**T**	**M**	**F**	**T**
Akluj	39	62	101	3	3	6	130	99	229	33	9	42	29	32	61	234	205	439
	(16.67)	(30.24)	(23.01)	(1.28)	(1.46)	(1.37)	(55.56)	(48.29)	(52.16)	(14.10)	(4.39)	(9.57)	(12.39)	(15.61)	(13.90)	(100)	(100)	(100)
Dahigaon	25	54	79	1	2	3	118	87	205	23	5	28	24	28	52	191	176	367
	(13.09)	(30.68)	(21.53)	(0.52)	(1.14)	(0.82)	(61.78)	(49.43)	(55.86)	(12.04)	(2.84)	(7.63)	(12.57)	(15.91)	(14.17)	(100)	(100)	(100)
Mahalung	25	40	65	3	4	9	93	75	168	25	8	33	26	13	39	172	140	314
	(14.53)	(28.57)	(20.70)	(1.74)	(2.86)	(2.87)	(54.07)	(53.57)	(53.50)	(14.53)	(5.71)	(10.51)	(15.12)	(9.29)	(12.42)	(100)	(100)	(100)
Malshiras	8	22	30	1	0	1	40	38	78	21	12	33	6	11	17	76	83	159
	(10.53)	(26.51)	(18.87)	(1.32)	--	(0.63)	(52.63)	(45.78)	(49.06)	(27.63)	(14.46)	(20.75)	(7.89)	(13.25)	(10.69)	(100)	(100)	(100)
Natepute	39	70	113	2	2	4	118	86	214	19	1	20	21	15	42	199	174	393
	(19.60)	(40.23)	(28.75)	(1.01)	(1.15)	(1.02)	(59.30)	(49.43)	(54.45)	(9.55)	(0.57)	(5.09)	(10.55)	(8.62)	(10.69)	(100)	(100)	(100)
Piliv	33	56	89	3	0	3	68	60	129	12	5	18	10	16	26	126	137	265
	(26.19)	(40.88)	(33.58)	(2.38)	--	(1.13)	(53.97)	(43.80)	(48.68)	(9.52)	(3.65)	(6.79)	(7.94)	(11.68)	(9.81)	(100)	(100)	(100)
Velapur	16	25	41	1	0	1	45	32	78	14	3	17	10	12	22	86	72	159
	(18.60)	(34.72)	(25.79)	(1.16)	--	(0.63)	(52.33)	(44.44)	(49.06)	(16.28)	(4.17)	(10.69)	(11.63)	(16.67)	(13.84)	(100)	(100)	(100)
Total	185	329	518	14	11	27	612	477	1101	147	43	191	126	127	259	1084	987	2096
	(17.07)	(33.33)	(24.71)	(1.29)	(1.11)	(1.29)	(56.46)	(48.33)	(52.53)	(13.56)	(4.36)	(9.11)	(11.62)	(12.87)	(12.36)	(100)	(100)	(100)

Figures in parentheses denote percentages.

***Table 5.5* : Distribution of population according to occupation**

Circle		Akluj		Dahigaon		Mahalung		Malshiras		Natepute		Piliv		Velapur		Total	
Agriculture	M	62	(24.03)	59	(28.37)	47	(26.11)	14	(16.28)	71	(32.13)	46	(30.46)	27	(28.13)	326	(27.17)
	F	28	(11.76)	29	(14.50)	34	(21.12)	12	(12.37)	54	(23.48)	25	(15.34)	12	(13.64)	194	(16.48)
	T	90	(18.15)	88	(21.57)	81	(23.62)	26	(14.21)	125	(27.72)	73	(23.10)	39	(21.08)	522	(21.91)
Agricultural & wage labour	M	45	(17.44)	23	(11.06)	33	(18.33)	14	(16.28)	31	(14.03)	36	(23.84)	15	(15.63)	197	(16.42)
	F	30	(12.61)	16	(8.00)	20	(12.42)	7	(7.22)	28	(12.17)	30	(18.40)	10	(11.36)	141	(11.98)
	T	75	(15.12)	39	(9.56)	55	(16.03)	21	(11.48)	59	(13.08)	66	(20.89)	26	(14.05)	341	(14.32)
Artisanal work	M	5	(1.94)	4	(1.92)	6	(3.33)		--	1	(0.45)	1	(0.66)	3	(3.13)	20	(1.67)
	F	1	(0.42)	0	--	1	(0.62)		--	0	--	1	(0.61)	1	(1.14)	4	(0.34)
	T	6	(1.21)	4	(0.98)	7	(2.04)		--	1	(0.22)	2	(0.63)	4	(2.16)	24	(1.01)
Salaried employment	M	18	(6.98)	8	(3.85)	7	(3.89)	7	(8.14)	8	(3.62)	6	(3.97)	7	(7.29)	61	(5.08)
	F	2	(0.84)	2	(1.00)	0	--	2	(2.06)	1	(0.43)	0	--	0	--	7	(0.59)
	T	20	(4.03)	10	(2.45)	7	(2.04)	9	(4.92)	9	(2.00)	6	(1.90)	7	(3.78)	68	(2.85)
Housework	M	4	(1.55)	7	(3.37)	3	(1.67)	1	(1.16)	1	(0.45)	1	(0.66)	2	(2.08)	19	(1.58)
	F	79	(33.19)	84	(42.00)	51	(31.68)	35	(36.08)	70	(30.43)	41	(25.15)	34	(38.64)	394	(33.47)
	T	83	(16.73)	91	(22.30)	54	(15.74)	36	(19.67)	71	(15.74)	42	(13.29)	36	(19.46)	413	(17.34)
Other work	M	12	(4.65)	19	(9.13)	8	(4.44)	13	(15.12)	11	(4.98)	4	(2.65)	7	(7.29)	74	(6.17)
	F	0	--	1	(0.50)	1	(0.62)	1	(1.03)	0	--	0	--	2	(2.27)	5	(0.42)
	T	12	(2.42)	20	(4.90)	9	(2.62)	14	(7.65)	11	(2.44)	4	(1.27)	9	(4.86)	79	(3.32)
Not Applicable	M	112	(43.41)	88	(42.31)	76	(42.22)	37	(43.02)	98	(44.34)	57	(37.75)	35	(36.46)	503	(41.92)
	F	98	(41.18)	68	(34.00)	54	(33.54)	40	(41.24)	77	(33.48)	66	(40.49)	29	(32.95)	432	(36.70)
	T	210	(42.34)	156	(38.24)	130	(37.90)	77	(42.08)	175	(38.80)	123	(38.92)	64	(34.59)	935	(39.25)
Total	M	258	(100)	208	(100)	180	(100)	86	(100)	221	(100)	151	(100)	96	(100)	1200	(100)
	F	238	(100)	200	(100)	161	(100)	97	(100)	230	(100)	163	(100)	88	(100)	1177	(100)
	T	496	(100)	408	(100)	343	(100)	183	(100)	451	(100)	316	(100)	185	(100)	2382	(100)

Not applicable refers to small children, students, old people and the disabled.
Figures in parentheses denote percentages.

<u>Table 5.6</u> : Distribution of households according to Non-Agricultural Income (NAI)

Circle	No NAI	NAI less than 10 thousand		NAI between 10 and 20 thousand		NAI more than 20 thousand		Total	
	No. of HH	No. of HH	NAI	No. of HH	NAI	No. of HH	NAI	No. of HH	NAI
Akluj	10	2	17,250.00	15	217,360.00	26	1,526,730.00	53	1,761,340.00
	(18.87)	(3.77)	(8,625.00)	(28.30)	(14,490.67)	(49.06)	(58,720.38)	(100.00)	(33,232.83)
Dahigaon	6	8	51,420.00	17	253,810.00	17	1,026,030.00	48	1,331,260.00
	(12.50)	(16.67)	(6,427.50)	(35.42)	(14,930.00)	(35.42)	(60,354.71)	(100.00)	(27,734.58)
Mahalung	18	8	46,400.00	10	141,080.00	15	758,995.00	51	946,475.00
	(35.29)	(15.69)	(5,800.00)	(19.61)	(14,108.00)	(29.41)	(50,599.67)	(100.00)	(18,558.33)
Malshiras	4	6	30,100.00	1	19,500.00	15	774,600.00	26	824,200.00
	(15.38)	(23.08)	(5,016.67)	(3.85)	(19,500.00)	(57.69)	(51,640.00)	(100.00)	(31,700.00)
Natepute	13	11	72,240.00	11	173,680.00	15	768,990.00	50	1,014,910.00
	(26.00)	(22.00)	(6,567.27)	(22.00)	(15,789.09)	(30.00)	(51,266.00)	(100.00)	(20,298.20)
Piliv	8	19	117,250.00	15	226,330.00	10	490,500.00	52	834,080.00
	(15.38)	(36.54)	(6,171.05)	(28.85)	(15,088.67)	(19.23)	(49,050.00)	(100.00)	(16,040.00)
Velapur	2	4	19,440.00	6	97,400.00	14	596,037.50	26	712,877.50
	(7.69)	(15.38)	(4,860.00)	(23.08)	(16,233.33)	(53.85)	(42,574.11)	(100.00)	(27,418.37)
Total	61	58	354,100.00	75	1,129,160.00	112	5,941,882.50	306	7,425,142.50
	(19.93)	(18.95)	(6,105.17)	(24.51)	(15,055.47)	(36.60)	(53,052.52)	(100.00)	(24,265.17)

Figures in parentheses denote percentages and NAI per reporting families.

***Table 5.7* : Distribution of households according to landholding**

Circle	Landless	Less than 0.5 ha		Between 0.5 and 2 ha		Between 2 and 4 ha		More than 4 ha		Total	
	No. of HH	No. of HH	Land (ha)	No. of HH	Land (ha)	No. of HH	Land (ha)	No. of HH	Land (ha)	No. of HH	Land (ha)
Akluj	19	5	2	17	18.43	7	20	5	37.2	53	77.63
	(35.85)	(9.43)	(0.40)	(32.08)	(1.08)	(13.21)	(2.86)	(9.43)	(7.44)	(100.00)	(1.46)
Dahigaon	20	3	0.8	12	15.66	5	13.4	8	72	48	101.86
	(41.67)	(6.25)	(0.27)	(25.00)	(1.31)	(10.42)	(2.68)	(16.67)	(9.00)	(100.00)	(2.12)
Mahalung	22	5	1.8	10	15.24	2	7.8	12	167.6	51	192.44
	(43.14)	(9.80)	(0.36)	(19.61)	(1.52)	(3.92)	(3.90)	(23.53)	(13.97)	(100.00)	(3.77)
Malshiras	14	1	0.4	7	8.4	2	6.2	2	14	26	29
	(53.85)	(3.85)	(0.40)	(26.92)	(1.20)	(7.69)	(3.10)	(7.69)	(7.00)	(100.00)	(1.12)
Natepute	6	6	1.88	19	24.62	6	17	13	102.8	50	146.3
	(12.00)	(12.00)	(0.31)	(38.00)	(1.30)	(12.00)	(2.83)	(26.00)	(7.91)	(100.00)	(2.93)
Piliv	13	1	0.4	17	18.36	13	41.4	8	54.4	52	114.56
	(25.00)	(1.92)	(0.40)	(32.69)	(1.08)	(25.00)	(3.18)	(15.38)	(6.80)	(100.00)	(2.20)
Velapur	9	1	0.3	8	8.93	4	13.3	4	24.4	26	46.93
	(34.62)	(3.85)	(0.30)	(30.77)	(1.12)	(15.38)	(3.33)	(15.38)	(6.10)	(100.00)	(1.81)
Total	103	22	7.58	90	109.64	39	119.1	52	472.4	306	708.72
	(33.66)	(7.19)	(0.34)	(29.41)	(1.22)	(12.75)	(3.05)	(16.99)	(9.08)	(100.00)	(2.32)

Figures in parentheses denote percentage of households and average landholding per household for that circle.

***Table 5.8* : Crop patterns and irrigation status**

All fiures are in ha

Crops		Bajara	Jowar	Wheat	Maize	Other cereals	Tur	Matki	Other pulses	Groun dnut	Other Oil-seeds	Vege-tables & spiceses	Onion	Frutis	Sugar-cane	Cotton	Fodder	Other crops	Total
	Unirrigat.	14.8 (47.60)	5.2 (16.75)	--	3 (9.66)	0.4 (1.28)	1.00 (3.22)	0.70 2.25)	2.2 (7.08)	-	-	0.03 (0.09)	-	-	0.40 (1.28)	0.40 (1.28)	0.90 (2.70)	2 (6.44)	31.03 (100)
Akluj	Irrigated	1.40 (2.09)	14.4 (37.80)	6.55 (14.38)	2.45 (5.4)		0.4 (0.88)	-	0.80 (1.76)	-	-	1.00 (2.21)	0.80 (1.76)	1.6 (3.53)	11.90 (26.3)	-	3.90 (8.62)	-	45.2 (100)
	Total	16.2 (21.25)	19.6 (25.79)	6.55 (8.52)	5.45 (7.14)	0.4 (0.52)	1.4 (1.83)	0.40 (0.52)	3 (3.93)	-	-	1.03 (1.35)	0.80 (1.04)	1.60 (2.09)	12.30 (16.5)	0.40 (0.47)	4.80 (6.21)	2.00 (5.24)	76.23 (100)
	Unirrigat.	12.9 (62)	3.2 (15.38)	-	0.80 (3.84)	-	-	1.8 (8.65)	0.20 (0.96)	0.60 (2.88)	-	-	0.10 (0.4)	-	-	0.6 (2.88)	0.6 (2.88)	-	20.8 (100)
Dahigaon	Irrigated	3.2 (5.10)	8.4 (13.3)	14.4 (22.9)	2.20 (3.5)	-	-	-	2.10 (3.34)	0.50 (0.79)	-	0.50 (0.79)	-	3.2 (5.10)	20.7 (33.0)	-	7.5 (11.96)	-	62.7 (100)
	Total	16.10 (19.28)	11.6 (13.8)	14.4 (17.2)	3 (3.5)	-	-	1.8 (2.15)	2.3 (2.75)	-	-	0.50 (0.59)	0.10 (0.1)	3.2 (3.83)	20.7 (24.7)	0.6 (0.7)	8.10 (9.7)	-	83.5 (100)
	Unirrigat.	14.8 (32.17)	8.3 (18.0)	-	2.2 (4.77)	-	0.6 (1.30)	-	1.2 (2.6)	1.2 (2.6)	0.10 (0.2)	0.10 (0.2)	-	-	0.20 (0.43)	-	3.4 (7.37)	14 (30.3)	46.1 (100)
Mahalung	Irrigated	--	24.8 (21.8)	17.9 (15.79)	3.2 (2.82)	1 (0.88)	-	0.4 (0.35)	0.7 (0.61)	-	-	1.04 (0.9)	0.08 (0.7)	15.6 (13.76)	43.7 (38.5)	-	4.85 (4.27)	0.08 (0.07)	113.35 (100)
	Total	14.8 (9.28)	33.10 (20.7)	17.9 (11.22)	5.4 (3.38)	1 (0.62)	0.6 (0.37)	0.4 (0.25)	1.9 (1.19)	1.2 (0.75)	0.10 (0.06)	1.14 (0.71)	0.08 (0.50)	15.6 (9.78)	43.90 (27.5)	-	8.25 (5.17)	14.08 (8.83)	159.45(100)
	Unirrigat.	6.4 (50.5)	-	-	1.9 (15)	-	-	-	-	2 (15.8)	-	0.15 (1.18)	-	-	-	-	1.40 (11.06)	0.80 (6.32)	12.65 (100)
Malshiras	Irrigated	-	5.6 (32.18)	3.5 (20.1)	0.20 (1.14)	-	-	-	-	-	-	0.10 (0.5)	0.40 (2.2)	0.40 (2.2)	4.6 (26.4)	0.40 (2.2)	2.20 (12.6)	-	17.40 (100)
	Total	6.4 (21.2)	5.6 (18.6)	3.5 (11.6)	2.10 (6.98)	-	-	-	-	2 (6.6)	-	0.25 (0.83)	0.40 (1.33)	0.40 (1.33)	4.6 (15.3)	0.40 (1.33)	3.60 (11.9)	0.80 (2.6)	30.05 (100)

***Table 5.8* : Crop patterns and irrigation status (continued)**

Crops		Bajara	Jowar	Wheat	Maize	Other cereals	Tur	Matki	Other pulses	Groun dnut	Other Oil-seeds	Vege-tables & spiceses	Onion	Frutis	Sugar-cane	Cotton	Fodder	Other crops	Total
Natepute	Unirrigat.	34.3 (55.68)	2 (3.2)	1.2 (1.94)	-	-	-	7.2 (11.6)	6.7 (10.8)	1.5 (2.4)	-	-	6.9 (11.2)	-	-	0.4 (0.64)	1.2 (1.9)	0.20 (0.32)	61.6 (100)
	Irrigated	1.6 (2.3)	39.5 (57.4)	13.05 (18.9)	1.4 (2.03)	-	-	-	0.60 (0.87)	2.6 (3.78)	-	0.51 (0.74)	1.6 (2.32)	0.80 (1.16)	3.2 (4.65)	1.2 (1.74)	2.64 (3.8)	-	68.7 (100)
	Total	35.90 27.55)	41.5 (31.8)	14.25 (10.9)	1.4 (1.07)	-	-	7.2 (5.5)	7.3 (5.6)	-	-	0.51 (0.39)	8.5 (6.5)	0.80 (0.61)	3.2 (2.4)	1.17 (1.2)	3.84 (2.94)	0.20 (0.15)	130.3 (100)
Piliv	Unirrigat.	22.20 (44.75)	5.5 (11.08)	0.20 (0.40)	2.6 (5.24)	-	1.10 (2.2)	14.8 (29.8)	1 (2.9)	0.4 (0.8)	-	-	-	1.2 (2.4)	-	0.40 (0.80)	0.20 (0.40)	-	49.6 (100)
	Irrigated	2.80 (8.2)	17 (49.7)	5.8 (16.9)	5.20 (15.23)	-	-	-	-	1.2 (3.51)	-	0.10 (0.29)	-	-	1 (2.9)	0.60 (1.75)	0.44 (1.28)	-	34.14 (100)
	Total	25 (29.85)	22.5 (26.86)	6 (7.16)	7.8 (9.31)	-	1.10 (1.31)	14.8 (17.67)	1 (1.19)	-	-	0.10 (0.11)	-	1.20 (1.43)	1 (1.19)	1 (1.19)	0.64 (0.76)	-	83.74 (100)
Velapur	Unirrigat.	3 (18.86)	7.20 (42.20)	0.10 (0.62)	1.5 (9.43)	-	-	-	0.60 (3.7)	1.2 (7.5)	-	0.20 (1.25)	-	-	0.40 (2.51)	1.4 (7.54)	0.50 (3.14)	-	15.9 (100)
	Irrigated	.40 (1.32)	1.7 (5.62)	4.02 (1.34)	1.35 (4.47)	0.6 (1.98)	-	-	-	1 (3.31)	-	0.55 (1.82)	0.05 (0.16)	-	15.60 (51.65)	-	4.9 (16.2)	-	30.2 (100)
	Total	3.40 (7.31)	8.9 (19.31)	4.19 (9)	2.85 (6.18)	0.6 (1.30)	-	-	0.60 (1.3)	2.20 (4.7)	-	0.75 (1.62)	0.05 (0.10)	-	16 (34.7)	1.20 (2.5)	5.4 (11.71)	-	46.1 (100)
Total	Unirrigat.	108.4 (45.6)	31.4 (13.2)	1.5 (0.63)	12 (5.04)	0.40 (0.16)	2.7 (1.13)	24.5 (10.3)	11.9 (5)	6.9 (2.9)	0.10 (0.04)	0.48 (0.20)	7 (2.94)	1.20 (0.50)	1 (0.42)	3 (1.26)	8.20 (3.4)	17 (7.15)	237.68 (100)
	Irrigated	9.4 (2.52)	111.40	65.25 (11.5)	16 (4.3)	1.6 (0.43)	0.40 (0.10)	0.40 (0.10)	4.2 (1.12)	5.3 (1.42)	-	3.8 (1.02)	2.93 (0.78)	21.60 (5.31)	100.7 (21.09)	2.20 (0.59)	26.43 (7.11)	0.08 (0.02)	371.69 (100)
	Total	117.80 (19.2)	142.80 (23.30)	66.75 (10.95)	28 (4.59)	2 (0.32)	3.10 (0.5)	24.90 (4.08)	16.1 (2.6)	12.20 (2)	0.10 (0.01)	4.28 (0.70)	9.93 (1.62)	22.80 (3.74)	101.70 (16.68)	5.20 (0.85)	34.63 (5.6)	17.08 (2.8)	609.37 (100)

Figures in parentheses denote percentages of irrigated, unirrigated and total cropped area respectively for each circle.

***Table 5.9* : Annual agricultural biomass production and biomass use from crop area**

All figures are in tons

Crop		Bajri	Jowar	Wheat	Maize	Other cereals	Tur	Matki	Other Pulses	Ground-nut	Other oilseeds	Vege-tables & spices	Onion	Fruits	Sugar-cane	Cotton	Fodder	Other crops	Total
Akluj	Production	28.73	17.65	12.85	15.30	0.50	0.83	1.15	0.72	--	--	41.98	15.00	30.00	1,870.00	1.50	--	1.50	2,037.70
	Fodder	25.62	52.35	--	11.95	0.25	0.23	0.20	0.30	--	--	--	--	--	78.90	--	104.60	0.30	274.70
	Fuel	7.23	4.16	0.10	3.83	0.13	0.88	--	05	--	--	--	--	--	45.50	1.50	--	0.30	63.67
Dahigaon	Production	29.20	9.80	30.26	1.50	--	--	0.10	0.71	1.81	--	1.40	0.75	1.50	2,070.00	0.82	0.05	--	2,147.90
	Fodder	19.80	55.10	0.40	73.00	--	--	--	1.02	0.97	--	--	--	--	65.33	--	243.48	--	459.09
	Fuel	7.30	4.33	--	0.38	--	--	--	--	0.50	--	--	--	--	53.08	1.10	--	--	66.68
Mahalung	Production	20.10	29.20	33.75	19.65	2.50	1.00	0.15	0.40	1.80	0.01	4.48	0.20	75.23	3,976.00	--	--	0.10	4,164.77
	Fodder	25.90	140.72	1.60	12.53	--	0.25	--	0.20	2.05	--	--	--	--	181.65	--	301.35	--	365.9
	Fuel	6.15	8.80	--	3.34	2.50	4.00	--	0.15	--	--	0.05	--	1.68	95.15	--	--	--	121.82
Malshiras	Production	7.68	6.54	6.10	4.20	--	--	--	--	1.88	--	3.02	1.00	1.40	390.00	0.20	--	0.80	422.82
	Fodder	5.44	22.75	--	6.55	--	--	--	--	--	--	--	4.00	--	34.50	--	81.84	--	155.08
	Fuel	1.92	1.64	--	1.02	--	--	--		--	--	--	--	0.80	8.65	0.40	--	--	14.43
Natepute	Production	39.70	30.90	22.65	3.33	--	--	0.55	0.95	9.00	--	3.11	29.20	8.00	234.00	1.75	--	0.10	383.19
	Fodder	45.83	81.47	1.50	6.13	--	--	4.30	5.7	4.18	--	--	0.60	--	8.70	1.00	59.80	--	219.20
	Fuel	9.93	7.81	--	0.83	--	--	--	--	--	--	--	--	--	5.85	3.00	--	--	27.42
Piliv	Production	25.00	18.25	10.25	15.73	--	1.00	1.13	0.09	1.30	--	0.10	--	2.00	100.00	1.60	--	--	176.45
	Fodder	49.20	35.60	0.40	9.05	--	2.00	2.10	--	0.20	--	--	--	--	3.80	0.20	4.50	--	107.05
	Fuel	6.25	4.56	--	3.93	--	1.70	--	--	--	--	--	--	--	2.50	0.78	--	--	19.73
Velapur	Production	3.55	4.73	7.55	8.64	0.40	--	--	0.06	0.95	--	6.85	0.60	--	1,339.50	0.60	1.20	--	1,374.63
	Fodder	5.55	16.80	0.50	20.35	--	--	--	--	1.00	--	--	--	--	54.18	1.00	181.50	--	280.88
	Fuel	0.89	1.18	--	2.00	--	--	--	--	--	--	--	--	--	34.61	0.60	--	2.50	41.78
Total	Production	153.96	117.07	123.41	68.35	3.40	2.83	3.08	2.86	16.74	0.01	60.94	46.75	118.13	9,979.50	6.47	1.25	2.50	10,707.25
	Fodder	177.33	404.79	4.40	139.55	0.25	2.48	6.60	7.22	8.40	--	--	4.60	--	427.05	2.20	977.07	0.30	2,162.23
	Fuel	39.67	32.48	0.10	15.32	2.63	6.58	--	0.2	0.50	--	0.05	--	2.48	245.34	7.38	--	2.80	355.51

***Table 5.10* : Annual utilisation of biomass from non-crop area**

Circle	Fodder (T)	Fuel (T)
Akluj	13.45	25.74
	(0.25)	(0.49)
Dahigaon	4.20	5.50
	(0.09)	(0.11)
Mahalung	32.68	37.95
	(0.64)	(0.74)
Malshiras	5.20	7.20
	(0.20)	(0.28)
Natepute	22.11	39.47
	(0.44)	(0.79)
Piliv	22.08	36.63
	(0.42)	(0.70)
Velapur	1.30	1.80
	(0.05)	(0.07)
Total	101.02	154.29
	(0.33)	(0.50)

Figures in parentheses are average values per household for that circle in tons.

***Table 5.11* : Trees owned by sample households**

Circle	Fodder, timber & fuel yielding trees	Fruit trees	Other trees	Total
Akluj	374	378	246	998
	(7.1)	(7.1)	(4.6)	(18.8)
Dahigaon	452	184	70	706
	(9.4)	(3.8)	(1.5)	(14.7)
Mahalung	560	351	73	984
	(11.0)	(6.9)	(1.4)	(19.3)
Malshiras	330	130	6	466
	(12.7)	(5.0)	(0.2)	(17.9)
Natepute	1,254	76	127	1,457
	(25.1)	(1.5)	(2.5)	(29.1)
Piliv	457	79	111	647
	(8.8)	(1.5)	(2.1)	(12.4)
Velapur	740	89	12	841
	(28.5)	(3.4)	(0.5)	(32.3)
Total	4,167	1,287	645	6,099
	(13.6)	(4.2)	(2.1)	(19.9)

***Table 5.12* : Animals owned by sample households**

Type of animal	Akluj		Dahigaon		Mahalung		Malshiras		Natepute		Piliv		Velapur		Total	
	No. of animals	Animal units	No. of animals	Animal units	No. of animals	Animal units	No. of animals	Animal units	No. of animals	Animal units	No. of animals	Animal units	No. of animals	Animal units	No. of animals	Animal units
Milch Cows (crossbred)	47	117.50	40	100.00	16	40.00	8	20.00	19	47.50	22	55.00	15	37.50	167	417.50
Other Milch Cows	6	6.00	9	9.00	27	27.00	4	4.00	16	16.00	12	12.00	7	7.00	81	81.00
Other Cows	5	3.00	2	1.20	5	3.00	3	1.80	10	6.00	11	6.60	6	3.60	42	25.20
Calves	31	18.60	21	12.60	27	16.20	8	4.80	28	16.80	29	17.40	11	6.60	155	93.00
Bullocks	16	16.00	27	27.00	18	18.00	3	3.00	37	37.00	17	17.00	15	15.00	133	133.00
Milch Buffaloes	33	46.20	17	23.80	40	56.00	10	14.00	18	25.20	17	23.80	20	28.00	155	217.00
Other Female buffaloes	9	7.20	10	8.00	4	3.20	3	2.40	11	8.80	6	4.80	2	1.60	45	36.00
He-buffaloes	17	17.00	6	6.00	12	12.00	9	9.00	4	4.00	11	11.00	4	4.00	63	63.00
Buffalo Calves	9	5.40	7	3.75	13	7.80	1	0.60	7	4.20	6	3.60	9	5.40	52	30.75
Goats	58	8.70	72	10.80	99	14.85	11	1.65	153	22.95	100	15.00	44	6.60	537	80.55
Sheep	47	7.05					1	0.15	62	9.30	150	22.50			260	39.00
Fowl	271	--	171	--	175	--	99	--	242	--	227	--	51	--	1236	--
Total	549	252.65	382	202.15	436	198.05	160	61.40	607	197.75	608	188.70	184	115.30	2926	1,216.00

***Table 5.13* : Annual fodder and feed consumption and dung production for the sample households**

All figures are in tons

Circle	No. of animal units	Green Fodder		Dry Fodder		Animal Feed		Dung	
		gross weight	dry weight	gross weight	dry weight	gross weight	dry weight	gross weight	dry weight
Akluj	252.65	208.69	104.35	125.83	100.66	43.53	39.18	249.08	99.63
		(0.83)	(0.41)	(0.50)	(0.40)	(0.17)	(0.16)	(0.99)	0.39
Dahigaon	202.15	216.86	108.43	56.47	45.17	33.52	30.16	223.27	89.31
		(1.07)	(0.54)	(0.28)	(0.22)	(0.17)	(0.15)	(1.10)	0.44
Mahalung	198.05	144.13	72.06	77.58	62.06	18.28	16.45	264.70	105.88
		(0.73)	(0.36)	(0.39)	(0.31)	(0.09)	(0.08)	(1.34)	0.53
Malshiras	61.40	65.66	32.83	28.19	22.55	8.45	7.61	78.69	31.48
		(1.07)	(0.53)	(0.46)	(0.37)	(0.14)	(0.12)	(1.28)	0.51
Natepute	197.75	146.68	73.34	105.07	84.05	17.35	15.62	221.81	88.72
		(0.74)	(0.37)	(0.53)	(0.43	(0.09)	(0.08)	(1.12)	0.45
Piliv	188.70	120.64	60.32	95.04	76.03	39.75	35.78	167.57	67.03
		(0.64)	(0.32)	(0.50)	(0.40)	(0.21)	(0.19)	(0.89)	0.36
Velapur	115.30	94.61	47.30	33.82	27.06	23.63	21.27	146.22	58.49
		(0.82)	(0.41)	(0.29)	(0.23)	(0.20)	(0.18)	(1.27)	0.51
Total	1,216.00	997.27	498.64	521.99	417.59	184.51	166.05	1351.34	540.54
		(0.82)	(0.41)	(0.43)	(0.34)	(0.15)	(0.14)	(1.11)	0.44

Figures in parentheses are average values per animal unit for that circle.

Table 5.14 ***: Annual use of draught power for the sample households***

All figures are in animal days

Circle	Agricultural operations			Transport			Total		
	Owned	**Rented**	**Total**	**Owned**	**Rented**	**Total**	**Owned**	**Rented**	**Total**
Akluj	590.00	497.00	1,087.00	168.00	137.00	305.00	758.00	634.00	1,392.00
	(6.88)	(5.80)	(12.68)	(1.96)	(1.60)	(3.56)	(8.84)	(7.40)	(16.24)
Dahigaon	1,901.00	531.00	2,432.00	577.00	211.00	788.00	2,478.00	742.00	3,220.00
	(18.66)	(5.21)	(23.87)	(5.66)	(2.07)	(7.73)	(24.32)	(7.28)	(31.60)
Mahalung	946.00	540.00	1,486.00	492.00	118.00	610.00	1,438.00	658.00	2,096.00
	(5.79)	(3.30)	(9.09)	(3.01)	(0.72)	(3.73)	(8.80)	(4.03)	(12.82)
Malshiras	300.00	264.00	564.00	200.00	32.00	232.00	500.00	296.00	796.00
	(9.98)	(8.79)	(18.77)	(6.66)	(1.06)	(7.72)	(16.64)	(9.85)	(26.49)
Natepute	1,751.00	565.00	2,316.00	1,725.00	85.00	1,810.00	3,476.00	650.00	4,126.00
	(12.83)	(4.14)	(16.97)	(12.64)	(0.62)	(13.26)	(25.47)	(4.76)	(30.23)
Piliv	386.00	644.00	1,030.00	59.00	119.00	178.00	445.00	763.00	1,208.00
	(4.45)	(7.42)	(11.87)	(0.68)	(1.37)	(2.05)	(5.13)	(8.80)	(13.93)
Velapur	850.00	304.00	1,154.00	97.00	352.00	449.00	947.00	656.00	1,603.00
	(17.53)	(6.27)	(23.79)	(2.00)	(7.26)	(9.26)	(19.53)	(13.53)	(33.05)
Total	6,724.00	3,345.00	10,069.00	3,318.00	1,054.00	4,372.00	10,042.00	4,399.00	14,441.00
	(10.30)	(5.12)	(15.42)	(5.08)	(1.61)	(6.70)	(15.38)	(6.74)	(22.12)

Figures in parentheses are average values per cropped area for that circle

***Table 5.15* : Annual use of mechanical equipment for the sample households**

All figures are in equipment hours

Circle	Tractors owned	Tractor use									Threshers owned	Thresher use		
		Agricultural operations			Transport			Total						
		Owned	Rented in	Total	Owned	Rented in	Total	Owned	Rented in	Total		Owned	Rented in	Total
Akluj	5	128	211	339	165	37	202	293	248	541	3	19	166	185
		(1.65)	(2.71)	(4.36)	(2.13)	(0.48)	(2.60)	(3.77)	(3.19)	(6.96)		(0.24)	(2.13)	(2.38)
Dahigaon	4	88	121	209	210	23	233	298	144	442	3	18	153	171
		(0.86)	(1.19)	(2.05)	(2.06)	(0.22)	(2.28)	(2.93)	(1.41)	(4.33)		(0.18)	(1.50)	(1.68)
Mahalung	7	357	115	472	360	48	408	717	163	880	1	1	172	173
		(1.86)	(0.60)	(2.45)	(1.87)	(0.25)	(2.12)	(3.73)	(0.85)	(4.57)		(0.01)	(0.89)	(0.90)
Malshiras	3	56	56	112	185	2	187	241	58	299			84	84
		(1.93)	(1.91)	(3.84)	(6.38)	(0.07)	(6.45)	(8.31)	(1.98)	(10.29)		--	(2.88)	(2.88)
Natepute	4	72	85	157	194	25	219	266	110	376	3	52	152	204
		(0.49)	(0.58)	(1.07)	(1.33)	(0.17)	(1.50)	(1.82)	(0.75)	(2.57)		(0.36)	(1.04)	(1.39)
Piliv	0	8	176	184	18	6	24	26	182	208	2	6	485	491
		(0.07)	(1.53)	(1.60)	(0.16)	(0.05)	(0.21)	(0.23)	(1.58)	(1.81)		(0.05)	(4.23)	(4.29)
Velapur	0	--	105	105	--	1	1	--	106	106	2	2	105	107
		--	(2.23)	(2.23)	--	(0.02)	(0.02)	--	(2.25)	(2.25)		(0.04)	(2.24)	(2.28)
Total	23	709	867	1,576	1,132	142	1,274	1,841	1,009	2,850	14	98	1,315	1,413
		(1.00)	(1.22)	(2.22)	(1.60)	(0.20)	(1.80)	(2.60)	(1.42)	(4.02)		(0.14)	(1.86)	(1.99)

Figures in parentheses are average values per cropped area for that circle.

***Table 5.16* : Annual pumping energy for the sample households**

Circle	Electric pumpsets				Diesel pumpsets			
	No. of pumpsets	Capacity (hp)	Annual hours of use (hrs)	Energy use (kWh)	No. of pumpsets	Capacity (hp)	Annual hours of use (hrs)	Energy use (kWh)
Akluj	31	138.5	24,857	91,861.69	--	--	--	--
		(4.47)	(801.84)	(2,963.28)		--	--	--
Dahigaon	28	132.5	19,166	69,549.58	1	3	192	429.70
		(4.73)	(684.50)	(2,483.91)		(3.00)	(192.00)	(429.70)
Mahalung	24	132.0	19,730	88,941.85	1	5	1,920	7,161.60
		(5.50)	(822.08)	(3,705.91)		(5.00)	(1,920.00)	(7,161.60)
Malshiras	8	34.0	10,298	36,510.73	--	--	--	--
		(4.25)	(1,287.25)	(4,563.84)		--	--	--
Natepute	36	160.0	27,362	103,080.79	14	68	2,356	8,644.65
		(4.44)	(760.06)	(2,863.36)		(4.86)	(168.29)	(617.47)
Piliv	19	84.0	6,069	19,676.50	5	25	652	2,431.96
		(4.42)	(319.42)	(1,035.61)		(5.00)	(130.40)	(486.39)
Velapur	17	81.0	13,748	59,653.14	--	--	--	--
		(4.76)	(808.71)	(3,509.01)		--	--	--
Total	163	762.0	121,230	469,274.28	21	101	5,120	18,667.90
		(4.67)	(743.74)	(2,878.98)		(4.81)	(243.81)	(888.95)

Figures in parentheses are per pumpset values for that circle.

<u>Table 5.17a</u> : Daily domestic per household fuel use (except electricity) for the sample households

Circle	Firewood (kg)	Dungcake (kg)	Kerosene (l)	LPG (kg)	Biogas (Nm3)
Akluj	572.30	35.25	10.05	2.18	32
	(10.80)	(0.67)	(0.19)	(0.04)	(0.60)
Dahigaon	447.00	10.63	7.15	2.09	14.4
	(9.31)	(0.22)	(0.15)	(0.04)	(0.30)
Mahalung	370.30	57.20	10.62	0.97	10.8
	(7.26)	(1.12)	(0.21)	(0.02)	(0.21)
Malshiras	189.50	12.50	8.92	2.29	0
	(7.29)	(0.48)	(0.34)	(0.09)	--
Natepute	551.50	10.25	9.60	0.27	0
	(11.03)	(0.21)	(0.19)	(0.01)	--
Piliv	386.00	27.40	10.20	0.00	0
	(7.42)	(0.53)	(0.20)	--	--
Velapur	207.30	22.50	5.38	0.48	6
	(7.97)	(0.87)	(0.21)	(0.02)	(0.23)
Total	2,723.90	175.73	61.92	8.28	63.2
	(8.90)	(0.57)	(0.20)	(0.03)	(0.21)

Figures in parentheses are average values per household for that circle.

<u>Table 5.17b</u> : Daily domestic per capita fuel use (except electricity) for the sample households

Circle	Firewood (kg)	Dungcake (kg)	Kerosene (l)	LPG (kg)	Biogas (Nm3)
Akluj	572.30	35.25	10.05	2.18	32
	(1.30)	(0.08)	(0.02)	(0.00)	(0.07)
Dahigaon	447.00	10.63	7.15	2.09	14.4
	(1.22)	(0.03)	(0.02)	(0.01)	(0.04)
Mahalung	370.30	57.20	10.62	0.97	10.8
	(1.18)	(0.18)	(0.03)	(0.00)	(0.03)
Malshiras	189.50	12.50	8.92	2.29	--
	(1.19)	(0.08)	(0.06)	(0.01)	--
Natepute	551.50	10.25	9.60	0.27	0
	(1.40)	(0.03)	(0.02)	(0.00)	--
Piliv	386.00	27.40	10.20	0.00	0
	(1.46)	(0.10)	(0.04)	--	--
Velapur	207.30	22.50	5.38	0.48	6
	(1.30)	(0.14)	(0.03)	(0.00)	(0.04)
Total	2,723.90	175.73	61.92	8.28	63.2
	(1.30)	(0.08)	(0.03)	(0.00)	(0.03)

Figures in parentheses are average values per capita for that circle.

***Table 5.17c* : Annual domestic per household fuel use (except electricity) for the sample households**

Circle	Firewood (T)	Dungcake (T)	Kerosene (kl)	LPG (T)	Biogas ('000 Nm3)
Akluj	208.89	12.87	3.67	0.79	11.68
	(3.94)	(0.24)	(0.07)	(0.01)	(0.22)
Dahigaon	163.16	3.88	2.61	0.76	5.26
	(3.40)	(0.08)	(0.05)	(0.02)	(0.11)
Mahalung	135.16	20.88	3.88	0.35	3.94
	(2.65)	(0.41)	(0.08)	(0.01)	(0.08)
Malshiras	69.17	4.56	3.25	0.84	0.00
	(2.66)	(0.18)	(0.13)	(0.03)	--
Natepute	201.30	3.74	3.50	0.10	0.00
	(4.03)	(0.07)	(0.07)	(0.00)	--
Piliv	140.89	10.00	3.72	0.00	0.00
	(2.71)	(0.19)	(0.07)	--	--
Velapur	75.66	8.21	1.96	0.18	2.19
	(2.91)	(0.32)	(0.08)	(0.01)	(0.08)
Total	994.22	64.14	22.60	3.02	23.07
	(3.25)	(0.21)	(0.07)	(0.01)	(0.08)

Figures in parentheses are average values per household for that circle.

<u>Table 5.17d</u> : Annual domestic per capita fuel use (except electricity) for the sample households

Circle	Firewood (T)	Dungcake (T)	Kerosene (kl)	LPG (T)	Biogas ('000 Nm3)
Akluj	208.89	12.87	3.67	0.79	11.68
	(0.48)	(0.03)	(0.01)	(0.00)	(0.03)
Dahigaon	163.16	3.88	2.61	0.76	5.26
	(0.44)	(0.01)	(0.01)	(0.00)	(0.01)
Mahalung	135.16	20.88	3.88	0.35	3.94
	(0.43)	(0.07)	(0.01)	(0.00)	(0.01)
Malshiras	69.17	4.56	3.25	0.84	0.00
	(0.44)	(0.03)	(0.02)	(0.01)	--
Natepute	201.30	3.74	3.50	0.10	0.00
	(0.51)	(0.01)	(0.01)	(0.00)	--
Piliv	140.89	10.00	3.72	0.00	0.00
	(0.53)	(0.04)	(0.01)	--	--
Velapur	75.66	8.21	1.96	0.18	2.19
	(0.48)	(0.05)	(0.01)	(0.00)	(0.01)
Total	994.22	64.14	22.60	3.02	23.07
	(0.47)	(0.03)	(0.01)	(0.00)	(0.01)

Figures in parentheses are average values per capita for that circle.

<u>Table 5.18</u> : Annual fuel value of domestic fuel used (except electricity) for the sample households

All figures are in '000 kcal/year

Circle	Firewood	Dungcake	Kerosene	LPG	Biogas	Total
Akluj	835,558.00	32,165.63	29,346.00	9,526.50	54,896.00	961,492.13
	(1,903.32)	(73.27)	(66.85)	(21.70)	(125.05)	(2,190.19)
Dahigaon	652,620.00	9,695.31	20,878.00	9,163.59	24,703.20	717,060.10
	(1,778.26)	(26.42)	(56.89)	(24.97)	(67.31)	(1,953.84)
Mahalung	540,638.00	52,195.00	31,013.32	4,234.00	18,527.40	646,607.72
	(1,721.78)	(166.23)	(98.77)	(13.48)	(59.00)	(2,059.26)
Malshiras	276,670.00	11,406.25	26,036.67	10,020.47	--	324,133.38
	(1,740.06)	(71.74)	(163.75)	(63.02)	--	(2,038.57)
Natepute	805,190.00	9,353.13	28,032.00	1,199.63	--	843,774.76
	(2,048.83)	(23.80)	(71.33)	(3.05)	--	(2,147.01)
Piliv	563,560.00	25,002.50	29,784.00	--	--	618,346.50
	(2,126.64)	(94.35)	(112.39)	--	--	(2,333.38)
Velapur	302,658.00	20,531.25	15,719.33	2,117.00	10,293.00	351,318.58
	(1,903.51)	(129.13)	(98.86)	(13.31)	(64.74)	(2,209.55)
Total	3,976,894.00	160,349.06	180,809.32	36,261.19	108,419.60	4,462,733.17
	(1,897.37)	(76.50)	(86.26)	(17.30)	(51.73)	(2,129.17)

Figures in parentheses are average values per capita for that circle.

<u>Table 5.19</u> : Annual delivered heat of domestic fuel used (except electricity) for the sample households

All figures are in '000 kcal/year

Circle	Firewood	Dungcake	Kerosene	LPG	Biogas	Total
Akluj	83,555.80	3,216.56	13,205.70	6,192.23	32,937.60	139,107.89
	(190.33)	(7.33)	(30.08)	(14.11)	(75.03)	(316.87)
Dahigaon	65,262.00	969.53	9,395.10	5,956.33	14,821.92	96,404.88
	(177.83)	(2.64)	(25.60)	(16.23)	(40.39)	(262.68)
Mahalung	54,063.80	5,219.50	13,955.99	2,752.10	11,116.44	87,107.83
	(172.18)	(16.62)	(44.45)	(8.76)	(35.40)	(277.41)
Malshiras	27,667.00	1,140.63	11,716.50	6,513.30	0.00	47,037.43
	(174.01)	(7.17)	(73.69)	(40.96)	--	(295.83)
Natepute	80,519.00	935.31	12,614.40	779.76	0.00	94,848.47
	(204.88)	(2.38)	(32.10)	(1.98)	--	(241.34)
Piliv	56,356.00	2,500.25	13,402.80	0.00	0.00	72,259.05
	(212.66)	(9.43)	(50.58)	--	--	(272.68)
Velapur	30,265.80	2,053.13	7,073.70	1,376.05	6,175.80	46,944.48
	(190.35)	(12.91)	(44.49)	(8.65)	(38.84)	(295.25)
Total	397,689.40	16,034.91	81,364.19	23,569.77	65,051.76	583,710.03
	(189.74)	(7.65)	(38.82)	(11.25)	(31.04)	(278.49)

Figures in parentheses are average values per capita for that circle.

***Table 5.20* : Estimated annual green fodder balance for the sample households**

All figures are in tons

Circle	Animal units	Green Fodder consumption	From fodder production	From cane tops	From purchases	Estimated shortfall, if any, collected from commons and forests
Akluj	252.65	208.69	104.60	78.90	5.55	91.64
		(0.83)	(0.41)	(0.31)	(0.02)	(0.08)
Dahigaon	202.15	216.86	243.48	65.33	25.16	No shortfall
		(1.07)	(1.20)	(0.32)	(0.12)	--
Mahalung	198.05	144.13	301.35	181.65	22.40	No shortfall
		(0.73)	(1.52)	(0.92)	(0.11)	--
Malshiras	61.40	65.66	81.84	34.50	5.40	No shortfall
		(1.07)	(1.33)	(0.56)	(0.09)	--
Natepute	197.75	146.68	59.80	8.70	18.10	60.08
		(0.74)	(0.30)	(0.04)	(0.09)	(0.33)
Piliv	188.70	120.64	4.50	3.80	34.02	78.32
		(0.64)	(0.02)	(0.02)	(0.18)	(0.42)
Velapur	115.30	94.61	181.50	54.18	5.30	No shortfall
		(0.82)	(1.57)	(0.47)	(0.05)	--
Total	1,216.00	997.27	977.07	427.05	115.93	No shortfall
		(0.82)	(0.80)	(0.35)	(0.10)	--

Figures in parentheses denote green fodder use per animal unit for that circle.

<u>Table 5.21</u> : Estimated annual dry fodder balance for the sample households

All figures are in tons

Circle	Animal units	Dry fodder consumption	From fodder residues	From non-crop land	From purchases	Estimated shortfall, if any collected from commons and forests
Akluj	252.65	125.83	195.80	13.45	39.15	No shortfall
		(0.50)	(0.77)	(0.05)	(0.15)	
Dahigaon	202.15	56.47	393.77	4.20	15.40	No shortfall
		(0.28)	(1.95)	(0.02)	(0.08)	
Mahalung	198.05	77.58	485.60	32.68	13.65	No shortfall
		(0.39)	(2.45)	(0.16)	(0.07)	
Malshiras	61.40	28.19	120.58	5.20	19.40	No shortfall
		(0.46)	(1.96)	(0.08)	(0.32)	
Natepute	197.75	105.07	210.50	22.11	31.60	No shortfall
		(0.53)	(1.06)	(0.11)	(0.16)	
Piliv	188.70	95.04	103.25	22.08	58.00	No shortfall
		(0.50)	(0.55)	(0.12)	(0.31)	
Velapur	115.30	33.83	226.70	1.30	13.20	No shortfall
		(0.29)	(1.97)	(0.01)	(0.11)	
Total	1,216.00	521.99	1,736.18	101.02	190.40	No shortfall
		(0.43)	(1.43)	(0.08)	(0.16)	

Figures in parentheses denote dry fodder use per animal unit for that circle.

<u>Table 5.22</u> : Estimated annual free grazing component

All values in tons

Circles	Akluj	Dahigaon	Mahalung	Malshiras	Natepute	Piliv	Velapur	Total
Animal units	252.65	202.15	198.05	61.40	197.75	188.70	115.30	1,216.00
Dung produced	249.08	223.27	264.70	78.69	221.81	167.57	146.22	1351.34
	(0.99)	(1.10)	(1.34)	(1.28)	(1.12)	(0.89)	(1.27)	(1.11)
Dung (dry weight)	99.63	89.31	105.88	31.48	88.72	67.03	58.49	540.54
	(0.39)	(0.44)	(0.53)	(0.51)	(0.45)	(0.36)	(0.51)	(0.44)
Estimated fodder consumption (dry weight)	249.08	223.27	264.70	78.69	221.81	167.57	146.22	1351.34
	(0.99)	(1.10)	(1.34)	(1.28)	(1.12)	(0.89)	(1.27)	(1.11)
Green fodder consumption (gross weight)	208.69	216.86	144.13	65.66	146.68	120.64	94.61	997.27
	(0.83)	(1.07)	(0.73)	(1.07)	(0.74)	(0.64)	(0.82)	(0.82)
Green fodder consumption (dry weight)	104.35	108.43	72.06	32.83	73.74	60.32	47.30	498.64
	(0.41)	(0.54)	(0.36)	(0.53)	(0.37)	(0.32)	(0.41)	(0.41)
Dry fodder consumption (gross weight)	125.83	56.47	77.58	28.19	105.07	95.04	33.82	521.99
	(0.50)	(0.28)	(0.39)	(0.46)	(0.53)	(0.50)	(0.29)	(0.43)
Dry fodder consumption (dry weight)	100.66	45.17	62.06	22.55	84.05	76.03	27.06	417.59
	(0.40)	(0.22)	(0.31)	(0.37)	(0.43)	(0.40)	(0.23)	(0.34)
Feed and concentrates consumption (gross weight)	43.53	33.52	18.28	8.45	17.35	39.75	23.63	184.51
	(0.17)	(0.17)	(0.09)	(0.14)	(0.09)	(0.21)	(0.20)	(0.15)
Feed and concentrates consumption (dry weight)	39.18	30.16	16.45	7.61	15.62	35.78	21.27	166.05
	(0.16)	(0.15)	(0.08)	(0.12)	(0.08)	(0.19)	(0.18)	(0.14)
Estimated free grazing component (dry weight)	4.89	39.50	114.12	15.71	48.80None	-	50.59	269.06
	(0.02)	(0.20)	(0.58)	(0.26)	(0.25)	-	(0.44)	(0.22)

Figures in parantheses denote values per animal unit for that circle.

***Table 5.23* : Estimated annual dung use for the sample households**

All values in tons

Circle	Animal units	Dung production		Dung used for Dungcake (dry weight)	Dung used for biogas (dry weight)	Estimated dung use for manure (dry weight)
		gross weight	dry weight			
Akluj	253	249.08	99.63	12.87	23.36	63.40
		(0.99)	(0.41)	(0.05)	(0.09)	(0.25)
Dahigaon	202	223.27	89.31	3.88	10.51	74.92
		(1.10)	(0.44)	(0.02)	(0.05)	(0.37)
Mahalung	198	264.70	105.88	20.88	4.42	80.59
		(1.34)	(0.53)	(0.11)	(0.02)	(0.41)
Malshiras	61	78.69	31.48	4.56	--	26.92
		(1.28)	(0.51)	(0.07)	--	(0.44)
Natepute	198	221.81	88.72	3.74	--	84.98
		(1.12)	(0.45)	(0.02)	--	(0.53)
Piliv	189	167.57	67.03	10.00	--	57.03
		(0.89)	(0.36)	(0.05)	--	(0.30)
Velapur	115	146.22	58.49	8.21	4.38	45.90
		(1.27)	(0.51)	(0.07)	(0.04)	(0.40)
Total	1,216	1351.34	540.54	64.14	42.67	433.73
		(1.11)	(0.44)	(0.05)	(0.04)	(0.36)

Figures in parantheses denote per animal unit values for that circle.

***Table 5.24* : Estimated annual firewood balance for the sample population**

All figures in tons

Circle	Population	Annual wood fuel consumption (T)	Annual firewood purchase (T)	Annual firewood from non-crop land	Annual fuel from crop stalks and residue(T)	Estimated fuel extraction from commons and forests (T)	Estimated fuel extraction from commons and forests (T dry)
Akluj	439.00	208.89	2.50	25.74	127.35	53.30	42.64
		(0.48)	(0.01)	(0.06)	(0.29)	(0.12)	(0.10)
Dahigaon	367.00	163.16	5.76	5.50	133.35	18.55	14.84
		(0.44)	(0.02)	(0.01)	(0.36)	(0.05)	(0.04)
Mahalung	314.00	135.16	11.66	37.95	243.64	None	None
		(0.43)	(0.04)	(0.12)	(0.78)	--	--
Malshiras	159.00	69.17	36.70	7.20	28.85	None	None
		(0.44)	(0.23)	(0.05)	(0.18)	--	--
Natepute	393.00	201.30	29.40	39.47	54.84	77.59	62.07
		(0.51)	(0.07)	(0.10)	(0.14)	(0.20)	(0.16)
Piliv	265.00	140.89	22.16	36.63	39.45	42.65	34.12
		(0.53)	(0.08)	(0.14)	(0.15)	(0.16)	(0.13)
Velapur	159.00	75.66	10.52	1.80	83.55	None	None
		(0.48)	(0.07)	(0.01)	(0.53)	--	--
Total	2,096.00	994.22	118.70	154.29	711.02	10.21	8.17
		(0.47)	(0.06)	(0.07)	(0.34)	(0.00)	(0.00)

Figures in parantheses denote per capita values for that circle.

***Table 5.25* : Households reporting no electricity by circles for the sample households**

	Akluj	Dahigaon	Mahalung	Malshiras	Natepute	Piliv	Velapur	Total
Households reporting no electricity	21	6	15	3	19	33	7	104
Total No. of households	53	48	51	26	50	52	26	306
% households reporting no electricity	40	13	29	12	38	63	27	34

***Table 5.26* : Domestic electricity use by type of equipment and circles for the sample households**

Equipment type	Akluj		Dahigaon		Mahalung		Malshiras		Natepute		Piliv		Velapur		Total	
	Total Wattage (W)	Annual Electricity use (kWh)	Total Wattage (W)	Annual Electricity use (kWh)	Total Wattage (W)	Annual Electricity use (kWh)	Total Wattage (W)	Annual Electricity use (kWh)	Total Wattage (W)	Annual Electricity use (kWh)	Total Wattage (W)	Annual Electricity use (kWh)	Total Wattage (W)	Annual Electricity use (kWh)	Total Wattage (W)	Annual Electricity use (kWh)
Electric bulbs	6,062.00	15,493.89	6,965.00	15,129.62	5,950.00	20,820.33	3,485.00	10,367.83	5,095.00	10,571.13	2,220.00	5,697.65	2,970.00	8,663.82	32,747.00	86,744.26
	(23.83)	(48.55)	(18.15)	(46.65)	(21.46)	(58.64)	(19.22)	(48.68)	(19.06)	(57.04)	(30.96)	(75.11)	(14.92)	(42.61)	(20.03)	(51.75)
Tubelights	480.00	744.60	680.00	1,080.40	440.00	525.60	900.00	1,379.70	520.00	350.40	200.00	438.00	530.00	781.10	3,750.00	5,299.80
	(1.89)	(2.33)	(1.77)	(3.33)	(1.59)	(1.48)	(4.96)	(6.48)	(1.95)	(1.89)	(2.79)	(5.77)	(2.66)	(3.84)	(2.29)	(3.16)
Energy saving lamps	--	--	--	--	--	--	10.00	7.30	10.00	7.30	--	--	--	--	20.00	14.60
	--	--	--	--	--	--	(0.06)	(0.03)	(0.04)	(0.04)	--	--	--	--	(0.01)	(0.01)
Electric irons	6,750.00	1,450.33	9,000.00	542.30	6,980.00	905.20	7,548.00	1,035.11	9,750.00	889.69	3,750.00	974.55	7,500.00	1,004.66	51,278.00	6,801.84
	(26.53)	(4.54)	(23.45)	(1.67)	(25.18)	(2.55)	(41.63)	(4.86)	(36.48)	(4.80)	(52.30)	(12.85)	(37.69)	(4.94)	(31.37)	(4.06)
Radios etc.	350.00	118.63	730.00	378.87	700.00	340.55	500.00	331.06	700.00	424.31	200.00	109.50	600.00	401.50	3,780.00	2,104.41
	(1.38)	(0.37)	(1.90)	(1.17)	(2.53)	(0.96)	(2.76)	(1.55)	(2.62)	(2.29)	(2.79)	(1.44)	(3.02)	(1.97)	(2.31)	(1.26)
TV, VCRs etc.	2,100.00	2,628.00	3,450.00	3,066.00	3,000.00	2,425.43	1,890.00	1,854.20	2,550.00	2,370.68	300.00	191.63	1,550.00	1,679.00	14,840.00	14,214.93
	(8.25)	(8.23)	(8.99)	(9.45)	(10.82)	(6.83)	(10.42)	(8.71)	(9.54)	(12.79)	(4.18)	(2.53)	(7.79)	(8.26)	(9.08)	(8.48)
Refrigerators	400.00	2,847.00	400.00	1,752.00	400.00	1,022.00	200.00	1,752.00	200.00	219.00	--	--	200.00	1,022.00	1,800.00	8,614.00
	(1.57)	(8.92)	(1.04)	(5.40)	(1.44)	(2.88)	(1.10)	(8.23)	(0.75)	(1.18)	--	--	(1.01)	(5.03)	(1.10)	(5.14)
Geysers	4,000.00	2,920.00	10,000.00	4,015.00	6,000.00	2,920.00	2,000.00	2,190.00	4,000.00	1,460.00	--	--	2,000.00	1,460.00	28,000.00	14,965.00
	(15.72)	(9.15)	(26.06)	(12.38)	(21.65)	(8.22)	(11.03)	(10.28)	(14.97)	(7.88)	--	--	(10.05)	(7.18)	(17.13)	(8.93)
Electric stoves	2,000.00	1,460.00	3,000.00	1,460.00	1,000.00	730.00	--	--	2,000.00	730.00	--	--	3,000.00	959.95	11,000.00	5,339.95
	(7.86)	(4.57)	(7.82)	(4.50)	(3.61)	(2.06)	--	--	(7.48)	(3.94)	--	--	(15.08)	(4.72)	(6.73)	(3.19)
Fans	2,700.00	4,161.00	3,750.00	4,982.25	3,000.00	5,803.50	1,200.00	2,381.63	1,500.00	1,500.15	300.00	164.25	1,350.00	4,352.63	13,800.00	23,345.40
	(10.61)	(13.04)	(9.77)	(15.36)	(10.82)	(16.34)	(6.62)	(11.18)	(5.61)	(8.09)	(4.18)	(2.17)	(6.78)	(21.40)	(8.44)	(13.93)
Mixers	600.00	91.25	400.00	28.47	200.00	5.11	400.00	--	400.00	11.68	200.00	10.22	200.00	10.22	2,400.00	156.95
	(2.36)	(0.29)	(1.04)	(0.09)	(0.72)	(0.01)	(2.21)	--	(1.50)	(0.06)	(2.79)	(0.13)	(1.01)	(0.05)	(1.47)	(0.09)
Total	25,442.00	31,914.69	38,375.00	32,434.90	27,720.00	35,506.84	18,133.00	21,298.82	26,725.00	18,534.34	7,170.00	7,585.80	19,900.00	20,334.88	163,465.00	167,610.26
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Figures in parentheses are percentage of wattage and annual electricity use for each item for each circle.

***Table 5.27* : Number of pressure cookers, biogas plants and improved chulhas in the sample households**

Name of villages	No. of HH	Pressure cookers	Biogas plants	Improved chulhas
Tambewadi	26	11	4	4
Kalamboli	22	4	5	1
Dahigaon	***48***	***15***	***9***	***5***
Karunde	25	6	0	0
Pimpari	25	4	0	1
Natepute	***50***	***10***	***0***	***1***
Malshiras	26	9	3	1
Malshiras	***26***	***9***	***3***	***1***
Kusmod	27	0	0	2
Salmukhwadi	25	2	0	0
Piliv	***52***	***2***	***0***	***2***
Tondale	26	8	2	0
Velapur	***26***	***8***	***2***	***0***
Chakore	27	6	6	0
Bijwadi	26	7	2	0
Akluj	***53***	***13***	***8***	***0***
Khandali	26	11	4	1
Mire	25	2	0	0
Mahalung	***51***	***13***	***4***	***1***
Total	306	70	26	10

***Table 5.28* : Status of biogas plants in sample households**

Circle	No. of plants	No. of plants in use	No. reporting capacity	Combined capacity (Nm3)	No. of plants not in use	Expected cost of bringing into use (Rs.)	Cost household ready to bear (Rs.)
Akluj	8	6	6	36.00	2	6,000	2,500
Dahigaon	9	4	4	26.00	5	16,000	4,700
Mahalung	4	3	1	6.00	1	3,000	1,500
Malshiras	3	--	3	49.00	3	6,000	2,500
Natepute	--	--	--	--	--	--	--
Piliv	--	--	--	--	--	--	--
Velapur	2	2	2	8.50	--	--	--
Total	26	15	16	125.50	11	31,000	11,200

***Table 5.29* : Status of improved chulhas in sample households**

Circle	No. of chulhas	No. reporting inadequate information	No. in use
Akluj	--	--	--
Dahigaon	5	2	1
Mahalung	--	--	--
Malshiras	2	--	1
Natepute	1	--	--
Piliv	2	--	2
Velapur	--	--	--
Total	10	2	4

***Table 5.30* : User response to improved chulhas**

Response	Change in Smoke	Change in Fuel use	Change in cooking time
Large increase	1	1	1
Small increase	--	1	1
No change	--	1	--
Small decrease	2	1	--
Large decease	1	--	2
No response	--	--	--
Chulhas in use	4	4	4

***Table 5.31* : Energy saving devices used in the sample households**

		Akluj	**Dahigaon**	**Mahalung**	**Malshiras**	**Natepute**	**Piliv**	**Velapur**	**Total**
Improved lantern	No.	--	--	--	2	1	--	--	3
	No. in use	--	--	--	2	1	--	--	3
Pressure cooker	No.	--	--	1	--	--	--	--	1
	No. in use	--	--	1	--	--	--	--	1
Solar cooker	No.	--	--	--	--	--	--	--	--
	No. in use	--	--	--	--	--	--	--	--
Energy saving lamp	No.	--	--	--	--	1	--	--	1
	No. in use	--	--	--	--	1	--	--	1
Wick stove	No.	--	--	1	--	--	--	--	1
	No. in use	--	--	1	--	--	--	--	1

Solar batteries	No.	--	--	--	--	--	--	--	--
	No. in use	--	--	--	--	--	--	--	--
Total devices	No.	--	--	2	2	2	--	--	6
	No. in use	--	--	2	2	2	--	--	6

***Table 5.32* : Use pattern of different energy saving devices in the sample households**

	No. of devices	No. in use	In constant use	In use occasionally	Rarely in use	Used when power fails	use unspecified
Improved Lantern	3	3	1	--	--	2	--
Pressure Cooker	1	1	1	--	--	--	--
Solar Cooker	--	--	--	--	--		--
Energy Saving Lamp	1	1	1	--	--	--	--
Wick Stove	--	--	--	--	--	--	--
Solar Batteries	--	--	--	--	--	--	--

***Table 5.33* : Reported number of establishments in the village and sample units by type of establishment**

Establishment type	Akluj		Dahigaon		Mahalung		Malshiras		Natepute		Piliv		Velapur		Total	
	No. of units reported	No. of units in sample	No. of units reported	No. of units in sample	No. of units reported	No. of units in sample	No. of units reported	No. of units in sample	No. of units reported	No. of units in sample	No. of units reported	No. of units in sample	No. of units reported	No. of units in sample	No. of units reported	No. of units in sample
Artisanal establishments	7	2	8	1	15	2	65	2	4	1	2	0	6	0	107	8
Brick kilns	2	0	1	1	0	0	6	1	1	1	0	0	0	0	10	3
Flour and masala mills	8	2	6	3	17	4	35	2	11	3	4	2	2	1	83	17
Food products	0	0	1	1	6	3	71	2	1	0	0	0	0	0	79	6
Poultry and goatery	0	0	1	0	2	0	4	1	0	0	0	0	0	0	7	1
Shops and small establishments	32	2	26	3	52	7	276	11	27	1	21	1	14	2	448	27
Small industrial establishments	0	0	1	0	2	2	23	3	1	0	0	0	1	1	28	6
Total	49	6	44	9	94	18	480	22	45	6	27	3	23	4	762	68

***Table 5.34* : Employment pattern in sample establishments by type of establishment**

Establishment type	No. of units	Permanent				Temporary				Total			
		HH members		Others		HH members		Others		HH members		Others	
		No. of persons	Person-days	No. of persons	Person-days	No. of persons	Person-days	No. of persons	Person-days	No. of persons	Person-days	No. of persons	Person-days
Artisanal establishments	8	21	6,450	4	1,200	8	1,920	--	--	29	8,370	4	1,200
Brick kilns	3	1	300	--	--	7	1,260	25	3,750	8	1,560	25	3,750
Flour and masala mills	17	22	6,400	3	850	--	--	--	--	22	6,400	3	850
Food products	6	10	2,695	10	2,365	3	1,095	--	--	13	3,790	10	2,365
Poultry and goatery	1	1	365	1	365	--	--	--	--	1	365	1	365
Shops & small establishments	27	31	9,931	82	17,596	--	--	42	9,015	31	9,931	124	26,611
Small industrial establishments	6	5	1,500	5	1,400	5	525	--	--	10	2,025	5	1,400
Total	68	91	27,641	105	23,776	23	4,800	67	12,765	114	32,441	172	36,541

<u>Table 5.35</u> : Annual fuel use in sample establishments by type of fuel and type of establishment

Establishment type	Annual coal use (T)	Annual diesel use (kl)	Annual firewood use (T)	Annual firewood purchase (T)	Annual crop residue use (T)	Annual crop residue purchase (T)	Annual dungcake use (T)	Annual dungcake purchase (T)	Annual LPG use (kg)	Annual kerosene use (kl)		
										Total	lighting	Heating
Artisanal establishments	0.05	--	161.28	1.20	--	--	0.40	0.30	--	0.01	0.01	0.01
Brick kilns	1.63	--	10.50	10.00	15.00	15.00	--	--	--	0.08	0.06	0.02
Flour and masala mills	--	6.66	--	--	--	--	--	--	--	0.48	0.06	2.58
Food products	--	--	35.20	31.04	--	--	--	--	--	1.65	0.01	1.64
Poultry and goatery	--	--	--	--	--	--	--	--	--	2.70	--	--
Shops and small establishments	--	15.25	--	--	--	--	--	--	1,363.00	0.76	0.22	0.06
Small industrial establishments	0.00	--	--	--	--	--	115.40	10.95	--	0.22	0.02	0.19
Total	1.69	21.91	206.98	42.24	15.00	15.00	115.80	11.25	1,363.00	5.90	0.39	4.49

Table 5.36 ***: Fuel value of annual fuel use in sample establishments by type of fuel and type of establishment***

All values in '000 kcal

Establishment type	Annual coal use (T)	Annual diesel use (kl)	Annual firewood use (T)	Annual firewood purchase (T)	Annual crop residue use (T)	Annual crop residue purchase (T)	Annual dungcake use (T)	Annual dungcake purchase (T)	Annual LPG use (kg)	Annual kerosene use (kl)			Total
										Total	lighting	heating	
Artisanal establishments	358.40	--	645,120.00	4,800.00	--	--	1,000.00	750.00	--	96.00	40.00	40.00	646,574.40
Brick kilns	11,410.00	--	42,000.00	40,000.00	37,500.00	37,500.00	--	--	--	600.00	480.00	120.00	91,510.00
Flour and masala mills	--	53,280.00	--	--	--	--	--	--	--	3,840.00	480.00	20,640.00	57,120.00
Food products	--	--	140,800.00	124,176.00	--	--	--	--	--	13,200.00	112.00	13,088.00	154,000.00
Poultry and goatery	--	--	--	--	--	--	--	--	--	21,600.00	--	--	21,600.00
Shops and small establishments	--	122,016.00	--	--	--	--	--	--	16,356.00	6,096.00	1,776.00	480.00	144,468.00
Small industrial establishments	27.02	--	--	--	--	--	288,500.00	27,375.00	--	1,728.00	192.00	1,536.00	290,255.02
Total	11,795.42	175,296.00	827,920.00	168,976.00	37,500.00	37,500.00	289,500.00	28,125.00	16,356.00	47,160.00	3,080.00	35,904.00	1,405,527.42

***Table 5.37* : Annual electricity use in sample establishments by type of establishment and type of equipment**

All values in kWh

Type of equipment	Artisanal establishments	Brick kilns	Flour and masala mills	Food products	Poultry and goatery	Shops & small establishments	Small industrial establishments	Total
Bulbs	192.84	720.00	2,570.55	1,001.90	788.40	6,082.68	307.20	11,663.57
	(19.22)	(26.33)	(4.23)	(36.01)	(100.00)	(15.57)	(3.86)	(10.14)
Tubelights	3.60		90.00	132.23	--	6,757.20	36.00	7,019.03
	(0.36)	--	(0.15)	(4.75)	--	(17.29)	(0.45)	(6.10)
Motors	--	2,014.20	58,038.80	272.29	--	17,456.40	783.30	78,564.99
	--	(73.67)	(95.62)	(9.79)	--	(44.67)	(9.85)	(68.29)
TV, etc.	--	--	--	53.98	--	705.00	--	758.98
	--	--	--	(1.94)	--	(1.80)	--	(0.66)
Refrigerator	--	--	--	252.50	--	--	--	252.50
	--	--	--	(9.08)	--	--	--	(0.22)
Fan	--	--	--	808.20	--	6,120.00	--	6,928.20
	--	--	--	(29.05)	--	(15.66)	--	(6.02)
Tape recorder	90.00	--	--	261.00	--	15.00	--	366.00
	(8.97)	--	--	(9.38)	--	(0.04)	--	(0.32)
Other	716.85	--	--	--	--	1,942.80	6,825.90	9,485.55
	(71.45)	--	--	--	--	(4.97)	(85.83)	(8.25)
Total	1,003.29	2,734.20	60,699.35	2,782.10	788.40	39,079.08	7,952.40	115,038.82
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

***Table 5.38* : Table of parameters and conversion factors**

Wattage	
Unspecified filament lamp	60 W
Unspecified tubelight	40 W
CFL	9 W
Electric iron	750 W
Radio, etc.	50 W
TV, VCR, etc.	150 W
Fridge	200 W
Geyser	1000 W
Fan	150 W
Mixer	200 W
Fuel Values	
Firewood	4000 kcal/kg
Dungcake	2500 kcal/kg
Kerosene	8000 kcal/kg
Coal	7000 kcal/kg
LPG	12000 kcal/kg
Diesel	8000 kcal/kg
Biogas	4700 kcal/Nm^3
Efficiencies	
Traditional chulha	10%
Improved chulha	25%
Biogas stove	60%
Kerosene stove	45%
Improved kerosene stove	65%
LPG stove	65%
Moisture content	
Firewood	20%
Dungcake	10%
Green fodder	50%
Fresh dung	60%
Dry fodder	80%

Chapter 6
Energy Consumption Scenario for Malshiras Block

In this chapter a scenario is developed for the purposes of estimation of the energy needs of Malshiras block for the next 10 years. This scenario, which we shall call the BAU scenario (short for `business as usual'), is based on present trends which are expected to continue so far as there are no significant interventions aimed at affecting these trends. This scenario serves as the reference point for developing an IREP plan, which will aim at modifying some of the BAU trends in order to arrive at a more sustainable pattern of energy use. How energy saving options will modify this scenario is developed and detailed in the next chapter.

6.1 Population projections

Population projections are based on the average trend for the last three decennial trends. This shows a decennial increase of 19.35%. Based on these trends, the population projections are as follows:

Year	Population
2010	527,228
2005	473,465
2000	425,184
1991	350,346

The projections show that the total population and the total number of households would be about 473,465 and 84,776 respectively in 2005. These figures are expected to rise to 527,228 and 94,402 respectively by the year 2010. Annual projections are given in Table 6.1.

6.2 Domestic fuel use

Domestic fuel use has been estimated on the basis of the survey findings presented in Chapter 5. For the purposes of the BAU scenario, it has been assumed that the consumption levels and the fuel composition are constant.

Domestic fuel use projections for firewood, dungcake, kerosene, LPG and biogas have been presented in Tables 6.2, 6.3 and 6.4. Besides fuel use, the calorific value of fuel use and estimated useful heat delivered are also important. These projections have been estimated in terms of actual fuel use, fuel value and delivered useful heat in the three tables, respectively.

Table 6.2 shows that in the year 2005 Malshiras block would require 224,580 T of firewood, 14,490 T of dungcake, 5,110 kl kerosene, 680 T LPG, and 5,210 MNm3 to meet its domestic fuel needs. The projections for the year 2010 indicate that the requirements would increase to 250,090 T (firewood), 16,130 T (dungcake), 5,690 kl (kerosene), 760 T (LPG), and 5,800 MNm3 (biogas).

6.3 Domestic and commercial electricity supply needs

Estimation of domestic electric supply needs at the block level is compounded by many factors. Firstly, MSEB categorisation of domestic electricity is not coterminous with household consumption. It often includes small establishments and offices. Secondly, though Malshiras block has been technically classified as fully rural, there are distinct semi-urban sectors in the block. For example, even though the Taluka headquarters of Malshiras and some of the villages like Akluj have been technically classed as rural, both of them have a strong urbanised sector. However, this factor has to a certain extent, been taken care of because Malshiras village has been included in the sample itself. Thirdly, these `semi-urban' sectors include industrial establishments, which cannot be treated on a sampling basis in the same way. Fourthly, an allowance has to be made for the transmission and distribution losses, which in the rural areas can be very high. Lastly, there is the problem of unauthorised drawal of electricity, which can also be significant.

For an estimation of these factors, we have preferred to lump together the industrial, commercial and domestic sectors as reported by MSEB in order to compare it with the survey data. The aggregation of the data on an assumption of 20% T&D losses leads us to an estimate of 4.6% of the total consumption being accounted for by the semi-urban sector. (Table 6.7). The reason for this low figure for the semi-urban sector is that, as mentioned earlier, Malshiras -- the most urbanised village and the Taluka headquarter -- has been included in the sample.

For purposes of the BAU, therefore, it is assumed that the ratio of electricity supply and the present domestic and small rural establishment electricity use is constant. Consumption is assumed to grow in proportion to the population increase along with a projected per household increase of 20% over the decade, leading to a pro-rata increase in electric supply needs.

The projections for domestic and small rural establishment electricity supply are presented in Tables 6.5, 6.6 and 6.7. Table 6.5 shows that the projected annual domestic electricity use for all the domestic electric equipment and gadgets together would be 25,722,537 kWh and 31,377,183 kWh for years 2005 and 2010 respectively.

According to Table 6.6 the projected annual electricity use by small rural establishments for the block would be 17,195,898 kWh and 19,148,541 kWh for the years 2005 and 2010 respectively.

The projected annual electricity supply need for rural household consumption, small rural establishment consumption and the consumption needs of the semi-urban sector together comes to 58,253,975 kWh and 71,060,085 kWh for the years 2005 and 2010 respectively. (Table 6.7).

6.4 Agriculture

Projections for the agriculture sector need to be based on projection of present trends in agriculture. The main determinant for the BAU scenario for agriculture in Malshiras block is assumed to be the extent of irrigation and the extent of fallow land being brought under cropped land. The trend indicates that irrigation is getting extended (and would continue to increase because of the further utilisation of water from the Krishna basin (Bhima is part of Krishna basin) because of the Krishna Water Tribunal Award and the specially set-up Krishna Valley Development Corporation as it is keen to utilise the share of Maharashtra as quickly as possible. The other important emerging trend is that people are bringing in more and more fallow (both current and permanent) under cultivation. Thus the increase in cropped land is going to be at the expense of the fallow lands and also to some extent the commons. We have assumed that in the next 10 years nearly half of the present fallow lands would be brought under cultivation. Thus the net cropped area would get increased by 50% of the present fallow land. The projected irrigated area would thus constitute of the present irrigated area, plus an equivalent area (50% of the present fallow) that would be brought under cultivation and another 20% of this to take care of the trend so far.

Projections for irrigated and unirrigated area are presented in Table 6.8. According to this table the gross cropped area would be about 134,264 ha and 138,941 ha in the years 2005 and 2010 respectively. The projected gross irrigated area for these years would be 59,064 ha and 63,244 ha respectively. The projections for unirigated area come to 75,199 ha and 75697 ha for the years 2005 and 2010 respectively.

6.5 Animal power and equipment use in agriculture

Animal power and equipment use is assumed to be proportional to gross cropped area. Estimates for the year 2000 are estimated on the basis of reported data. These are then extrapolated for later years according to projected gross cropped area.

Projections for animal power and equipment use are presented in Tables 6.9 and 6.10. Table 6.9 gives the projected annual draught power use in agricultural operations and transport for the next ten years. The table also gives the break-up between owned and rented animals supplying draught power. The table indicates that the total draught power required for both agricultural operations and transport together would be 2,969,902 and 3,073,360 bullocks-days for the years 2005 and 2010 respectively.

The projected annual tractor use for both agricultural operations and transport would be 2,426,864 and 2,511,404 equipment hours for the years 2005 and 2010 respectively. The projected thresher use would be 270,440 and 279,861 equipment hours respectively (Table 6.10).

6.6 Pumping energy

We have taken the data of 1998-99 as the basis for estimating the pumping energy requirements for 2000 to 2010. This is mainly because the statistics reported in the socio-economic abstracts for more recent years for the block in respect of number of electrical pumpsets seem to be inconsistent. The inconsistencies are of the order of 2 or 3 times specially in the case of number electrical motors for the recent years. The data for 1998-99 give both the total irrigated area and the number of pumpsets and the area irrigated by wells. So we have taken the proportionate share of irrigation by wells in the total irrigated area to estimate the number of irrigation pumpsets. In 1998-99 the total number of pumpsets were 3,075 and the irrigated areas was 36,262 ha. In the year 2000 the estimated irrigation area is 53,798 and on the basis of this the estimated number of pumpsets is 4,562. Thus, the estimates for the year 2000 are thus worked out on the basis of a capacity equivalent to 4,562 pumpsets. On this assumption, the estimated pumping energy consumed by electrical pumpsets for the year 2000 works out to 2,878.98 x 4562 = 13,133,906 kWh.

Later projections are related to the increase in irrigated area and all increase in pumping energy consumption is assumed to come from electrical pumpsets and is assumed to be proportional to increase in gross irrigated area. These projections are presented in Table 6.11. According to this table the projected electricity consumption by agricultural pumpsets would 14,419,471 kWh and 15,439,824 kWh for the years 2005 and 2010 respectively.

6.7 Pressure on the forests, commons and wastelands

The largest utilised renewable energy resource in the area is biomass and we need to assess the different components of the biomass balance and determine what their implications are. As in the earlier chapter, balances are worked out to determine the pressure on forests, commons and wasteland.

This needs estimates of production for the fodder and fuel components from different sources as well as an estimate of the livestock and other animal population and their requirements. For the purposes of the BAU scenario, the projected irrigated area assessments are combined with the district and survey productivity figures to arrive at estimates of fodder and fuel availability. Growth of livestock in terms of animal units is assumed to keep pace with the growth of gross irrigated area and fodder needs as well as dung availability are calculated on those counts.

Projected livestock fodder needs and dung availability are presented in Table 6.12, and the biomass fuel and green and dry fodder balances and the estimated free grazing components are presented in Tables 6.13, 6.14, 6.15 and 6.16 respectively.

According to Table 6.12 the projected number of animal units for the years 2005 and 2010 would be 230,638 and 238,672 respectively. The projected green fodder, dry fodder, feed and concentrates requirement would be 189,152 T, 99,006 T and 34,995 T for the year 2005 and 195,741 T, 102,455 T and 36,214 T for the year 2010 respectively. The projected dung production for these years would be 256,308 T and 265,236 T respectively.

Table 6.13 shows that the projected annual firewood collection from non-crop land, commons and forest would be 100,480 T and 116,980 T for the years 2005 and 2010 respectively. According to Table 6.14 there would not be any shortfall. The same is the case with dry fodder (Table 6.15).

The projected estimate for the free grazing component is given in Table 6.16. As per this table the projected free grazing component would be to the tune of 51,030 T and 52,810 T respectively for the years 2005 and 2010.

6.8 Annual increment and accumulated stock

Table 6.17 shows that the pressure on the commons is of the order of 4.35 T/ha at the moment, and is likely to increase to about 5.5 T/ha in the next ten years according to the BAU scenario. Of this projected 5.5 T/ha extraction rate, about 3.78 T/ha constitutes the firewood component and 1.72 T/ha constitutes the fodder component of extraction. The fodder component comes almost solely out of the annual biomass increment, and though it does affect subsequent growth potential, it does not cut into accumulated stock. The firewood component however need not come from the annual increment. In view of the fact that unmanaged stands would rarely show productivities greater than 12 kg/ha-mm of water use and that in degraded conditions actual water use is likely to be of the order of 200 to 250 mm, we have an annual estimated increment of 2.5 to 3 T/ha. This indicates that we are cutting into accumulated biomass stock at the rate of about 2.5 T/ha, certainly a situation that calls for urgent rectification measures.

6.9 Total domestic and rural establishment energy consumption

The total energy consumption by rural households and small rural establishments is summarised in Table 6.18. The table makes it quite clear that firewood (inclusive of brushwood and small shrubs) forms the major component of the aggregated energy equivalent of their fuel use. Dungcake comes next followed by biogas. Fossil fuels are as yet not a major component of the total fuel value used by rural establishments. This is a double edged situation, even while the high extraction rates of biomass derived materials from the ecosystem present an immediate danger to the integrity of the ecosystem, at the same time it presents an opportunity of modifying, optimising and restructuring biomass use to fulfil livelihood needs for the rural population.

6.10 Solar energy

Solar energy, as elsewhere in most of India is the most abundant source of renewable energy. However it is marred by the same variability which has proved to be the bane of solar energy development, especially for the domestic sector.

Solar energy has not been monitored anywhere in Malshiras block. The closest figures available are for the Pune region. The available data are summarised in Tables 6.19, 6.20 and 6.21. The data incidentally, are from a study that compares theoretically calculated and observed values and show that even though the agreement between them is quite close for global radiation, it is variable in case of diffuse radiation, showing a variation of up to 25% in some months.

Except for July and August, values for global radiation are above 5kWh/sq.m. /day, which shows that there is good potential for solar energy. The mean daily hours of sunshine however are not very well distributed and are consistently low for the four monsoon months.

Harnessing of solar energy would however require a different approach towards renewable sources, which is described in the next chapter.

6.11 Wind energy

Wind energy is not being monitored at any site in Malshiras as part of the study of wind energy sites being taken up all over Maharashtra. So there is no data available to assess the potential for wind energy in the block. Even if any future study indicates wind energy potential or partial potential for the block (on any site in the block) we would advocate a hybridisation approach in harnessing that potential. For this, see Datye (1997) and Paranjape and Joy (1995).

6.12 Hydro power

Malshiras block being situated in the drought-prone region, the annual rainfall is only about 500 mm. Analysis of the rainfall series data shows that there would not be significant dependable flows within the block. The terrain of the block is also relatively flat. Thus, Malshiras block will not have a significant hydro potential.

***Table 6.1* : Projected population and households for Malshiras block (2000 to 2010)**

Year	Population	Households
1991	350,346	62,731
2000	**425,184**	**76,131**
2001	434,429	77,786
2002	443,875	79,478
2003	453,527	81,206
2004	463,389	82,972
2005	**473,465**	**84,776**
2006	483,760	86,619
2007	494,279	88,503
2008	505,026	90,427
2009	516,008	92,393
2010	**527,228**	**94,402**

<u>Table 6.2</u> : Projected annual domestic fuel use for Malshiras block (2000 To 2010)

Year	Firewood ('000 T)	Dungcake ('000 T)	Kerosene ('000 kl)	LPG ('000 T)	Biogas ('000 MNm3)
2000	**201.68**	**13.01**	**4.58**	**0.61**	**4.68**
2001	206.07	13.29	4.68	0.63	4.78
2002	210.55	13.58	4.79	0.64	4.89
2003	215.13	13.88	4.89	0.65	4.99
2004	219.81	14.18	5.00	0.67	5.10
2005	**224.58**	**14.49**	**5.11**	**0.68**	**5.21**
2006	229.47	14.80	5.22	0.70	5.32
2007	234.46	15.13	5.33	0.71	5.44
2008	239.56	15.45	5.45	0.73	5.56
2009	244.76	15.79	5.56	0.74	5.68
2010	**250.09**	**16.13**	**5.69**	**0.76**	**5.80**

<u>Table 6.3</u> : Fuel value of projected annual domestic fuel use for Malshiras block (2000 to 2010)

All values in '000 Mkcal

Year	Firewood	Dungcake	Kerosene	LPG	Biogas	Total
2000	**806.73**	**32.53**	**36.68**	**7.36**	**21.99**	**905.29**
2001	824.27	33.23	37.48	7.52	22.47	924.97
2002	842.20	33.96	38.29	7.68	22.96	945.08
2003	860.51	34.70	39.12	7.85	23.46	965.63
2004	879.22	35.45	39.97	8.02	23.97	986.63
2005	**898.34**	**36.22**	**40.84**	**8.19**	**24.49**	**1,008.09**
2006	917.87	37.01	41.73	8.37	25.02	1,030.01
2007	937.83	37.81	42.64	8.55	25.57	1,052.40
2008	958.22	38.64	43.57	8.74	26.12	1,075.29
2009	979.06	39.48	44.51	8.93	26.69	1,098.67
2010	**1,000.35**	**40.33**	**45.48**	**9.12**	**27.27**	**1,122.56**

Table 6.4 ***: Delivered useful heat of projected annual domestic fuel use for Malshiras block (2000 To 2010)***

All values in'000 Mkcal

Year	Firewood	Dungcake	Kerosene	LPG	Biogas	Total
2000	**80.67**	**3.25**	**16.51**	**4.78**	**13.20**	**118.41**
2001	82.43	3.32	16.86	4.89	13.48	120.98
2002	84.22	3.40	17.23	4.99	13.78	123.61
2003	86.05	3.47	17.61	5.10	14.08	126.30
2004	87.92	3.55	17.99	5.21	14.38	129.05
2005	**89.83**	**3.62**	**18.38**	**5.32**	**14.69**	**131.85**
2006	91.79	3.70	18.78	5.44	15.01	134.72
2007	93.78	3.78	19.19	5.56	15.34	137.65
2008	95.82	3.86	19.60	5.68	15.67	140.64
2009	97.91	3.95	20.03	5.80	16.01	143.70
2010	**100.03**	**4.03**	**20.47**	**5.93**	**16.36**	**146.83**

***Table 6.5* : Projected annual domestic electricity use by households for Malshiras block (2000 to 2010)**

All values in kWh

Year	Electric bulbs	Tubelights	Energy saving lamps	Electric irons	Radios etc.	TV, tape recorders, VCRs etc.	Refrigerators	Geysers	Electric stoves	Fans	Mixers	Total
2000	**12,194,702**	**919,602**	**2,962**	**489,113**	**426,889**	**2,883,567**	**1,140,247**	**888,504**	**935,151**	**1,649,514**	**31,838**	**21,086,943**
2001	12,689,112	956,885	3,082	508,944	444,197	3,000,475	1,186,476	924,527	973,065	1,716,390	33,129	21,941,871
2002	13,203,567	995,680	3,207	529,578	462,206	3,122,123	1,234,579	962,010	1,012,516	1,785,978	34,472	22,831,461
2003	13,738,879	1,036,048	3,337	551,048	480,945	3,248,703	1,284,633	1,001,013	1,053,566	1,858,387	35,870	23,757,117
2004	14,295,894	1,078,053	3,472	573,389	500,444	3,380,416	1,336,716	1,041,597	1,096,281	1,933,732	37,324	24,720,301
2005	**14,875,493**	**1,121,760**	**3,613**	**596,636**	**520,733**	**3,517,468**	**1,390,910**	**1,083,826**	**1,140,727**	**2,012,131**	**38,837**	**25,722,537**
2006	15,478,590	1,167,240	3,759	620,826	541,845	3,660,077	1,447,302	1,127,768	1,186,976	2,093,709	40,412	26,765,405
2007	16,106,138	1,214,563	3,912	645,996	563,813	3,808,467	1,505,980	1,173,491	1,235,099	2,178,594	42,050	27,850,555
2008	16,759,129	1,263,805	4,070	672,187	586,672	3,962,874	1,567,037	1,221,068	1,285,174	2,266,921	43,755	28,979,700
2009	17,438,595	1,315,044	4,235	699,439	610,458	4,123,540	1,630,569	1,270,574	1,337,279	2,358,828	45,529	30,154,624
2010	**18,145,608**	**1,368,359**	**4,407**	**727,796**	**635,207**	**4,290,721**	**1,696,678**	**1,322,086**	**1,391,496**	**2,454,462**	**47,375**	**31,377,183**

***Table 6.6* : Projected annual electricity use by small rural establishments for Malshiras block (2000 to 2010)**

All values in kWh

Year	Electric bulbs	Tubelights	Motors	TVs, tape recorders, etc.	Refrigerators	Fans	Other	Total
2000	**2,182,200**	**1,188,487**	**12,057,566**	**77,618**	**53,548**	**53,548**	**2,011,606**	**15,442,372**
2001	2,229,650	1,214,329	12,319,748	79,306	54,712	54,712	2,055,346	15,778,153
2002	2,278,132	1,240,734	12,587,630	81,030	55,902	55,902	2,100,038	16,121,236
2003	2,327,668	1,267,713	12,861,338	82,792	57,117	57,117	2,145,702	16,471,779
2004	2,378,281	1,295,278	13,140,997	84,592	58,359	58,359	2,192,358	16,829,944
2005	**2,429,995**	**1,323,443**	**13,426,737**	**86,432**	**59,628**	**59,628**	**2,240,029**	**17,195,898**
2006	2,482,833	1,352,220	13,718,690	88,311	60,925	60,925	2,288,737	17,569,808
2007	2,536,820	1,381,623	14,016,992	90,231	62,250	62,250	2,338,504	17,951,849
2008	2,591,981	1,411,665	14,321,780	92,193	63,603	63,603	2,389,353	18,342,197
2009	2,648,341	1,442,361	14,633,195	94,198	64,986	64,986	2,441,307	18,741,033
2010	**2,705,927**	**1,473,724**	**14,951,382**	**96,246**	**66,399**	**66,399**	**2,494,391**	**19,148,541**

***Table 6.7* : Projected annual electricity supply need for domestic and non-agricultural sector for Malshiras block (2000 to 2010)**

All values in kWh

Year	Rural household consumption	Small rural establishment consumption	Semi-urban sector	Estimated supply need
2000	**21,086,943**	**15,442,372**	**1,675,261**	**47,755,721**
2001	21,941,871	15,778,153	2,033,480	49,691,881
2002	22,831,461	16,121,236	2,412,534	51,706,539
2003	23,757,117	16,471,779	2,813,406	53,802,877
2004	24,720,301	16,829,944	3,237,120	55,984,207
2005	**25,722,537**	**17,195,898**	**3,684,746**	**58,253,975**
2006	26,765,405	17,569,808	4,157,399	60,615,766
2007	27,850,555	17,951,849	4,656,245	63,073,311
2008	28,979,700	18,342,197	5,182,496	65,630,492
2009	30,154,624	18,741,033	5,737,422	68,291,349
2010	**31,377,183**	**19,148,541**	**6,322,344**	**71,060,085**

***Table 6.8* : Projected gross irrigated area for Malshiras block (2000 To 2010)**

All values in hectares

Year	Gross Irrigated area	Unirrigated area	Gross Cropped area	Double Cropped area	Net cropped area
2000	**53,798.59**	**74,572.26**	**128,370.85**	**15,371.03**	**112,999.83**
2001	54,951.28	74,709.49	129,660.76	15,700.37	113,960.40
2002	56,051.91	74,840.51	130,892.42	16,014.83	114,877.59
2003	57,102.84	74,965.62	132,068.46	16,315.10	115,753.37
2004	58,106.31	75,085.08	133,191.40	16,601.80	116,589.59
2005	**59,064.47**	**75,199.15**	**134,263.62**	**16,875.56**	**117,388.06**
2006	59,979.36	75,308.07	135,287.42	17,136.96	118,150.46
2007	60,852.93	75,412.06	136,264.99	17,386.55	118,878.44
2008	61,687.05	75,511.36	137,198.42	17,624.87	119,573.55
2009	62,483.51	75,606.18	138,089.69	17,852.43	120,237.26
2010	**63,244.00**	**75,696.71**	**138,940.71**	**18,069.71**	**120,871.00**

***Table 6.9* : Projected annual draught power for Malshiras block (2000 To 2010)**

All values in bullock days

Year	Agricultural operations		Transport		Total	
	Owned	Rented	Owned	Rented	Owned	Rented
2000	**1,322,150**	**657,732**	**652,423**	**207,250**	**1,974,573**	**864,982**
2001	1,335,435	664,341	658,979	209,332	1,994,414	873,673
2002	1,348,121	670,652	665,239	211,321	2,013,359	881,973
2003	1,360,233	676,678	671,216	213,219	2,031,449	889,897
2004	1,371,799	682,431	676,923	215,032	2,048,722	897,463
2005	**1,382,842**	**687,925**	**682,372**	**216,763**	**2,065,214**	**904,688**
2006	1,393,387	693,171	687,576	218,416	2,080,962	911,587
2007	1,403,455	698,179	692,544	219,994	2,095,999	918,174
2008	1,413,069	702,962	697,288	221,501	2,110,357	924,463
2009	1,422,249	707,529	701,818	222,940	2,124,066	930,469
2010	**1,431,014**	**711,889**	**706,143**	**224,314**	**2,137,157**	**936,203**

<u>Table 6.10</u> : Projected annual mechanical agricultural equipment use for Malshiras block (2000 To 2010)

All values in equipment hours

Year	Tractor							Thresher	
	Agricultural operations		Transport		Total		Total use		
	owned	rented in	owned	rented in	owned	rented in		owned	rented in
2,000	**1,217,935**	**251,688**	**545,062**	**27,823**	**1,782,268**	**538,082**	**2,320,350**	**19,270**	**258,570**
2,001	1,230,173	254,217	550,539	28,103	1,800,176	543,489	2,343,665	19,464	261,169
2,002	1,241,859	256,632	555,769	28,370	1,817,276	548,651	2,365,928	19,648	263,649
2,003	1,253,017	258,938	560,762	28,625	1,833,604	553,581	2,387,185	19,825	266,018
2,004	1,263,671	261,140	565,530	28,868	1,849,195	558,288	2,407,483	19,994	268,280
2,005	**1,273,844**	**263,242**	**570,083**	**29,101**	**1,864,081**	**562,782**	**2,426,864**	**20,154**	**270,440**
2,006	1,283,557	265,249	574,430	29,322	1,878,295	567,074	2,445,369	20,308	272,502
2,007	1,292,832	267,166	578,581	29,534	1,891,868	571,171	2,463,039	20,455	274,471
2,008	1,301,688	268,996	582,544	29,737	1,904,827	575,084	2,479,911	20,595	276,351
2,009	1,310,144	270,743	586,329	29,930	1,917,201	578,820	2,496,021	20,729	278,147
2,010	**1,318,218**	**272,412**	**589,942**	**30,114**	**1,929,017**	**582,387**	**2,511,404**	**20,857**	**279,861**

***Table 6.11* : Projected annual electricity consumption by agricultural pumpsets for Malshiras block (2000 To 2010)**

All values in kWh

Year	Elecricity consumption by agricultural pumpsets
2000	**13,133,907**
2001	13,415,313
2002	13,684,012
2003	13,940,577
2004	14,185,555
2005	**14,419,471**
2006	14,642,824
2007	14,856,090
2008	15,059,726
2009	15,254,165
2010	**15,439,824**

***Table 6.12* : Projected livestock population, annual fodder and feed needs and dung availability for Malshiras block (2000 To 2010)**

Year	Animal units (#)	Green fodder (T)	Dry fodder (T)	Feed and concentrates (T)	Dung (T)
2000	**220,515**	**180,850**	**94,660**	**33,459**	**245,058**
2001	222,731	182,667	95,612	33,795	247,521
2002	224,847	184,403	96,520	34,116	249,872
2003	226,867	186,059	97,387	34,423	252,117
2004	228,796	187,641	98,215	34,715	254,261
2005	**230,638**	**189,152**	**99,006**	**34,995**	**256,308**
2006	232,397	190,594	99,761	35,262	258,262
2007	234,076	191,971	100,481	35,517	260,128
2008	235,679	193,286	101,170	35,760	261,910
2009	237,210	194,542	101,827	35,992	263,612
2010	**238,672**	**195,741**	**102,455**	**36,214**	**265,236**

Table 6.13* : *Projected domestic firewood balance for Malshiras block (2000 To 2010)

All values in '000 T

Year	Annual firewood consumption	Annual Firewood purchase	Annual firewood from crop residue	Annual firewood from non-crop land	Estimated annual firewood collection from commons and forests	Estimated annual firewood collection from commons and forests (dry wt.)
2000	**201.68**	**24.08**	**59.12**	**10.74**	**107.74**	**86.19**
2001	206.07	24.60	60.11	10.26	111.10	88.88
2002	210.55	25.14	61.06	9.79	114.56	91.65
2003	215.13	25.68	61.96	9.35	118.13	94.51
2004	219.81	26.24	62.82	8.93	121.81	97.45
2005	**224.58**	**26.81**	**63.64**	**8.53**	**125.60**	**100.48**
2006	229.47	27.40	64.43	8.14	129.50	103.60
2007	234.46	27.99	65.18	7.78	133.51	106.81
2008	239.56	28.60	65.90	7.43	137.63	110.11
2009	244.76	29.22	66.58	7.09	141.87	113.50
2010	**250.09**	**29.86**	**67.23**	**6.77**	**146.23**	**116.98**

Table 6.14* : *Projected green fodder balance for Malshiras block (2000 To 2010)

All values in '000 T

Year	Green fodder requirement	From fodder production and cane tops	Annual purchase	Estimated shortfall collected from commons and forests	Estimated shortfall collected from commons and forests (dry weight
2000	**180.85**	**285.71**	**21.02**	**None**	**None**
2001	182.67	291.61	21.23	None	None
2002	184.40	297.24	21.44	None	None
2003	186.06	302.62	21.63	None	None
2004	187.64	307.75	21.81	None	None
2005	**189.15**	**312.65**	**21.99**	**None**	**None**
2006	190.59	317.33	22.16	None	None
2007	191.97	321.80	22.32	None	None
2008	193.29	326.07	22.47	None	None
2009	194.54	330.14	22.61	None	None
2010	**195.74**	**334.04**	**22.75**	**None**	**None**

Table 6.15 ***: Projected dry fodder balance for Malshiras block (2000 To 2010)***

All values in '000 T

Year	Dry fodder requirement	From crop residues	From non crop area	From purchase	Estimated shortfall collected from commons	Estimated shortfall collected from commons (dry biomass)
2000	**94.66**	**162.13**	**7.03**	**35.28**	**None**	**None**
2001	95.61	162.83	6.71	35.64	None	None
2002	96.52	163.50	6.41	35.98	None	None
2003	97.39	164.14	6.12	36.30	None	None
2004	98.22	164.75	5.84	36.61	None	None
2005	**99.01**	**165.33**	**5.58**	**36.90**	**None**	**None**
2006	99.76	165.89	5.33	37.18	None	None
2007	100.48	166.42	5.09	37.45	None	None
2008	101.17	166.92	4.86	37.71	None	None
2009	101.83	167.41	4.64	37.95	None	None
2010	**102.45**	**167.87**	**4.43**	**38.19**	**None**	**None**

***Table 6.16* : Projected estimate for free grazing component in Malshiras block (2000 to 2010)**

Animal units in #, all other values in '000 T

Year	Animal units	Dung (gross wt.)	Dung (dry wt.)	Estimated fodder cons. (dry wt.)	Green fodder cons. (gross wt.)	Green fodder cons. (dry wt.)	Dry fodder cons. (gross wt.)	Dry fodder cons. (dry wt.)	Feed and concentrates (gross wt.)	Feed and concentrates (dry wt.)	Estimated free grazing component (dry wt.)
2000	**220.52**	**245.06**	**98.02**	**245.06**	**180.85**	**90.43**	**94.66**	**75.73**	**33.46**	**30.11**	**48.79**
2001	222.73	247.52	99.01	247.52	182.67	91.33	95.61	76.49	33.80	30.42	49.28
2002	224.85	249.87	99.95	249.87	184.40	92.20	96.52	77.22	34.12	30.70	49.75
2003	226.87	252.12	100.85	252.12	186.06	93.03	97.39	77.91	34.42	30.98	50.20
2004	228.80	254.26	101.70	254.26	187.64	93.82	98.22	78.57	34.72	31.24	50.62
2005	**230.64**	**256.31**	**102.52**	**256.31**	**189.15**	**94.58**	**99.01**	**79.20**	**34.99**	**31.50**	**51.03**
2006	232.40	258.26	103.30	258.26	190.59	95.30	99.76	79.81	35.26	31.74	51.42
2007	234.08	260.13	104.05	260.13	191.97	95.99	100.48	80.39	35.52	31.96	51.79
2008	235.68	261.91	104.76	261.91	193.29	96.64	101.17	80.94	35.76	32.18	52.15
2009	237.21	263.61	105.44	263.61	194.54	97.27	101.83	81.46	35.99	32.39	52.49
2010	**238.67**	**265.24**	**106.09**	**265.24**	**195.74**	**97.87**	**102.45**	**81.96**	**36.21**	**32.59**	**52.81**

***Table 6.17* : Projected estimate of pressure on the forest, commons and wastelands for Malshiras block (2000 to 2010)**

Year	Firewood dry wt ('000T)	Free grazing dry wt ('000T)	Total extraction dry wt ('000T)	Estimated area of commons (ha)	Extraction rate dry wt (T/ha)
2000	**86.19**	**48.79**	**134.98**	**31,000**	**4.35**
2001	88.88	49.28	138.16	31,001	4.46
2002	91.65	49.75	141.40	31,002	4.56
2003	94.51	50.20	144.70	31,003	4.67
2004	97.45	50.62	148.07	31,004	4.78
2005	**100.48**	**51.03**	**151.51**	**31,005**	**4.89**
2006	103.60	51.42	155.02	31,006	5.00
2007	106.81	51.79	158.60	31,007	5.11
2008	110.11	52.15	162.25	31,008	5.23
2009	113.50	52.49	165.98	31,009	5.35
2010	**116.98**	**52.81**	**169.79**	**31,010**	**5.48**

***Table 6.18* : Summary for various kinds of energy use for Malshiras block (2000)**

Kinds of energy use	Units	Total Annual Consumption	Energy equivalent		Percentage
			'000 Mkcal	'000 GJ	
Firewood	'000 T	201.68	806.73	3,372.14	84.77
Dungcake	'000 T	13.01	32.53	135.97	3.42
Kerosene	'000 kl	4.58	3.67	15.33	0.39
LPG	'000 T	0.61	7.36	30.75	0.77
Biogas	MNm3	4.68	21.99	91.93	2.31
Diesel	'000 kl	2.03	16.24	67.88	1.71
Electricity	MU	51.34	44.14	184.53	4.64
Bullocks	'000 days	3,070.00	11.86	49.57	1.25
Total			**951.72**	**3948.11**	**100.00**

***Table 6.19* : Comparison of computed and observed values of global solar radiation for Pune region**

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Calculated	5.32	6.10	6.53	6.91	6.99	5.74	4.57	4.68	5.19	5.60	5.35	5.03
Observed	5.30	6.17	6.81	7.16	7.30	5.88	4.54	4.58	5.31	5.67	5.24	4.93
% Diff.	0.4	1.1	4.1	3.5	4.3	2.4	0.7	2.2	2.3	1.2	2.1	2.0

Source : *Mani, A. and Rangarajan S., Solar radiation over India*

***Table 6.20* : Comparison of computed and observed values of diffuse solar radiation for Pune region**

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Calculated	1.23	1.32	1.83	2.11	2.29	3.21	3.37	3.37	3.02	2.18	1.51	1.28
Observed	1.11	1.19	1.59	2.07	2.24	3.32	3.49	3.49	2.93	1.73	1.22	1.14
% Diff.	10.2	10.6	15.1	2.0	2.4	3.3	3.6	3.6	3.2	25.5	23.1	12.5

Source : *Mani, A. and Rangarajan S., Solar radiation over India*

***Table 6.21* : Mean Daily hours of sunshine - estimated for Malshiras block**

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Mean daily hrs of sunshine	9.75	10.25	9.75	9.75	9.5	6.25	3	4	5.5	8	9.25	9.75

Based on : *Mani, A. and Rangarajan S., Solar radiation over India*

Chapter 7
IREP and Beyond

This chapter starts with the broad objectives of an IREP programme. It then discusses the various energy saving devices and implements and proposes a programme for their dissemination. This part concentrates on devices, which can be propagated independently, discusses their pros and cons, their potential reach, the requirements for their successful dissemination and their energy saving potential at the block level. It proposes a programme based on their full potential and investigates the implications of the programme at different levels of achievement. The chapter also discusses supplementary measures, which need to be taken to stabilise the gains of the programme and put them on a sustainable footing. Finally the chapter ends with a brief discussion about the long term question of the mass utilisation of renewable resources and what needs to be done in the next ten years in order to move towards sustainable, energy self-reliant options.

7.1 Objectives of IREP programme

An IREP programme cannot remain confined to any one sphere of activity and has a very broad set of objectives which may be summarised as follows:

- Ensuring that all rural households are provided with basic household energy needs like energy for cooking, heating and lighting;
- Ensuring that the energy required for fulfilling livelihood needs of the population on an equitable and sustainable basis are adequately met;
- Ensuring that the disparities in access to energy necessary for improving the quality of life between different sections of the population (between the landed and the landless, men and women, rural and urban populations, etc.) progressively decrease;
- Ensuring that the pressure on common pool resources in the rural areas and the consequent process of environmental degradation be firstly, arrested and then reversed, so that a sustainable eco-system enhancement takes place, and last but not least, that the rural population becomes self-reliant (not to be confused with self-sufficient) in energy needs.

7.2 Improved *chulhas*

Firewood accounts for a lion's share of the fuel value of domestic fuel use and the low efficiency of traditional *chulhas* in which firewood is burnt has long been recognised. Any improvement in *chulha* efficiency is therefore expected to bring about large savings in domestic fuel use and with this in mind, a number of improved *chulha* designs have been evolved over the years. However, though a very large number of improved *chulhas* have been installed so far, the programme has not really been able to bring about a mass utilisation of improved *chulhas* by the rural population. There is a need to discuss the possible reasons for this before moving on to evolve a programme for their mass propagation.

For example, of the 306 households surveyed, only 10 had improved *chulhas* installed, and of these, only 4 *chulhas* were in use. The difficulties reported in respect of the improved *chulha* have been summarised in an earlier chapter. Many of the problems relate to a lack of adequate information on *chulha* use and also of sufficient repair and maintenance back up and advice. Some of the other problems (which, in our experience, have also been reported in other areas) are: limitations of size and kind of fuel, unsuitability of the mouth of the *chulha* and insufficient heat delivery for the cooking needs of the family, and also increase in the consumption of firewood.

Know your adversary -- the traditional chulha

The important point is that these problems and consequent perceptions exist, not because of `faulty' design, but in spite of good design. And that these perceptions are rooted not simply in ignorance or unconcern for fuel efficiency, but in real difficulties faced by the users. The starting point is to know the advantages offered by the adversary **--** the traditional *chulha*.

Domestic fuel for the rural households comes in different sizes and quality. The paucity of firewood compels households to utilise all kinds of fuel **--** crop residues, thorns, small stalks, straw **--** households have to make do with any kind of fuel that is available. The traditional *chulha* is a device that can take all these kinds of fuel in its stride **--** though efficiency may be impaired, ways can always be found to utilise the fuel in these *chulhas*. Secondly, it is possible to change rapidly to different scales of heat delivery in the traditional *chulhas*. In this respect, traditional *chulhas* represent somewhat of a robust, `general purpose' combustion device, which can handle the range of situations and needs faced by rural households.

Problems inherent in changing from `general purpose' to `special purpose' devices

In contrast, in order to increase efficiency, improved *chulhas* incorporate many design aspects, which act to limit their use to a subset of the situations, faced by rural households. These are problems inherent in changing over from `general purpose' to `special purpose' combustion devices and this needs to be taken into account in planning a programme for improved *chulhas*. Many of the difficulties reported in respect of improved *chulhas* can be understood if placed in this context. For example, it is much more difficult to extract higher than design heat deliveries from improved *chulhas* and attempts to do so would normally result in diminishing air supply, increased smoke and lowered efficiency, and any household that has attempted to do this would, contrary to expectation, report increased smoke, cooking time and fuel consumption.

Implications for IREP programmes

The first implication is that the programme should not attempt, and as importantly, should not attempt to propagate, improved *chulhas* as full replacement devices for the traditional *chulha*. They should be looked at as *additional* devices, which will reduce and limit traditional *chulha* use without necessarily eliminating its use. For the purposes of the programme, we suggest that they be viewed as devices, which bring about a 50% replacement of traditional *chulha* use.

Energy savings

It should be emphasised that even at half replacement level, improved *chulhas* can bring about considerable fuel savings. For example, sample households show an annual consumption of 3.25 T of firewood per household supplying about 1.90 Mkcal of useful heat. If half of this heat is supplied by improved *chulhas*, assuming an average efficiency of 10% for the traditional and 25% for the improved *chulha*, the resultant annual firewood saving is 0.925 T. Considering an improved *chulha* cost of Rs. 180, the potential saving is very large indeed. Considering firewood cost as low as 0.5 Rs/kg, the return on investment in terms of fuel saved comes to about 260%. In fact, the *chulha* gives a 100% return at a replacement rate of around 20%.

The second implication is that greater attention needs to be given to matching household needs and the kind and quantity of fuel when making a choice between different improved *chulha* design. There is now fairly detailed information on technical specifications and efficiency requirements for standard *chulha* designs chosen for propagation. This needs to be brought to bear on prevalent cooking practices and translated into specific recommendations in respect of replacement by improved *chulhas*.

Additional information required is the scale of heat delivery by the *chulha* within its range of efficiency. This information is not routinely reported at the moment. It would also be useful to have developers study and report on adapting the design to different heat loads, etc.

The third implication is that there needs to be a two-way communication between users and MEDA and MEDA suppliers, whether they are government agencies or other institutions. There is often an element of change in well established cooking practices and food preferences if improved *chulha* efficiencies are to be achieved. For example, in the *bhakri* areas, cooking practice and food preference is to roast the half cooked *bhakri* on an open fire. This involves considerable losses and can lower efficiencies to levels where the fuel saving gains do not make an impact. We also need to keep in mind that `user' here does not signify the household, but very specifically, the rural women who are the actual users.

In short, we feel that the issue of propagation of improved *chulhas*, which has the greatest immediate potential for fuel saving needs to be given much more attention than it presently receives. The implications for the underlying institutional arrangements are further discussed in the separate section on the institutional requirements of the programme.

7.3 Family bio-gas plants

Biogas plants may be classified as fixed dome and floating dome, as family plants and community plants, and as those based primarily on dung, night soil or crop residue and leaf litter according to different criteria. Almost all the plants reported in the sample households were fixed dome family plants based on dung and night soil. The sample survey reported 26 biogas plants and though only about a little more than half the plants were reported to be in use, the users of biogas plants in use were well satisfied by their performance. The less than half that were not in use had fallen into disuse mainly due to disrepair. There was also greater awareness about the usefulness of biogas plants in the sample households. The plants reporting capacity showed an average capacity of about 7.8 Nm^3. The households owning plants that had fallen into disuse, reported an assessed expenditure of about 2,800 Rs/plant in order to bring them back into use, and together they were ready to contribute about 30% of the cost.

Our discussions show that there is considerable scope for developing biogas fuel systems in the block. Three types of programmes are suggested below for different sections.

2Nm^3 optimised Deenbandhu model

The first type of programme is targeted at the middle farmer household and above with daily access to a minimum of 10 kg of dung. A 2m^3 to 4 m^3 capacity plant is suggested as optimal. The optimised design of such a plant based on the Deenbandhu model, developed by Shri V. N. Gore and later adopted by the Vivekananda Kendra and CAPART as the Vincap model is suggested as the basis. This model uses natural material and is specifically designed to help eliminate the common leakage, settlement and uplift problems, which often cause failure in biogas plants. The Vivekananda Kendra has built the standardised model in many places in Tamil Nadu. The cost comparison in 1995 prices of the conventional and optimised Deenbandhu model shows that the optimised model costs Rs. 3,000 as compared to Rs. 5,000 for the conventional model. This would allow the state to bear a larger proportion of the cost within the same rate of subsidy burden per Nm3 capacity.

Assessment of energy saving and reach

Analysis of sample household data shows that 104 out of 306 families had a dung availability of over 2 kg per capita per day. Thus the reach of the programme may be taken to cover about one-third of the population.

A $2Nm^3$ plant delivers 2.06 Mkcal and a $4Nm^3$ plant 4.12 Mkcal annually as useful heat. The average total useful heat annually utilised per household is about 2 Mkcal of which 1.36 comes from biofuels excluding biogas. Estimated cost of optimised Deenbandhu model in 2000 would come to Rs. 4,760 or say Rs. 5,000.

7.4 Community biogas plants

Biogas is an ideal fuel in more than one ways. However, family biogas plants presuppose access to adequate quantities of dung, and this excludes most marginal farmers and the landless. Improved *chulhas* would go some way towards meeting the needs of these sections, but there are many difficulties in the way. One way out is that of community biogas plants, which are based on night soil and optionally on dung, supplement. In fact in Malshiras village MEDA has taken the initiative to install a community biogas plant and it is yet to become operational.

Purely as an illustrative example, considering all the 202 households in the sample who either do not have access to dung or have a per household access less than 2 kg per capita per day, they constitute 1392 persons and together have a daily dung availability of 914 kg. If this `community' pools their dung and nightsoil resources, they have an availability of 230 Nm3 of biogas or about 62% of the delivered heat they require for their domestic fuels. If ways and means are found of brining this about, these resources have the ability to save above 2 T of firewood per household.

The main bottleneck in case of community biogas plants is the organisational effort and the institutional arrangements, which are required. Unlike the *chulha* and the family biogas programmes, a programme for community biogas plants cannot be taken to a mass scale in the same manner. Considerations of spatial contiguity also affect the realisable reach of the programme.

Suggested modifications for the existing community biogas programmes

MEDA has already taken up a programme of community biogas plants based on night soil. This is an important programme, which also has its own importance as a health programme in its own right. We would however suggest that groups be based on bringing together two kinds of households: a) households with no cattle comprising mainly the landless and b) households whose daily dung access is less than the quantity which would make family biogas plant viable. The latter would participate in the programme and would receive fertiliser as consideration for their dung contribution. As shown above, if an appropriate mix is maintained, the programme is capable of meeting 62% of delivered useful heat requirement of all the households. Without the participation of the latter group, the programme would be able to meet at most 15% of the delivered useful heat requirement of the participating households. It is unlikely that interest would be sustained at this level of replacement. Moreover, the problem of contiguity would also be eased somewhat because of increased coverage.

It is suggested that in the first instance, over the first five years, the attempt should be to set up about five such plants in each circle in the block, that is, about 40 plants over the next 5 years. A minimum plant size of 15 Nm3 with half of the contribution coming from dung and half from night soil is recommended. This implies a total group of about 40 to 50 households comprising at least 300 persons and a daily dung availability of about 100 kg per day. On the basis of the learning of the first five year period, it is assumed that it would be possible to extend the coverage so that on an average there is one community biogas plant per village, implying the setting up of about 160 plants in the next five years which gives a total of about 200 plants over the next 10 years period.

7.5 Leaf litter, brushwood and biowaste based biogas plants

Leaf litter, brushwood and other crop and biowastes are manifold more abundantly available than dung or night soil. If dung or night soil resources could be supplemented by such biowastes, the constraint on resource availability for the poorer sections could be substantially overcome. Assuming that fuel extraction from biowastes is half as efficient as that for dung in terms of dry matter, about 5 to 6 kg of dry biowaste would be required per Nm^3 of biogas.

A workable design had been developed by ASTRA at the Indian Institute of Science, Bangalore which worked on a substantial component of leaf litter, brushwood and biowastes in the feed. The plant had been installed at Pura village and the gas was utilised to generate electricity to meet the lighting requirement and the drinking water pumping requirement for the village. The electricity generation plant ran for a few years and has since got into institutional difficulties and the facility is no longer in use. However, the biogas component was a demonstrated success and there is a need to adapt that design for similar requirements.

We suggest that in the first five years three trial plants be set up in the block. The locations of these plants can be chosen in such a way that it has the best demonstration effect. The plants could be set up in three sizes ranging from 20 to 100 Nm3 (the estimated requirements for each of these sizes may be worked out on the basis of a module of 150 persons contributing nightsoil, 50 kg daily dung and 50 kg dry litter per 10 Nm3 capacity). Based on the learning of that experience, a programme may be taken up to establish 30 more plants in the entire block in the next five years of 2005 to 2010.

7.6 Energy saving lamps

Tubelights with electronic chokes

It is well established that tubelights provide greater luminosity per watt and that one of the main constraints on acceptance of tubelights is the lack of adequate chokes, which can work at less than rated voltages prevalent in the rural area. This is also a well-accepted programme.

However, there is a need to estimate the potential scale of the programme. A simulation was carried out on the basis of the survey data. The simulation shows that if all bulbs up to 40 W replaced by one 20 W tubelight with electronic choke, and 60 and above by one 40 W tubelight, there is a resultant saving of more than 35% of electricity consumed for lighting. If we take into account the fact that the electricity consumed in lighting forms a major share of domestic electric use, substantial savings are possible. For the sample households, 612 lamps would be replaced and the resultant annual energy saving per lamp would be about 32 kWh per lamp along with a similar reduction in connected load.

According to the slogan that every unit saved is a unit generated, the energy saved could be costed at the marginal cost of new power generation, which stands at more than Rs. 3/kWh. This does not take into account the considerable benefit derived from a reduction in connected load during peak hours.

Compact Fluorescent Lamps (CFLs)

Replacing electric filament lamps by compact fluorescent lamps (CFL) is another option that has even greater benefit in the long run. However, CFLs have not been all that acceptable as general lighting devices and it is doubtful whether simple replacement of filament lamps by CFLs would be effective. For effective use and acceptance, CFLs require that space lighting needs and their pattern is studied and the lamps accordingly placed. Used in this manner they have the potential of greatly reducing electricity need for lighting even while increasing the quality of lighting. We would recommend a study along these lines be taken up and guidelines evolved for the replacement of filament lamps by CFLs in the next two years and a programme be taken up on the basis of these studies.

Assuming for the time being that two CFL lamps will be required for every 60 W filament lamp to be replaced, we still have here an energy saving that is substantially more than that possible with electronic chokes and conventional tubelights. For our sample, proceeding along the same lines, if we assume that all filament lamps of up to 40 W are replaced by one, those up to 60 W with two and those above 60 W with three, then with a standard CFL wattage of 9 W, we have a reduction in energy consumption by about 70% and a corresponding reduction in connected load. The energy saving per CFL installed is about 44 kWh. Costing as above, with a CFL cost of 325 Rs., we have a rate of return of more than 33%. The total investment in replacement however involves replacement of 612 filament lamps with 1,106 CFLs. We should also take into account the very considerable reduction in connected load, and the fact that CFL costs are at the time mainly constrained by lack of an adequate mass market. The main bottleneck here is the acceptance and the scale of investment, which we believe, should improve over time. The programme therefore provides for an increasing component of CFL instead of conventional tubelight with electronic choke in the later phases.

7.7 Kerosene saving devices

Improved kerosene stoves and improved lanterns

Since stoves and lanterns are the two main kerosene devices in use, improved kerosene stoves and lanterns are aimed at improving the efficiency of these devices. These devices are already a well-established part of MEDA programmes. With a rise in efficiency from around 40 to 45% to 60 to 65%, there is a fuel saving of 30 to 33%, thus one litre of kerosene out of every three could be saved by these devices.

Kerosene and the landless labourers and marginal farmers

The landless labourers are the section, which is most vulnerable to fuel shortage. They have no access to firewood resources of their own and their dependence on kerosene is high. Though they have a somewhat better access to firewood and biofuels, marginal farmers face practically the same situation. For these sections therefore there is a twofold need in respect of kerosene: a) they should be the first target for dissemination of kerosene saving devices at a higher rate of subsidy, and b) they should have expanded access to kerosene supply. It is unfortunate that kerosene quotas for the block have been consistently declining and most households have demanded an increase in kerosene supplies.

7.8 Institutional issues

Besides its technical component, any programme must take account of the social mechanisms through which the programme objectives are to be achieved. Whether it is left to the market mechanism or the state machinery, every programme presupposes a social mechanism through which the objectives are to be achieved and this mechanism always leaves a profound mark on the programme.

Presently, government personnel who are already burdened with their own departmental responsibilities administer the programmes. They are not in a position to fulfil the multifarious functions that such a comprehensive programme demands. While targets are achieved, the gains are not sustainable, and the potential reach is constrained. Users often do not receive adequate information and there is no mechanism by which they can communicate their difficulties and get adequate advice or help. The government personnel implementing the programme often do not have the necessary technical expertise or the time to go into the issues and resolve them adequately. Moreover for far too long they have been used to one-way communication (best described in the term -- delivery system) and are not adequately equipped to handle the needs of two-way communication.

All this can be summed up in a short phrase -- lack of participation and an adequate institutional mechanism to ensure participation. For this reason, we propose here an alternative institutional mechanism for handling the multifarious needs that an IREP programme demands. The two main elements in it are the user groups and the service organisation/group.

User Groups

User groups are now a well-recognised institutional measure for ensuring participation. User groups should be formed villagewise around each component as the programme progresses. User groups should be formed before the programme implementation. Prospective users should be organised into groups, the programme and its importance explained to them, measures necessary for ensuring efficiency of devices and any difficulties in this regard should be fully discussed, and choice of appropriate device made with their consent.

The users of the two major energy devices -- the improved *chulhas* and biogas plants -- are women, and it is proposed that these user groups should be formed from the women in the household. It has also been found that women on the whole respond much better and carry out the functions of the user groups much better than men. Besides it is important to see that women gain an independent voice in collective affairs. Periodic consultations with the village men folk can also be arranged to keep the men involved in these programmes.

Wherever possible, programmes should feed into SHG activities and those SHGs themselves can become user groups for the programme. The advantage is that a homogeneous well functioning group with some empowerment and good communication can become a medium for the two-way communication needed by the programme. This will also help convergence of different government schemes.

Support services

Any such programme cannot be taken up on a mass scale without ensuring effective support service mechanisms. There re three main types of support services, which are needed: a) Awareness creation, information dissemination and motivation, b) Provision of technical services and c) preparing guidelines, recommendations and improvements.

Awareness creation, information dissemination and motivation

The programmes described above, especially the improved *chulha* and biogas programmes, have aspects which are relevant for many other government programmes like community health, women's programmes, watershed and wasteland development programmes, etc. These support services can therefore be combined with similar activities carried out in all these other programmes. In fact, many of these programmes can be taken up as part of other programmes. However, MEDA should see to it that this is done, and should secondly, provide material and train persons for this task and provide a roster of trainers and speakers for this purpose.

Provision of technical services

One of the major bottlenecks in these programmes is the timely provision of technical services involving troubleshooting, as well as repairs and modifications. Our discussions reveal that if such help is available in time and users are aware beforehand of the cost they will have to bear, they are ready to pay such costs. What generally seems to happen is that lack of timely intervention leads to aggravation and finally disuse of the equipment leading to a situation where cost of re-mobilising the equipment becomes too large for users to bear.

An equally important aspect is the quality control at the time of construction/installation itself. This need not require extensive technical knowledge in most cases; someone who has some technical understanding could monitor a simple checklist. This aspect is as important as the first one, and is quite clear in the case of biogas plants.

The government machinery is not in a position to fulfil these functions today. It will also not be helpful to entrust the task entirely to NGOs, because though they can carry out support activity for this aspect, except for a very few blocks, there do not exist NGOs with sufficient technical background and personnel.

Team of para-professionals

It is proposed that MEDA should take up the task of forming and training a team of para-professionals at the block level, somewhat along the lines of a village health worker. The para-professional should be resident in the area, should have studied up to matriculation, and should have some technical aptitude. The person would need to be trained specifically in the devices propagated under the IREP. The person should receive training about making an appropriate choice of device, constructing/installing the devices, and handling the routine repairs and advise on and monitor maintenance. The person should be entitled to a reasonable fee from the users for actual repairs and construction/installation and should also be able to act as the conduit for a two-way communication between users and the government as well as support scientific institutions.

It is suggested that the person be paid a stipend for a five-year period after training and should be able to get significant supplementary income during that period. The stipend would be mainly for the services rendered to the programme in terms of helping form user groups, helping user groups to carry out their activities in a regular manner and act as the communication link between users and the government.

It is suggested that there should be one such para-professional for approximately 500 households (about 3000 population).

7.9 Funds

As pointed out above, IREP has a component that can form part of many other programmes. At present MEDA supported IREP programmes and distribution is being carried out independently of other programmes. This constrains both the IREP programmes as well as the other programmes. It is suggested that each of these other programmes should have an energy saving component of its own which would be supplemented by IREP programmes. There are two types of funds, which need to be considered a) the programme funds and b) funds for the support services.

Programme funds

It is suggested that each of the other relevant programmes take up energy saving devices and measures as part of its own programme and that IREP should match that share with its funds.

For example, let us take watershed development programmes. In the block, we have an average of a little more than 2.50 ha watershed area per household. Thus a typical 400 to 500 ha micro-watershed would have at least about 150 households. Providing for the optimised Deenbandhu biogas plant for an estimated one-third of the households and improved *chulhas* and kerosene stoves for the other two thirds would cost, 50 x 5000 + 100 x 180 + 100 x 185 = 2,50,000 + 18,000 + 18,500 = 2,86,000 Rs, say 3,00,000 Rs. This measure would go a long way towards reducing the pressure on the commons with an immediate effect, which would greatly help the watershed programme. Of the 3,00,000 a three-way division is possible, with the users paying for 1,00,000, the watershed programme bearing the burden of 1,00,000 and the IREP contributing 1,00,000. It should also be pointed out that since the users as a whole would gain substantial immediate benefits as wages as well as long term benefits from the watershed programme, users would be ready to bear a larger share of the cost than otherwise. In the projections, which follow the proportions of one-third each for *chulhas*, stoves, and biogas plants (except for community biogas plants) is assumed.

7.10 Projection, phasing and distribution of the programme

It is necessary to take into account that the programme may not always be able to provide the full potential coverage. Projection estimates of the programme are worked out below on the basis of 100, 50, 25 and 10% of the potential recommended coverage of the programme.

Programmes designed to ensure participation have to follow a learning curve and cannot be just distributed evenly among all the years. In what follows, the learning curve is assumed to be completed by the second year, with the exception of the community biogas programmes which are expected to take a longer period of gestation. Therefore it is assumed that 4% of the programme is covered during the first, 8% during the second and then onwards 11% every year till the tenth year.

Village as a basis

In the distribution of the programme the following points need to taken into account: a) it is important to cover a substantial section of a village and proceed villagewise, so that the combined effect of the measures makes a noticeable impact; b) the more vulnerable sections like the landless and marginal farmers need to be given a multiple device benefit if the devices are to make an impact significant enough for replication (for example an improved *chulha* and an improved kerosene stove and an improved lantern are much more likely to make a perceptible difference and sustain the benefit of each of the device), and c) special care must be taken to ensure the participation of women, for two independent reasons -- empowerment of women as well as better and more efficient implementation of the programme.

7.11 The suggested programme details and its resultant energy savings

Family biogas plants

As mentioned earlier, the survey findings show that family biogas plants are viable for roughly one-third of the households. Thus, the full potential (100%) of this programme is assumed to cover one-third of the total projected number of households in 2010. Since we are dealing with broad estimates all figures are rounded to the nearest convenient unit. The full potential for the family biogas programme is thus taken to be 30,000 households. The programme details at different levels of potential reached are presented in Tables 7.2 and the resultant fuel savings are presented in Table 7.10. This programme shows an energy saving of about 2700 kcal per Re invested (in coal equivalents at 1 Re/kg, this gives a gross return of about 40%).

Improved chulhas

The largest savings are of course shown in the improved *chulha* programme. The potential of this programme is calculated on the assumption that most of the households not covered by the family biogas programme would have to be covered by the other programme nets. Thus excluding 10,000 better off households from the rest, 50,000 households are assumed to form the full potential of the improved *chulha* programme. The programme details at different levels of potential reached are presented in Tables 7.1 and the resultant fuel savings are presented in Table 7.9. This programme expectedly shows a very large energy saving of almost 22,500 kcal per Re invested (in coal equivalents at 1 Re/kg, this gives a gross return of almost 320%) even at half replacement.

Improved kerosene stoves

As pointed out earlier, multiple coverage in the net should not be excluded if significant impact is aimed at and accordingly, it is assumed that the same 50,000 households also constitute the full potential for the improved kerosene stove programme. The programme details at different levels of potential reached are presented in Tables 7.3 and the resultant fuel savings are presented in Table 7.11. This programme shows an energy saving of about 700 kcal per Re invested (in coal equivalents at 1 Re/kg, this gives a gross return of almost 10%). The pattern of energy consumption is such that the per Re energy saved is very less and hence gadgets aimed at kerosene saving could get a low priority in the over all programme of MEDA. As we would see later the same holds true for improved kerosene lanterns.

Community biogas plants based on dung and night soil

As discussed earlier, each plant of 15 m3 is assumed to serve 50 households with about 40% of their cooking needs. The programme, because of its more stringent requirements, is limited to a coverage of about one plant per village (may be two in bigger villages). The programme thus assumes the installation of 200 plants of 1,50,000 unit cost at 100% potential and the programme details at different levels of potential reached are presented in Tables 7.4 and the resultant fuel savings are presented in Table 7.12. This programme shows an energy saving of almost 3,200 kcal per Re invested (in coal equivalents at 1 Re/kg, this gives a gross return of almost 45%).

Community biogas plants based on dung and night soil and leaf litter/biowaste supplement

This programme is mainly an experimental programme in the first phase of five years and it assumes that the plants would serve 50 families and supply 60% of their cooking energy at the same cost. The programme details at different levels of potential reached are presented in Tables 7.5 and the resultant fuel savings are presented in Table 7.13. This programme shows an energy saving of almost 4,600 kcal per Re invested (in coal equivalents at 1 Re/kg, this gives a gross return of about 65%).

Improved kerosene lanterns

Insufficient reach of electricity to all households as well as frequent power failure has made this an important item of fuel use. The potential households for these devices are again assumed to be the bottom 50,000 families. Unit cost is assumed to be Rs. 105. The programme details at different levels of potential reached are presented in Tables 7.6 and the resultant fuel savings are presented in Table 7.14. This programme shows an energy saving of about 410 kcal per Re invested (in coal equivalents at 1 Re/kg, this gives a gross return of only about 6%).

Electronic chokes with tubelights and CFLs

An estimated eighty thousand filament lamps are assumed to be converted half to electronic coke and tubelights and half to CFLs as described earlier. Unit costs are assumed respectively to be Rs. 400 and Rs. 325 for the electronic choke and tubelight assembly and Rs. 325 for CFL. The programme details at different levels of potential reached are presented in Tables 7.7 and the resultant fuel savings are presented in Table 7.15 for electronic chokes and tubelights and in Tables 7.8 and 7.16 respectively for CFLs. This programme shows an electricity saving of about 0.08 kWh and 0.11 kWh per Re invested respectively for electronic choke and tube and CFLs (in marginal electricity cost at Rs. 3/kWh, this gives a gross return of almost 24% and 33% respectively).

Para professional core and its costs

As has been emphasised earlier, the programme requires a core of trained para professionals and that related cost must be provided for in the costs of the programme. It is suggested that there be one para professional for every 500 households (approximately 3000 persons). This means a total of about 180 para professionals to be inducted for the block.

The para professional will receive on-job as well as separate training. It is suggested that the person get a stipend of Rs. 750 p.m. during the first year which shall be considered a training period. However, the person will have to begin the work of organising around ongoing programmes immediately on induction.

After training, the person will be entitled to a stipend of Rs. 1000 p.m. for another four years, during which he or she shall be responsible for the targets to be achieved within the person's designated area/group. Since as emphasised earlier, the programme should not disperse its efforts but should concentrate on covering an area progressively but intensively, it is assumed that the para professionals are inducted in a phased manner. Thus every year for the first six years, 30 para professionals will be inducted and trained. The costs are presented in Table 7.17. It may be seen that, distributed over the entire range of IREP activity, they are not very high, even at 10% coverage, but provide a vital and important missing link in the programme.

7.12 Total fuel saving and the impact of the programme on the pressure on the commons

The total impact of the programme at full potential on fuel consumption in the block is presented in Table 7.18 and the fuel value of fuel saving is presented in Table 7.19. At full potential the saving in fuel comes to 174,710 T of firewood, 11,300 T of dungcake, 2,630 kl of kerosene with a total fuel value of 748,110 Mkcal. Savings in electricity come to about 6,444,900 kWh.

One of the most important criteria is the reduction of pressure that such a programme can bring about on the commons. The estimation of this impact of the programme of projected pressure on the commons is presented in Table 7.20. It may be seen that there is a substantial reduction in pressure on the commons when the programme operates at full potential. In fact, we may assess this reduction in two ways:

Projections show that the pressure on the commons in the BAU scenario would increase from 4.35 T/ha in 2000 to 5.48 T/ha in 2010. One of the minimum conditions for an energy programme would be that it succeeds in arresting the increase in pressure on the commons. This implies that the programme should be successful in maintaining the 2010 pressure at 4.35 T/ha or less. From the table one may see that the even if the programme is aimed at achieving 10% potential the above mentioned objective could be achieved. This sets **a minimum target** for the programme.

The second important landmark would be when the extraction from the commons falls below the estimated annual biomass increment of about 3 T/ha. From the table it may be seen that the 2010 extraction rate from the commons falls below 3 T/ha when the programme reaches an achievement level of about 60% achievement of the full potential. This sets a target for what should be the desirable coverage. Suggested scale of programmes

The estimates above are based on equal coverage for each programme. It is possible to arrive at an alternative programme based on a coverage, which gives greater priority to those programmes, which show a higher energy gain per Rupee invested in the programme. From this point of view it is suggested that an acceptable scale of programme would be to take up the improved *chulha* programme which has the largest energy gain per Re at a coverage of 50% and all other programmes at a coverage of 10%. With this programme composition, the programme would be just able to maintain the pressure on the commons at the present level and show a small saving. This also brings out the necessity of other complementary measures if IREP gains are to be consolidated.

7.13 Convergence and complementary activity

The IREP by itself cannot hope to achieve the objective of sustainability and energy self reliance, and this becomes quite clear from the table showing pressure on the commons. The importance of convergence cannot be over emphasised in this respect. It is only by acting in concert and by complementing each other's efforts that the sum total of government schemes can bring about the desired effect. As mentioned earlier, IREP should seek convergence with other related schemes. Some of these areas of convergence are: a) Watershed and wasteland development programme, b) Integrated fodder and livestock programmes, c) Social forestry programmes, d) Programmes related to more efficient utilisation of crop wastes, e) Health and hygiene programmes involving night soil and solid waste management, f) Pasture development programmes, g) Programmes for improving habitats and living conditions of disadvantaged sections.

In this respect, the newly emerging importance given to participation as well as convergence is a favourable context. However, it needs to be backed up by active search of areas of convergence. Self-Help Groups and User Groups have an important role to play in this as do NGOs and other voluntary agencies.

The defining parameters for sustainable and equitable productivity enhancement have been described in detail in Datye (1997) and Paranjape and Joy (1995). Without convergence with sustainable productivity enhancement and equitable access to water and biomass resources, it will not be possible to fully eliminate the pressure on the environment while ensuring livelihood needs of all in the rural areas.

7.14 Beyond IREP -- Towards mass utilisation of renewable energy

In the preceding sections we have dealt with IREP programmes related to energy saving devices and measures related to biofuels like firewood and biogas, and towards mainly non renewable sources like kerosene and electricity (most electricity today comes from coal based thermal plants and the proportion of hydro power has secularly decreased). We have not covered the solar and other renewable energy options that are being propagated under the IREP. This is because there are major problems with the IREP direction in respect of renewable energy.

Solar cookers, solar water heaters, solar photo voltaic devices

For example, solar cookers, solar water heaters, solar photovoltaic devices are the three main groups of solar devices being propagated under the IREP. All of them have received lukewarm response, and at best have a demonstration and awareness value. They have found little acceptance in the rural areas. Any programme that tries to propagate these devices in a similar manner is bound to face the same problems because there is a fundamental shift in the approach towards renewable energy if renewable energy sources are to be utilised on a mass scale and become the basis for energy self reliance in the rural areas.

There are a host of problems associated with domestic solar devices. Because of their seasonal nature, users have to maintain other energy systems to take care of periods when solar does not satisfy the requirements. They do not represent savings in establishment costs, but in additional costs. Secondly, for the rural poor, labour represents a non-cash input, which is within their control, and so they prefer prolonged periods of foraging and collection to cash and monetary investments. Thirdly, solar devices do not sit well with the cycle of activities they carry out where they often have to cook early and carry their food with them. Fourthly, in non-rice areas, solar devices are at a distinct disadvantage because of the higher cooking temperatures needed. All these reasons lie behind their poor acceptance in rural areas, and especially by the rural poor.

However, they do have a demonstration and awareness creation value. For this reason it is suggested that they should be taken up on that scale, for example, as part of *Urja Grams*. SPV street lighting is also one of the possible demonstration devices, provided there is a service back up.

Realising the specific nature of renewable resources, especially solar energy, wind energy and hydropower

It is necessary to realise first that though renewable energy sources are the only hope of the future, except for biomass to some degree, they all suffer from specific limitations. Realising these limitations is the first step in overcoming them. It is well recognised that renewable energy sources are dispersed, difficult to store, do not lend themselves easily to aggregation and are subject to large temporal and spatial variation.

The next step involves a perspective about how to overcome these limitations. The present direction in this respect is an attempt to upgrade a given renewable resource, individually, to a level where they can compete with non-renewable sources. As soon as this is accepted, the cost of harnessing the resource begins to increase and the higher up the upgradation scale one goes, the steeper is the increase.

Though, frontier area research like those in photovoltaics does seem to promise abundant energy in the future, that future is still far off. Even solar devices like solar cookers, which on the face of it, should have been very popular, have not been able to satisfy domestic requirements. Anyone with a solar cooker has to maintain a double cooking establishment so to speak, because of the unreliability of solar insulation. Adding a storage element to it would increase what is already perceived as a very high cost. Hence, we have not included any of these devices in the programme. Their role as demonstration units and awareness creation devices can continue at a low key.

From individual sources to systems

The perspective pointed out above pertains not only to the harnessing of renewable energy sources for domestic use, but also in larger use, including their use in industry and in power generation. A change in perspective is needed here from energy sources to energy systems.

The non-systemic thinking which thinks of each individual source as an independent energy source is rooted in the fossil fuel era. Since fossil fuels have been widely available on a large scale, are capable of aggregation on virtually any scale, can be stored and conveniently handled, they are each capable of being looked upon as independent sources and has led to a thinking which exploits each source independently. As indicated earlier individual sources like solar, wind and hydro have serious limitations in Malshiras block.

With an energy systems approach, it becomes possible to turn limitations into strengths. One way is to go for hybridisation. Serious efforts are being made in the field of solar, thermal and biomass hybrid systems and wind-hydro systems. This is specially needed if exploitation renewable sources of energy to become viable and also for the mass utilisation of renewable energy.

Mass utilisation of renewable energy as basis for sustainable prosperity

Many of these possibilities are examined in greater detail in Datye (1997) and Paranjape and Joy (1995). A note, which lays out some of the main ideas, is annexed (Annexure7.1). Subsequent work is mentioned in the References. At present, crop wastes surpluses as well as other utilisable biomass surpluses are not readily available. If IREP is treated as a supplementary part of associated convergent schemes for sustainable productivity enhancement, biomass surpluses will be generated and can be integrated into sustainable energy systems described in the annexed note. Most of the programmes flowing out of these fall outside the current scope and nature of IREP. Moreover, without supplementing IREP with a programme on that scale, IREP might only prove to be symptomatic relief; but joined with it, it can become a part of a synergetic energy system that ensures an enhanced quality of life for the rural population without compromising on sustainability and equity. That however requires a separate study focussed on evolving a pilot project for this purpose.

<u>Table 7.1</u> : Projected programme for improved chulha

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
100% potential											
Target (no. of chulhas)	2,000	4,000	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	50,000
Cost (Rs. '000)	360	720	990	990	990	990	990	990	990	990	9,000
Suggested contribution to cost											
IREP (Rs. '000)	120	240	330	330	330	330	330	330	330	330	3,000
Other Govt. schemes	120	240	330	330	330	330	330	330	330	330	3,000
User contribution	120	240	330	330	330	330	330	330	330	330	3,000
50% potential											
Target (no. of chulhas)	1,000	2,000	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	25,000
Cost (Rs. '000)	180	360	495	495	495	495	495	495	495	495	4,500
Suggested contribution to cost											
IREP (Rs. '000)	60	120	165	165	165	165	165	165	165	165	1,500
Other Govt. schemes	60	120	165	165	165	165	165	165	165	165	1,500
User contribution	60	120	165	165	165	165	165	165	165	165	1,500
25% potential											
Target (no. of chulhas)	500	1,000	1,375	1,375	1,375	1,375	1,375	1,375	1,375	1,375	12,500
Cost (Rs. '000)	90	180	248	248	248	248	248	248	248	248	2,250
Suggested contribution to cost											
IREP (Rs. '000)	30	60	83	83	83	83	83	83	83	83	750
Other Govt. schemes	30	60	83	83	83	83	83	83	83	83	750
User contribution	30	60	83	83	83	83	83	83	83	83	750
10% potential											
Target (no. of chulhas)	200	400	550	550	550	550	550	550	550	550	5,000
Cost (Rs. '000)	36	72	99	99	99	99	99	99	99	99	900
Suggested contribution to cost											
IREP (Rs. '000)	12	24	33	33	33	33	33	33	33	33	300

Other Govt. schemes	12	24	33	33	33	33	33	33	33	33	300
User contribution	12	24	33	33	33	33	33	33	33	33	300

***Table 7.2* : Projected programme for optimised Deenbandhu type biogas plants**

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
100% potential											
Target (no. of plants)	1,200	2,400	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	30,000
Cost (Rs. '000)	6,000	12,000	16,500	16,500	16,500	16,500	16,500	16,500	16,500	16,500	150,000
Suggested contribution to cost											
IREP (Rs. '000)	2,000	4,000	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	50,000
Other Govt. schemes	2,000	4,000	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	50,000
User contribution	2,000	4,000	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	50,000
50% potential											
Target (no. of plants)	600	1,200	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	15,000
Cost (Rs. '000)	3,000	6,000	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	75,000
Suggested contribution to cost											
IREP (Rs. '000)	1,000	2,000	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	25,000
Other Govt. schemes	1,000	2,000	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	25,000
User contribution	1,000	2,000	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	25,000
25% potential											
Target (no. of plants)	300	600	825	825	825	825	825	825	825	825	7,500
Cost (Rs. '000)	1,500	3,000	4,125	4,125	4,125	4,125	4,125	4,125	4,125	4,125	37,500
Suggested contribution to cost											
IREP (Rs. '000)	500	1,000	1,375	1,375	1,375	1,375	1,375	1,375	1,375	1,375	12,500
Other Govt. schemes	500	1,000	1,375	1,375	1,375	1,375	1,375	1,375	1,375	1,375	12,500
User contribution	500	1,000	1,375	1,375	1,375	1,375	1,375	1,375	1,375	1,375	12,500
10% potential											
Target (no. of plants)	120	240	330	330	330	330	330	330	330	330	3,000
Cost (Rs. '000)	600	1,200	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	15,000

Suggested contribution to cost											
IREP (Rs. '000)	200	400	550	550	550	550	550	550	550	550	5,000
Other Govt. schemes	200	400	550	550	550	550	550	550	550	550	5,000
User contribution	200	400	550	550	550	550	550	550	550	550	5,000

***Table 7.3* : Projected programme for improved kerosene stoves**

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
100% potential											
Target (no. of stovess)	2,000	4,000	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	50,000
Cost (Rs. '000)	370	740	1,018	1,018	1,018	1,018	1,018	1,018	1,018	1,018	9,250
Suggested contribution to cost											
IREP (Rs. '000)	185	370	509	509	509	509	509	509	509	509	4,625
User contribution	185	370	509	509	509	509	509	509	509	509	4,625
50% potential											
Target (no. of stovess)	1,000	2,000	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	25,000
Cost (Rs. '000)	185	370	509	509	509	509	509	509	509	509	4,625
Suggested contribution to cost											
IREP (Rs. '000)	93	123	170	170	170	170	170	170	170	170	1,542
User contribution	93	123	170	170	170	170	170	170	170	170	1,542
25% potential											
Target (no. of stovess)	500	1,000	1,375	1,375	1,375	1,375	1,375	1,375	1,375	1,375	12,500
Cost (Rs. '000)	93	185	254	254	254	254	254	254	254	254	2,313
Suggested contribution to cost											
IREP (Rs. '000)	46	93	127	127	127	127	127	127	127	127	1,156
User contribution	46	93	127	127	127	127	127	127	127	127	1,156
10% potential											
Target (no. of stovess)	200	400	550	550	550	550	550	550	550	550	5,000
Cost (Rs. '000)	37	74	102	102	102	102	102	102	102	102	925

Suggested contribution to cost											
IREP (Rs. '000)	19	37	51	51	51	51	51	51	51	51	463
User contribution	19	37	51	51	51	51	51	51	51	51	463

<u>Table 7.4</u> : Projected programme for nightsoil and dung based community biogas plants

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
100% potential											
Target (no. of plants)	8	8	8	8	8	32	32	32	32	32	200
Cost (Rs. '000)	1,200	1,200	1,200	1,200	1,200	4,800	4,800	4,800	4,800	4,800	30,000
Suggested contribution to cost											
IREP (Rs. '000)	400	400	400	400	400	1,600	1,600	1,600	1,600	1,600	10,000
Other Govt. schemes	400	400	400	400	400	1,600	1,600	1,600	1,600	1,600	10,000
User contribution	400	400	400	400	400	1,600	1,600	1,600	1,600	1,600	10,000
50% potential											
Target (no. of plants)	4	4	4	4	4	16	16	16	16	16	100
Cost (Rs. '000)	600	600	600	600	600	2,400	2,400	2,400	2,400	2,400	15,000
Suggested contribution to cost											
IREP (Rs. '000)	200	200	200	200	200	800	800	800	800	800	5,000
Other Govt. schemes	200	200	200	200	200	800	800	800	800	800	5,000
User contribution	200	200	200	200	200	800	800	800	800	800	5,000
25% potential											
Target (no. of plants)	2	2	2	2	2	8	8	8	8	8	50
Cost (Rs. '000)	300	300	300	300	300	1,200	1,200	1,200	1,200	1,200	7,500
Suggested contribution to cost											
IREP (Rs. '000)	100	100	100	100	100	400	400	400	400	400	2,500
Other Govt. schemes	100	100	100	100	100	400	400	400	400	400	2,500
User contribution	100	100	100	100	100	400	400	400	400	400	2,500
10% potential											
Target (no. of plants)	1	1	1	1	1	3	3	3	3	3	20
Cost (Rs. '000)	150	150	150	150	150	450	450	450	450	450	3,000
Suggested contribution to cost											
IREP (Rs. '000)	50	50	50	50	50	150	150	150	150	150	1,000

Other Govt. schemes	50	50	50	50	50	150	150	150	150	150	1,000
User contribution	50	50	50	50	50	150	150	150	150	150	1,000

***Table 7.5* : Projected programme for leaf litter/biowaste, nightsoil and dung based community biogas plants**

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Target (no. of plants)	--	--	1	1	1	6	6	6	6	6	33
Cost (Rs. '000)	--	--	150	150	150	900	900	900	900	900	4,950
Suggested contribution to cost											
IREP (Rs. '000)	--	--	50	50	50	300	300	300	300	300	1,650
Other Govt. schemes	--	--	50	50	50	300	300	300	300	300	1,650
User contribution	--	--	50	50	50	300	300	300	300	300	1,650

Table 7.6* : *Projected programme for improved kerosene lanterns

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
100% potential											
Target (no. of lanternss)	2,000	4,000	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	50,000
Cost (Rs. '000)	210	420	578	578	578	578	578	578	578	578	5,250
Suggested contribution to cost											
IREP (Rs. '000)	105	210	289	289	289	289	289	289	289	289	2,625
User contribution	105	210	289	289	289	289	289	289	289	289	2,625
50% potential											
Target (no. of lanternss)	1,000	2,000	2,750	2,750	2,750	2,750	2,750	2,750	2,750	2,750	25,000
Cost (Rs. '000)	105	210	289	289	289	289	289	289	289	289	2,625
Suggested contribution to cost											
IREP (Rs. '000)	53	70	96	96	96	96	96	96	96	96	875
User contribution	53	70	96	96	96	96	96	96	96	96	875
25% potential											
Target (no. of lanternss)	500	1,000	1,375	1,375	1,375	1,375	1,375	1,375	1,375	1,375	12,500
Cost (Rs. '000)	53	105	144	144	144	144	144	144	144	144	1,313
Suggested contribution to cost											
IREP (Rs. '000)	26	53	72	72	72	72	72	72	72	72	656
User contribution	26	53	72	72	72	72	72	72	72	72	656
10% potential											
Target (no. of lanternss)	200	400	550	550	550	550	550	550	550	550	5,000
Cost (Rs. '000)	21	42	58	58	58	58	58	58	58	58	525
Suggested contribution to cost											
IREP (Rs. '000)	11	21	29	29	29	29	29	29	29	29	263
User contribution	11	21	29	29	29	29	29	29	29	29	263

***Table 7.7* : Projected programme for replacement of filament lamps by electronic choke and tubelights**

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
100% potential											
Target (no. of lampss)	3,600	7,200	9,900	9,900	9,900	9,900	9,900	9,900	9,900	9,900	90,000
Cost (Rs. '000)	1,440	2,880	3,960	3,960	3,960	3,960	3,960	3,960	3,960	3,960	36,000
Suggested contribution to cost											
IREP (Rs. '000)	720	1,440	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	18,000
User contribution	720	1,440	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	18,000
50% potential											
Target (no. of lampss)	1,800	3,600	4,950	4,950	4,950	4,950	4,950	4,950	4,950	4,950	45,000
Cost (Rs. '000)	720	1,440	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	18,000
Suggested contribution to cost											
IREP (Rs. '000)	360	480	660	660	660	660	660	660	660	660	6,000
User contribution	360	480	660	660	660	660	660	660	660	660	6,000
25% potential											
Target (no. of lampss)	900	1,800	2,475	2,475	2,475	2,475	2,475	2,475	2,475	2,475	22,500
Cost (Rs. '000)	360	720	990	990	990	990	990	990	990	990	9,000
Suggested contribution to cost											
IREP (Rs. '000)	180	360	495	495	495	495	495	495	495	495	4,500
User contribution	180	360	495	495	495	495	495	495	495	495	4,500
10% potential											
Target (no. of lampss)	360	720	990	990	990	990	990	990	990	990	9,000
Cost (Rs. '000)	144	288	396	396	396	396	396	396	396	396	3,600
Suggested contribution to cost											
IREP (Rs. '000)	72	144	198	198	198	198	198	198	198	198	1,800
User contribution	72	144	198	198	198	198	198	198	198	198	1,800

***Table 7.8* : Projected programme for replacement of filament lamps by CFL**

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
100% potential											
Target (no. of lampss)	6,400	12,800	17,600	17,600	17,600	17,600	17,600	17,600	17,600	17,600	160,000
Cost (Rs. '000)	2,080	4,160	5,720	5,720	5,720	5,720	5,720	5,720	5,720	5,720	52,000
Suggested contribution to cost											
IREP (Rs. '000)	1,040	2,080	2,860	2,860	2,860	2,860	2,860	2,860	2,860	2,860	26,000
User contribution	1,040	2,080	2,860	2,860	2,860	2,860	2,860	2,860	2,860	2,860	26,000
50% potential											
Target (no. of lampss)	3,200	6,400	8,800	8,800	8,800	8,800	8,800	8,800	8,800	8,800	80,000
Cost (Rs. '000)	1,040	2,080	2,860	2,860	2,860	2,860	2,860	2,860	2,860	2,860	26,000
Suggested contribution to cost											
IREP (Rs. '000)	520	693	953	953	953	953	953	953	953	953	8,667
User contribution	520	693	953	953	953	953	953	953	953	953	8,667
25% potential											
Target (no. of lampss)	1,600	3,200	4,400	4,400	4,400	4,400	4,400	4,400	4,400	4,400	40,000
Cost (Rs. '000)	520	1,040	1,430	1,430	1,430	1,430	1,430	1,430	1,430	1,430	13,000
Suggested contribution to cost											
IREP (Rs. '000)	260	520	715	715	715	715	715	715	715	715	6,500
User contribution	260	520	715	715	715	715	715	715	715	715	6,500
10% potential											
Target (no. of lampss)	640	1,280	1,760	1,760	1,760	1,760	1,760	1,760	1,760	1,760	16,000
Cost (Rs. '000)	208	416	572	572	572	572	572	572	572	572	5,200
Suggested contribution to cost											
IREP (Rs. '000)	104	208	286	286	286	286	286	286	286	286	2,600
User contribution	104	208	286	286	286	286	286	286	286	286	2,600

***Table 7.9* : Projected fuel savings from the programme for improved chulha**

	No. of Households	Firewood ('000 T)	Dungcake ('000 T)	Total
Fuel saving				
100% potential	50000	48.75	3.15	--
050% potential	25000	24.38	1.58	--
025% potential	12500	12.19	0.79	--
10% potential	5000	4.88	0.32	--
Fuel value saved ('000 Mkcal)				
100% potential	50000	195.00	7.88	202.88
050% potential	25000	97.50	3.94	101.44
025% potential	12500	48.75	1.97	50.72
10% potential	5000	19.50	0.79	20.29
Annual fuel value saved per Re (kcal/Re)				
		21,666.67	875.00	22,541.67

***Table 7.10* : Projected fuel saving from the programme for Deenbandhu type biogas plants**

	No. of households	Firewood ('000 T)	Dungcake ('000 T)	Kerosene cooking fuel ('000 kl)	Total
Fuel saving					
100% potential	30000	97.50	6.30	1.47	--
050% potential	15000	48.75	3.15	0.74	--
025% potential	7500	24.38	1.58	0.37	--
10% potential	3000	9.75	0.63	0.15	--
Fuel value saved ('000 Mkcal)					
100% potential	30000	390.00	15.75	10.80	416.55
050% potential	15000	195.00	7.88	5.40	208.28
025% potential	7500	97.50	3.94	2.70	104.14
10% potential	3000	39.00	1.58	1.08	41.66
Annual fuel value saved per Re (kcal/Re)					
		2,600.00	105.00	72.00	2,777.00

***Table 7.11* : Projected fuel saving for the programme for improved kerosene stoves**

	Hh	Kerosene cooking fuel ('000 kl)	Total
Fuel saving			
100% potential	50000	0.81	--
050% potential	25000	0.40	--
025% potential	12500	0.20	--
10% potential	5000	0.08	--
Fuel value saved ('000 Mkcal)			
100% potential	50000	6.46	6.46
050% potential	25000	3.23	3.23
025% potential	12500	1.62	1.62
10% potential	5000	0.65	0.65
Annual fuel value saved per Re (kcal/Re)			

		702.70	702.70

***Table 7.12* : Projected fuel savings from the programme for nightsoil and dung based community biogas plants**

	Hh	Firewood ('000 T)	Dungcake ('000 T)	Kerosene ('000 kl)	Total
Fuel saving					
100% potential	10000	23.10	1.50	0.35	--
050% potential	5000	11.55	0.75	0.18	--
025% potential	2500	5.78	0.38	0.09	--
10% potential	1000	2.31	0.15	0.04	--
Fuel value saved ('000 Mkcal)					
100% potential	10000	92.40	3.75	2.57	98.72
050% potential	5000	46.20	1.88	1.29	49.37
025% potential	2500	23.10	0.94	0.64	24.68
10% potential	1000	9.24	0.38	0.26	9.88
Annual fuel value saved per Re (kcal/Re)					
		3,080.00	125.00	86.67	3,378.34

***Table 7.13* : Projected fuel saving for the programme for leaf litter/biowaste, night soil and dung based community biogas plants**

	Hh	Firewood ('000 T)	Dungcake ('000 T)	Kerosene cooking fuel ('000 kl)	Total
Fuel saved					
	1650	5.36	0.35	0.08	--
Fuel value saved ('000 Mkcal)					
	1650	21.45	0.87	0.65	22.96
Annual fuel value saved per Re (kcal/Re)					
		4,333.33	175.00	130.67	4,639.00

***Table 7.14* : Projected fuel savings for the programme for improved kerosene lanterns**

	Hh	Kerosene lighting fuel ('000 kl)	Total
Fuel saving			
100% potential	50000	0.27	--
050% potential	25000	0.13	--
025% potential	12500	0.07	--
10% potential	5000	0.03	--
Fuel value saved ('000 Mkcal)			
100% potential	50000	2.15	2.15
050% potential	25000	1.08	1.08
025% potential	12500	0.54	0.54
10% potential	5000	0.22	0.22

Annual fuel value saved per Re (kcal/Re)			
		409.90	409.90

<u>Table 7.15</u> : Projected fuel savings for the programme for replacement of filament lamps by electronic choke and tubelights

	Lamps	**Electricity (kWh)**
Electicity saved		
100% potential	90000	2,207,850.83
50% potential	45000	1,103,925.42
25% potential	22500	55,196.71
10% potential	9000	220,785.08
Annual energy saved per Re (kWh/Re)		
		0.08

<u>Table 7.16</u> : Projected fuel savings for the programme for replacement of filament lamps by CFL

	Lamps	**Electricity (kWh)**
Electicity saved		
100% potential	160000	4,237,049.28
050% potential	80000	2,118,524.64
025% potential	40000	1,059,262.32
10% potential	16000	423,704.93
Annual energy saved per Re (kWh/Re)		
		0.11

***Table 7.17* : Expenditure on training and stipend of para professionals**

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Stipend	270,000	630,000	990,000	1,350,000	1,710,000	1,710,000	1,440,000	1,080,000	720,000	360,000	10,260,000
Training expenses	90,000	90,000	90,000	90,000	90,000	90,000	--	--	--	--	540,000
Persons inducted	30	30	30	30	30	30	--	--	--	--	180
Total expenses	360,000	720,000	1,080,000	1,440,000	1,800,000	1,800,000	1,440,000	1,080,000	720,000	360,000	10,800,000

***Table 7.18* : Projected fuel savings for the entire programme at 100% potential**

	Firewood ('000 T)	Dungcake ('000 T)	Kerosene cooking fuel ('000 kl)	Kerosene lighting fuel ('000 kl)	Electricity ('000 kWh)
Improved chulha	48.75	3.15	--	--	--
Family biogas plants	97.50	6.30	1.47	--	--
Improved kerosene stove	--	--	0.81	--	--
Community biogas plant (night soil and dung)	23.10	1.50	--	--	--
Community biogas plant (night soil and dung with litter/biowaste)	5.36	0.35	0.08	--	--
Improved kerosene lantern	--	--	--	0.27	--
Electronic choke and tube	--	--	--	--	2,207.85
CFL	--	--	--	--	4,237.05
Total	174.71	11.30	2.36	0.27	6,444.90

***Table 7.19* : Fuel value of projected fuel savings for the entire programme at 100% potential**

	Firewood ('000 Mkcal)	Dungcake ('000 Mkcal)	Kerosene cooking ('000 Mkcal)	Kerosene lighting ('000 Mkcal)	Total fuel ('000 Mkcal)	Electricity ('000 kWh)
Improved chulha	195.00	7.88	--	--	202.88	--
Family biogas plants	390.00	15.75	11.76	--	417.51	--
Improved kerosene stove	--	--	6.46	--	6.46	--
Community biogas plant (night soil and dung)	92.40	3.75	--	--	96.15	--
Community biogas plant (night soil and dung with litter/biowaste)	21.45	0.87	0.65	--	22.96	--
Improved kerosene lantern	--	--	--	2.15	2.15	--
Electronic choke and tube	--	--	--	--	--	2,207.85
CFL	--	--	--	--	--	4,237.05
Total	698.85	28.24	18.87	2.15	748.11	6,444.90

***Table 7.20* : Impact of entire biofuel programme on the pressure on the commons at different levels of achievement of potential**

Programme coverage as % of potential	Projected 2010 dry biomass extraction from the commons ('000 T)	Estimated firewood saving from the entire programme ('000 T)	Dry weight of estimated firewood saving from the entire programme ('000 T)	Estimated area of forests and commons (ha)	Extraction rate from commons (T dry biomass per ha)	Reduction in extraction rate due to programme (T dry biomass per ha)
100%	169.79	174.10	139.28	39.50	0.77	4.50
50%	169.79	87.05	69.64	39.50	2.54	2.25
25%	169.79	43.53	34.82	39.50	3.42	1.12
10%	169.79	17.41	13.93	39.50	3.95	0.45

Annexure 7.1

Sustainable and Affordable Energy in Rural and Small Town Communities

K. R. Datye

Abstract

The paper presents an energy perspective based on mass utilisation of renewable energy a paradigm change is foreseen which aims at energy self reliance. Energy will be affordable for poor while the availability of energy will be rapidly improved with improved cost recovery so that adequate finance can be mobilised.

With a systemic synergy between energy and materials input constraints will be overcomed. Advances in material technology based on biomass and renewable energy will contribute to cost reduction in construction of facilities and fabrication of equipment.

By use of biomass fuel in conjunction with hydro and wind energy system biomass fuel requirement will be reduced and further with cogeneration the energy generation will become competitive with conventional options.

The result of parametric studies are presented, cost of generation for replicable system of 6.5 MW to serve a variety covering the whole range of users including small producers irrigation and lightening needs in isolated locations through user participation in management with internal cross subsidies through differential tariff have been worked out. The energy will be affordable to poor because irrigation cost of proposed system will be competitive with conventional options based on supply from grid of electricity generated in mega projects based on imported fuel and yet cost recovery obligation will be made for capital investment with commercial rates of interest. By availing the interest subsidy the user producers community would become entitled to low interest rate finance which would further contribute to cost reduction.

A methodology of water balance and biomass balance study is described and results of on going studies with participation of rural communities are presented which serve to establish how the competition with regards to land and water required for agriculture will be avoided.

==

1.0 Introduction

Biomass is an input to serve various end uses of energy such as fuel and material for construction or equipment fabrication. Biomass use can be reduced by use of solar thermal energy, hydro - power in hybrid systems. Biomass can also be used for the productions of liquid fuels, intermediates and fine chemicals. An important consideration in energy planning, is the generation and sustenance of biomass surplus after meeting the subsistence need of fodder and fuel. It can be seen from the overview presented later that various biomass inputs such as wood bamboo fibers, starch from tubers and produce from forest trees and trunks such as oil resins and latex can be produced from waste lands unsuitable for agriculture production.

The waste land which would be developed with labour intensive technologies using very limited quantity of irrigation water supplied from local storage reservoirs. Preliminary water balance studies show that the required water doesn't create allocation problem since it is not needed in the good years for agriculture. This variable water when acquired over the hydrological cycle can be sufficient for the yield consumption needed to generate the desired biomass surplus.

2.0 Technology assessment criterion.

We propose the following parameters for assessment of technologies for renewable energy generation and biomass utilisation.

Energy Gain Ratio (EGR)

Energy Gain Ratio (EGR) is defined as the ratio of net energy generated over the service life of plant and equipment to the energy invested in the installation. Energy required, to produce and transport equipment must also be included. For example, the solar collector design proposed in this paper require 40kg of steel and would produce heat energy equivalent to 1kg coal per day. Three kilograms of coal are required to manufacture one kilogram of steel. Over a service life of 20 years, use of this solar collector will result in a coal saving of 5000 kg, while investing an energy equivalent of 120 kg of coal. This leads to an energy gain ratio > 40. This is a simple illustration of this parameter, in practice all material and fabrication energy inputs will be need to be considered.

Coal Replacement Value Multiplier (CRV)

This parameter reflects the energy conservation benefits of the materials technologies. The goal of these technologies is to add use or market value to biomass by processing. Otherwise, unprocessed biomass is only equivalent to 1 kg of coal. For example, the preservative treated wood and reconstituted wood can replace 1 to 2 kg of steel with equal structural capability. Since 1 kg of steel requires 3 kg of coal energy input, we obtain a CRV multiplier of 3 to 6. Similar value addition prospects exist when biomass is used to produce chemical intermediates, liquid fuels, resins and pesticides.

Energy Self Reliance

The strategic goal is to balance the exchange between the rural and small town population and the urban, industrial economy. This would be measured in monetary as well as energy terms. The goals would be accomplished by having net excess in the coal replacement value of locally produced biomass and renewable energy over external inputs. The exchange should be balanced in monetary as well as energy terms. Energy Self reliance can be achieved by giving a priority to the development of techniques with a high Energy Gain Ratio(EGR) and the use of materials with a high CRV Multiplier.

If the EGR and CRV values for specific technology are higher than the minimum values established through energy growth rate analysis the availability biomass and fossil energy would not be a constraint.

Benefit of trade is recognised in the concept of self - reliance. Hence it would not suffer the rigidity of a closed economy based on self - sufficiency. Thus consumption need not be restricted to material or energy from local sources.

3.0 Energy end-use

Usually energy demand is considered in terms of fuel supply or electricity. In developing countries investment needs for infrastructure and development of energy sector should take a priority over consumption needs. Renewable sources have an advantage of saving of fuel inputs for energy generation and material inputs for construction and fabrication of equipment. However they have been significant investment liability. It is often not recognised that process energy is a major end use and supply where demand options exists with regard to the form of energy i.e. heat and mechanical versus electricity. Conversion transmission and distribution losses add to the cost of energy. If renewable energy can be used locally in the form in which it is produced investment cost for transmission and transport can be reduced and conversion losses can be minimised.

The following grouping of end uses was done to facilitate demand management by consideration of energy generation and supply options. It was seen from energy growth analysis presented later that the sustenance of biomass surplus may become a major constraint if it is directly used as a fuel to substitute conventional fuel sources. Alternatively if biomass is a material input supply constraints can be minimised with right technology choices.

There is a second order benefit when biomass is used to fabricate renewable energy generation equipment. Further through demand management renewable energy can be used in various forms as process energy. In hybrid systems such as solar thermal and mechanical to save fossil fuel and electricity a matrix analysis will be peresented in the next paragraph and which will help understand feed back loop and to evaluate second order benefits.

The major end uses are grouped in four categories -

Materials:

Inputs for development of water resources energy generation and infrastructure facilities to serve various needs like building sanitation water supply and roads.

Electricity:

Electricity for domestic, commercial, light industry and irrigation pumping needs etc.

Process Energy:

Mainly heat and mechanical energy in conventional industries such as biomass processing, i.e. agro and forest products industries, local mineral processing such as rock, sand, clay, lime, waste recycling. Advanced medium temperature processes would also be considered such methane reforming pyrolysis, chemical processes such as distillation concentration, separation, mechanical processes for small industrial units like wire drawing forging etc.

Over a long term electricity from renewable sources can be used in conjunction with solar thermal and gasified low grade fuel can be used for high temperature furnaces closed control on frequency and voltage would be required and energy generation costs could be brought down in several applications through coordinated efforts of energy users and providers.

Chemicals:

Basically organic chemicals produced with biomass input in dispersed industry. Small quantity of fossil fuel based materials would be blended e.g. phenol formaldehyde with phenol from biomass. It would be seen from the matrix that CRV multiplier is a important consideration for achieving desired growth of the energy sector for the demand pattern presented later in the section 5.0.

4.0 Growth rate analysis.

Physical constraints on energy growth rate are considered and scenario has been worked out to examine the impact on growth rate. A high rate of growth in energy and infrastructure sector is foreseen. The growth table shows that energy saving required to produce necessary inputs will not exceed 300 kgcr. With CRV of around 2.4 a biomass of input of only 125 kgcr and a fossil input of 50 kgcr is needed. Thus with the proposed CRV and EGR input constraints can be easily overcomed.

It was recognised that the fuel inputs are required.

- Availability depends on the rate of saving.
- The growth analysis presented in the following table has a preparatory phase of ten years. In the first five years the process bio resource base will be to build up and in the next five years the technology upgradation will be done to get higher energy gain ratios.

The following table illustrates the growth in per-capita, per-year renewable energy generation that is possible when the initial renewable energy equipment has an EGR of 60, and 10-15% of the energy generated is invested in additional renewable energy generation infrastructure every year. It can be seen that under such conditions, and assuming a service life of 20 years for the equipment, the renewable energy component of about 1300 kgcr that is envisaged in the 2025 scenario can be achieved in about 6 years.

Renewable Energy Growth Table
(All values in kgcr/capita/year)

Year	Generation #	Saving •	Increment +	Energy Gain
1.	500	50	----	1:60
2.	500	50	----	"
3.	650	65	150	"
4.	650	65	----	"
5.	845	84.5	195	"
6.	845	84.5	----	1:40
7.	1015	155	170	"
8.	1015	155	----	"
9.	1325	200	310	"
10.	1325	200	----	"
11.	1625	245	300	1:30
12.	1625	245	----	"
13.	1995	300	370	"
14.	1995	300	---	"
15.	2445	----	450	"

- In the above scenario the rate of saving is 10% for the first five years then the from sixth year onward the rate of saving is assumed as 15%.
- It is assumed that new equipment starts generating after a time loss of two years from the year of investment.
- Annual increment of generation works out to energy gain ratio / service life. Thus , the investment of 50 Kg in the first year starts giving incremental generation of 150Kg / yr. after two years when energy gain ration is 60.
- With a service life of 20 years multipliers are 3, 2, 5 respectively for energy gain ratio of 60, 40, 30 respectively.
- With growth of energy sector labour cost will rise and hence energy gain ratio will down ,also biomass will become a constraint at high rate of investment hence energy gain ratio reduces.
- It is evident from the above tables that even half of the targeted energy saving and renewable energy usage is incorporated the energy availability considered in the energy production scenario can be easily achieved.

- Energy saved is traded with fuel and biomass and invested into renewable energy generation and conservation facilities .
- Even if this entire 300 kgcr invested is fossil fuel it should be possible to obtain the fuel inputs from local sources or imports of cheap low grade fuels. For a five fold increase in the energy generation fuel consumption in India will be within the acceptable norms of the global worming mitigation. Most of the renewable material will be produced in small industries and large industries.

5.0 Scenario 2025 with input output matrix

In the scenario it is assumed that technologically the energy gain ratio considered in the following tables are already achieved.

The energy scenario for 2025 presented here pre supposes a restructuring of the energy, water, agriculture and allied sectors. Providing a basci service to all at affordable rate will be possible by use of interest subsidies as a insentive for metigaion of C02 emmission and dispersal. Withdrawal of consumption subsidy will be socially acceptable with reduce transportation demand resulting from reduction of distance between workplace and habitation. More specifically, we adopt an integrated view that encompasses biomass production, food processing, and processing of biomass for infrastructure input and chemical intermediate production. It shows that the restructuring makes it possible for India to overcome resource constraints and reach a quality of life comparable to that of post-Second World War Europe on the basis of an energy availability of 2500 Kgcr.

The demand assessment is generally on the lines of work Mr. A. K. N. Reddy, Mr. Gustavson

The following tables indicate how energy self - reliance can be achieved and various needs can be fulfilled through an optimum combination of biomass, fossil fuel and renewable energy. In fact biomass could play a major role in making renewable energy competitive with fossil energy. The scenario shows how a five fold improvement in the energy availability can be achieved without significant increase in the fossil energy supply. The critical input is biomass and the starting point is therefore creating the essential biomass surplus after fulfilling the basic needs. The study shows how energy in various forms i.e. materials, process energy, chemicals and electrical energy for domestic, commercial and industrial use become available in the optimized hybrid system. The affordability and availability of renewable energy and materials for infrastructure is critically dependent on supply of necessary biomass inputs.

Energy Production Scenario for 2025

(All values in kg/capita/year)

END USE

	Materials	Electricity	Process Energy	Chemicals*	
Biomass	**250**	**100**	**-**	**90**	**350**
Fossil (std.)	**100**	**250**	**80**	**120**	**350 std. Coal**
Local low grade fuel		**100**	**80**	**120**	**300**
Renewable (solar, wind, hydro)	**100**	**300**	**620**	**300**	**1320**
Energy Availability	**600 (kgcr)**	**900 kWh**	**700 (kgcr)**	**300 (kgcr)**	**2500 (kgcr)**
C.R.V. Multiplier	**2.4**			**3.3**	

- 90 Ethanol equivalent. The column chemical includes liquid fuels, chemical intermediates and fine chemicals. The biomass input required is the input required to produce liquid chemicals have energy equivalent of 90 liters of ethanol.
- Solid fuel energy is taken as standard fuel of 4000 kcal per kg. This is the fuel value of common Indian coal. This is half of petroleum products which is around 10000 kcal per lit. Currently we are considering 500 cc. Petroleum as equivalent to our standard fuel of one kg.
- Chemicals like liquid fuels intermediate chemicals and fine chemicals are considered e.g. ethanol, methane, styrene etc.
- Fuel efficient engines consume per kWh 1250 kcal where as coal based plants of large turbine consume 2500 kcal and that of small turbine 3000 kcal along with this they also have heavy transmission losses. On the other hand chemical based prime movers can be used directly at the workplace. Hence the ratio of coal value multiplier for ethanol is taken as 3.3.
- The energy input figures in materials and chemical by low grade fuels and renewable energy are interchangeable and can be decided on the availability of the sources. This gives a higher flexibility for the functioning of the system. This is possible because of the dispersed nature of the project.

In order to reach the situation presented in the Scenario for 2025. It is clear that the renewable energy infrastructure has to grow considerably. We believe that such growth can be achieved if 10 - 15% of the energy produced every year is invested into building new infrastructure for harnessing renewable energy.

This table basically depicts the input output matrix of the energy system.

Biomass, Local low grade fuels like fossil (e.g. lignite), Renewable energy sources such as solar, wind and hydro.

The outputs for which the energy will be used are grouped in four categories.

Group1: Materials used for water and energy resource development and related facilities and infrastructure for transportation and habitat. This will cover the whole range of equipment's and structures for roads and bridges, waterways, pipelines, waste water treatment plants, storage reservoirs, windmills, hydro power and solar thermal energy generation. Biomass to be used in combination with synthetic polymers, metals (steel) and ceramics.

Group 2: Hybrid energy generation systems for domestic, agricultural and commercial use.

Group 3: Process heat and electricity used for processing local minerals, waste recycling and production of advanced materials.

Group 4: Biomass based chemicals and liquid fuels with a blend of coal or petroleum based chemicals.

The figures in the table are equivalent Kilograms of coal having calorific value as 4000 Kcal/kg. 'Kgcr' indicates replacement values of 'Coal Equivalent Kg' of products with equal use or market values. The figures in the table are 'per capita'.

6.0 Parametric Study of Energy Generation Costs.

A widely replicable hybrid system with solar biofuel, fossil fuel and hydropower is considered in the table below. The values may be scaled up according to the size of installation. A 6.5 MW system is expected to serve 6000 rural and small town households (Values in the following table are based on requirement of six households -- 24000 KWh per year as against present availability of only 6000 KWh). One U.S. $ = Rs. 43/- (subject to variation)

Source	KWh /year	Installation KW	Capital cost/ Rs./kW	Fixed Cost			Fuel Cost		Cost
				Investment Rs.	Annual Levalised cost	Cost Per year	Cost/KW	Cost/year	Rs / kW
Gas /Liquid Fuel	1800	1.0	10000	10000	@20%	2000	3.00	5400	**4.11**
		2.5	25000	62500	@20%	12,500			
Biomass	5000 *	---					1.28	6400	
Fossil	6000 *	---					1.28	7680	**2.41**
Solar	5000 *	---	30000	75000	@16%	12,000	---	---	
Pumped Storage	800	1.0	10000	10000	@16%	1,600	2.0 X 1.0 #	1600	
Hydro Small	1200	1.0	20000	20000	@16%	3200			
Hydro Large	1200	1.0	20000	20000	@16%	3200			**2.03**
Grid Supply	3000		--	--	--	--	1.0	3000	
Total	**24000**	**6.5**		**197500**		**34,500**		**24080**	**2.45**

- For steam turbine Source wise break is as above, with total of 6,400 x 2.5 = 16,000 kWh/year
- #Pumped storage used for storing off-peak energy priced at 1 Rs /kWh.
- Off peak energy input of 2.0 KWh to deliver 1.0 kWh on demand during peak hours
- Average installation cost works out to Rs. 31,385/kilowatt.
- Solar Collector Area 6 m2 /kilowatt at Rs. 5000/m2
- Average Generation Cost resulting from above analysis Rs. 2.45/ kWh, after adding Rs. 0.25/kwh for operation, maintenance and overhead, break even tariffs works out to Rs. 2.7/kwh at distribution transformer.
- The biomass fuel is priced at 1.6 Rs./kg of dry processed fuelwood. This allows for 1 Re./kg. For collection and protection and 0.6 Rs./kg. for processing. Considering an energy value of 4000 kcal/kg. A fuel cost works out to Rs. 0.4/1000 kcal. This is comparable to the present cost of coal in India in areas with transportation limited to about 500km.
- The parameters reflect average values for techniques currently in use as well as field-tested innovations for solar.

The solar biomass hybrid system cost and grid integrated with small and large hydro are viable and competitive with mega project options. They have no liability for transmission, since new generation will be mostly near the demand centers. within economic

The average generation cost is competitive with mega projects. There is a margin of 10% for average selling price of Rs. 3 per kWh.

7.0 Overview of technology development (Materials and Hydro)

The technology development is simultaneously done in the three major renewable sources of energy viz. solar thermal, small hydro and wind energy. Along with these developments, developments also have been done in the field of wood bamboo composite structures which can be used in the infrastructure development.

It has been found that the development work in the composites has been competitive with the existing infrastructure facilities available in the market.

It is established that the solar thermal equipment can be fabricated in small workshops which doesn't require spcialised manufacturing facilities in a very economical price. The existing manufacturing prices of one sq. meter area is 7500 Rs which is competitive as compared to the international coated prices of solar dishes which are around 9000 Rs. It has also been realised that with optimisation with composite materials the cost of fabrications can be brought down to 4500 Rs. Currently the energy gain ratio available from solar thermal dishes is around 30 which can be raised up to 60 by composite optimisation.

8.0 Details of chemicals

HIGH VALUE CHEMICALS AND LIQUID BIOFUEL PRODUCTION

Chemical intermediates having an equal energy value such as butanol isopropanol, acetone and ethanol have higher market values as compared to diesel or fuel oil. Production of ethanol and chemical intermediates per hectare of land in the common property domain can easily be taken at 2000 liter/ha/year for plots of sweet sorghum, sugarcane, cassava (Table and 3). Assuming consumption of 500 Kwh/family/year or 150 litre of liquid petroleum fuel/year, requirement of 100 families of liquid fuel works out to 15 kiloliters of diesel. This can profitably be exchanged with equal quantity ethanol and chemicals at market prices. In watershed projects preference should be given to allocation of funds to the enterprises of the poor for production of inputs into the liquid fuel or chemical intermediates production. For land producing biomass input such as cassava, sweet sorghum, Brazilian average is 2000 litres of ethanol ha/year. With Prayog arriver techniques this can be increased to 3000 litres/ha/year (Annex 1). The requirement of land then reduces to 5.0 ha for 100 families.

There are several other products which have a high energy and market value such as pesticides, latex, oils, resins (Table 1). Usually their plantations have longer periods of yield realisation. There is no hazard of market saturation as a wide range of application possibilities exist. Diversity of biomass production can be maintained and a mix can be chosen of early maturing species and other which requires longer period for yield realisation/establishment. This will enable a strategy to be worked out for phased development where by overall availability of bioenergy can be raised progressively (Tables 1,2 and 3).

Table 1 **High Value Biomass Products. Inputs for Liquid Fuel and Chemical Intermediate Production.**
- Starch - various tubers including tapioca, cassava, sweet potato - Sugary juices - sweet sorghum, sugarcane and palms - Various oils essentially as energy or chemical intermediates - Jatropha - Valuable oils with preservative and pesticides value such as neem, Karanj Latex including Jatropha - Acrylic resins - from latex yielding dryland species - Phenols including cashewnut shell and Bhilava nut (Bibba) - Tannin - Bark and Harda

The above list does not include items which have very specific uses and therefore difficult to market such as medicinal herbs, and consumer products such as perfumes, essential oils, flowers with hazard of market saturation.

Table 2

Ethanol Yields of Various Crops,
Based on Average Yields in Brazil

Two crops a year are possible in some areas. Cassava yields could be boosted to 3600 liter/ha/year by improved cultivation technologies (except for corn which is based on US yields).

	Ethanol yield from crop Crop (lit/T)	Crop yield (T/ha/yr)	Ethanol yield (lit/ha/yr.)
Sugarcane	70	50#	3500
Cassava	180	12#	2160
Sweet Sorghum	86	35*	3010
Sweet Potato	125	15	1875
Corn (maize)	370	6	2220
Wood	160	20	3200

Ref: John W. Twidell, Anthony D.Weir, 'Renewable Energy Resources'

Table 3
Types of Raw Materials Potentially Useful for Microbial Conversion to fuels

Ethanol	Acetone-Butanol	Butanol-Isopropanol	Acetone-Ethanol
Molasses	Molasses	Molasses	Molasses
Sulfite liquors	Sulfite liquors	Sugarcane	Potatoes
Cellulose pulp	Corn cobs	Sulfite liquors	Peanut Hulls
Potato products	Wood sugars	Starchy products	Corn cobs
Citrus waste	Cassava		
Sweet potato			

Ref : National Academy of Sciences 'Energy for Rural Development'

Table 4
Ethanol Production
Energy analysis of ethanol production from various crop substrates

Data refer to the gross energy requirement for the crop input and each component of manufacture : unit MJ/kg of anhydrous ethanol produced. The heat of combustion of the output ethanol is 30 MJ/kg.

Sr. No.		Sugarcane	Cassava
1.	Substrate	7.3	19.2
2.	Chemicals	0.6	0.9
3.	Water pumping Rs. 1/kwh	0.3	0.4
4.	Electricity Rs. 1/kwh	7.0	10.5
5.	Fuel oil Rs. 1/kwh	8.0	29
6.	Machinery and Buildings	0.5	1.2
7.	Total (1 to 6) : MJ/kg	24	61
8.	Net Energy : 30 MJ/kg - (7)	+8	-31
9.	Total (1 + 2 + 6)	8.4	21
10.	Net Energy : 30 MJ/kg - (9)	+21	+9

Ref: John W. Twidell, Anthony D. Weir, 'Renewable Energy Resources Materials, Energy, Fuels and Biomass System Sustainable Options for conventional Fossil Energy Technology.

Various end-uses

- Liquid and soil fuels, and solar thermal energy use in hybrid systems for electricity and heat energy production and dispersed materials production.
- Allocation of 0.1 hectare to produce inputs for liquid fuel and chemicals intermediate production. When combined with entitlement to water and assistance for education and employment. The production potential would be at least 300 litres of ethanol or equivalent energy value as butaneol acetone or high value oils such as Jatropha, phenolic resins, latex as acrylic substitute.
- The energy value would be equivalent of 1500 kg coal replacement value.

Pesticides and medicinal herbs would be high value item requiring for production, an extended period of 5 to 8 years. Care and attention will be needed to the tree crop areas a whole range of consumer products, herbs cosmetics can also be produced and this being supplementary item of income livelihood would not depend on production and marketing of this consumer items.

Biomass based materials such as wood, bamboo fibres will provide inputs for a whole range of infrastructure needs i.e. buildings, habitat infrastructure and transportation, pipelines, waterways, bridges, roads, containers, barges.

Equipment and facilities for water and energy production would also use biomass based materials and solar thermal processed energy based inputs. This will contribute to raising of the energy gain ratio.

With inter connection and hybrid energy use (wind/hydro) based electricity in conjunction with high temperature solar equipment would provide process energy for energy intensive conversion of methane into high value fuels and chemicals. This solar aided production of water - gas and methane reforming will provide inputs for chemical industry. Methane could be natural gas or derived from biomass. The renewable energy hybrid system can as well be used for high-tech production of ceramic carbon fibre glass fibre.

9.0 Land use modeling

It is necessary to take up studies of an energy input output, water balance and productivity of land to access the potential for biomass use. Market mechanism can be used to optimise the allocation of land and water to biomass production and their by to augment the biomass supply. There is a very good prospect of overcoming the supply constraints through value addition by availing advances in materials and renewable energy generation technology.

However, it is necessary to ensure that the market mechanism doesn't not result in encroachment on the subsistence base of the poor. The main objective of the land use, water balance and productivity studies would be determine decide the policy on regulations of trade in water and restriction of private ownership of land. The regulation and land legislation should result in building common resources pool of water and biomass and ensure access for the poor to this pool.

The land use and water balance studies should be performed to establish the minimum water requirement for household food security and to provide fodder and fuel to satisfy basic domestic and cattle needs.

Water for the minimum needs should be exclude from the tradable component and the biomass market would also have to be regulated by allocating the share of the produce to the resource poor families which can be determined on the basis of the regional needs of material input requirements of the biomass based material production systems.

In areas of water scarcity and population pressure interest subsidies for the solar energy system and supply of low grade fuels through a public distribution systems would contribute to overcoming fuel shortages.

This will help to overcome the short term distress of the poor when due to restriction imposed that rural communities are subjected to the poor on grazing and fuel collection on common lands and degraded private wastelands.

Pilot projects can be taken up based on the technology for wood bamboo and fiber processing which is in advanced state of development to validate the income generation potential assessment for the dispersed material production units.

Domestic fuel needs of 2 ton biomass can easily be met from low grade fuel of only about 500 kg in conjunction with solar thermal energy, biomass to meet the domestic needs.

The briquetting technology for low grade fuel has a very good market potential and the cost of briquetting can be brought down by using the waste heat of solar thermal energy based equipment for electricity generation and mechanical energy supply.

Just about a ton of biomass supply to each household for value added processing would generate income of 5000 Rs. which will make the low grade fuel affordable since its cost is not likely to exceed 1000 Rs/household.

This opens up the avenue of immediate shift to interest subsidy to make withdrawal of subsidies for electricity and water and reallocating public funds to create incentives for technology which could be used to enhance biomass production on wasteland by ensuring early establishment, high survival rates and yield improvement with very optimal use of chemical inputs.

By combination of scientific and participative approach the studies should aim at identifying areas. The studies can also be used for identification of area where pilot projects can be taken up. Overall objective would be to test the validity of the postulations of this paper that use of biomass as an energy input will not compete with agriculture and would not thereby encroach on the livelihood of the poor.

Annexure 7.2

List of NGOs and their addresses

Given below is a list of NGOs and organisations, along with their addresses, working in Solapur district and the nearby areas who could be associated with the energy programme in the block.

e) ***Mahatma Phule Samaj Seva Mandal***
Niyojan nagar
Jamkhed Road P.B.No 9
Karmala
District Solapur 413203
Contact person: Shri Pramod Zinjade
Tel. No. 02182-20609

f) ***Model Action for Rural Change***
'Nimbonichamala' At post Kem
Taluka Karmala
District Solapur 413223
Contact person: Shri Shivaji Talekar
Tel. No. 02182-40760/40778

g) ***Nisarg Yatri***
20, Pundaliknagar,
Pandharpur
District Solapur 413304
Contact person: Shri R. Govind Sabnis
Tel. No. 020-6870957, 6878243

h) ***Vanashthali Rural Development Centre***
318/19 B Canal Road
Shivajinagar
Pune, 411016
Contact person: Prof. Nirmala Purandare
Phone 020-5651550

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