Natural Resources Management

Addressing Household Energy Needs the Clean Fuel Way:
A Case Study of Narlewadi

Sujaya Dangwar
with Sunil Agarwal

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Contents

List of Abbreviations

CBO:	Community Based Organisation
FGD:	Focus Group Discussion
HHs:	Households
IGWDP:	Indo German Watershed Development Program
MSEB:	Maharashtra State Electricity Board
RE:	Renewable Energy
RRC:	Regional Resource Centre
SHG:	Self Help Group
SHL:	Solar Home Light
SMS:	Samyukta Mahila Samiti
VDC:	Village Development Committee
WSD:	Watershed Development
WOTR:	Watershed Organisation Trust

Foreword

Women, energy for cooking and sustainability of the watershed development projects are closely interlinked. Yet it is found that addressing the cooking energy needs have not yet become part of watershed development plans.

My very first interaction with women in watershed development was way back in 1995, when I joined WOTR as Coordinator for Women's Promotion. The women pleaded for an appropriate alternative for cooking fuel, so that the ban on tree felling (for cooking needs) would not bear heavy on them. Since then, we in WOTR have been attempting to construct a menu of tested alternatives so that women and households can choose the stove/s based on the pocket, which suits the local context, reduce women's household chores and which contributes to maintaining the tree cover. Over the years, various stove / chula pilots have been made in our villages. We are not satisfied with just putting these trials on the ground and counting these as successful initiatives. We realize the need of studying the projects to determine if the initial intent is adequately addressed. We realize that it is important to re-visit projects and identify gaps, as also to adequately address newer demands in a fast changing context.

We in WOTR have realized that we need to continuously learn, even from the small and big negative findings and not be satisfied with overall successes. In fact the gaps and so-called mistakes are really the best pointers of what needs to be addressed. The subtle negatives, which are often overlooked, are actually issues that will affect the sustainability of the initiative in the long run. Learning through such studies / evaluations helps to fill in the gaps and to improve the quality of the next interventions.

This case study shares with you the findings of what is considered even by the people of Narlewadi, a successful project. They are very proud of their project that has drawn many visitors from the district, from other parts of the state and the country. The women are rightly proud of their achievements.

We share our findings with a hope that you, who are donors, project designers and implementers can benefit as we do.

Marcella D'Souza,
Executive Director, WOTR

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This case study would not have been possible without the co-operation of the residents of Narlewadi, especially the women folk, and Mr. Lote, the Panlot Sevak (PLS) of Narlewadi. We would like to thank Mr. Haribhau Nagre, Mr. Sheldon Mendonca and the entire team of WOTR, Aurangabad RRC for their unrelenting support.

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Sujaya Dangwar
Sunil Agarwal

Abstract

The renewable energy (RE) initiative was taken up in Narlewadi in 2006 with two major objectives. One, to protect the tree cover ensuring sustainability of the watershed development project and two, to reduce the drudgery of women. Through the RE project solar home lights and gobar-gas units that were linked to household toilets were introduced in Narlewadi hamlet. Prior to the RE initiative, there was heavy dependence on fuel wood, cow dung and agricultural residue for cooking, as is the situation in most if not all villages in rural India. However, in the post project period, almost all households now use the solar home light. With regard to cooking fuel, a little less than 50% of the households use gobar-gas for the entire cooking. While the gobar-gas units are functioning well and are being used daily, it appears to be the second source of energy. Almost all households are still using the traditional chula with fuel wood and agriculture residue. The main use of the traditional chula is for heating water and preparing "bhakar" – the staple sorghum & pearl millet bread. This study shows that to adequately replace the traditional energy sources, appropriate alternatives are required.

With the introduction of the solar home lights and the gobar-gas stoves, women benefit. They save time and money. They gain many other social benefits. Today the people of Narlewadi are rightly proud of their success and achievements.

Section 1: INTRODUCTION

1.1 Introduction

In watershed development programs across the country, the main objective is to improve water and soil conservation and to enhance the economic returns through improved agriculture. WOTR has developed the capacities of various NGOs and village CBOs to implement participatory watershed development whereby the local institutions are also equipped to manage their natural resources in a sustained manner. One of the preconditions of accepting WSD is that the villagers accept to ban felling of trees in the village and forest lands nearby and free grazing on treated areas. Lopping, without destroying the tree is permitted. During the implementation of the project, tree plantation is also carried out extensively. However, as the basic need of cooking fuel is not sufficiently addressed, it is observed that the households living in these treated watersheds are still dependent on fuel wood and dried livestock dung (dirty fuels) to meet the cooking energy requirements, which in turn results in cutting of trees. Hence unless the cooking fuel requirement is adequately met, the sustainability of the measures undertaken during the WSD is severely challenged.

While attempts to meet the fuel need was initiated back in 1996, through the introduction of smokeless chulas and where feasible the gobar gas, it was in 2006, that WOTR initiated the renewable and alternative energy activities in the watershed project villages. The main purpose was to ensure the sustainability of the tree cover undertaken during watershed implementation, while at the same time to reduce the drudgery of women. All other benefits that accrue during this process are incidental.

In Narlewadi hamlet, watershed development was started in April 2005 under the WASUNDHARA approach of WOTR. It was funded by the Swiss Development Cooperation (SDC) and was completed in March 2009. Here too, as in the other project villages, there was heavy dependence on dirty fuels for the energy needs of the villagers. In this village addressing the energy needs was also included as part of the project activities, hence, the residents of Narlewadi hamlet were taken on an exposure visit to the IGWDP Kalamkarwadi watershed project where toilets were linked to the gobar gas plants that are used for cooking since the past 8 years. Once the residents of Narlewadi were convinced of the benefits, the women expressed their interest in the activity by their willingness to contribute part of the cost, which was taken as a loan to be repaid later. The balance cost was met through the women's development fund of the project.

1.2 Purpose of the Study

Today as Narlewadi has become a role model and receives many visitors from across the state, a case study was conducted to better understand the ground reality. Besides, since addressing energy needs has not yet been mainstreamed in watershed development projects, it was considered necessary, so that when interventions are put in place, the energy needs are adequately met, and the trees planted have a chance to survive. Besides, it was also necessary to see how the benefits are viewed by the community.

The following were the objectives:

- To study the present sources of energy and their actual utilization at household level.
- To understand the role of renewable energy interventions in saving time of women; its benefits for the school going children, family and community and its subsequent impacts on them.

- To study the monetary benefits that households have gained by the use of these interventions.
- To study the extent of domestic energy needs fulfilled to achieve energy security and measures adopted for getting sustainable benefits of renewable energy interventions at household level.

1.3 Methodology of the Study

A case study method was used. The baseline socio-economic survey was carried out in May 2006 which serves as the pre Renewable Energy (RE) initiative data and the post intervention data was collected in Oct 2008. In the pre study period there were 32 HHs in the hamlet. Subsequently during project implementation, two of the HHs were split bringing the total HHs in the post project period 34. However, one of the HHs moved out of the hamlet during the study period. Hence the total HHs in Narlewadi for the current study is 33. Since it is a very small sample, all thirty three households were covered for the study.

During the watershed implementation, in order to get a better representation and participation of each and every section of the community, the residents were grouped according to wealth ranking in three categories; the very poor, poor and medium HHs. Data was collected by administering a questionnaire to the women of each HHs.

Section 2: Background of Narlewadi Watershed

Narlewadi is a small hamlet located in the Ambad block of Jalna District. It is situated at a distance of 55 km from Aurangabad, 50 km from Jalna, the district headquarters and 25 km away from block headquarters. It can be approached by partially tarred road from village Jamkhed. The project was implemented by the Narlewadi villagers through the Jambuwant Gram Vikas Samiti and facilitated by Watershed Organisation Trust (WOTR). The financial support was extended by the Swiss Agency for Development and Cooperation (SDC).

The total area of the hamlet is 356.56 ha., of which 35 ha is forest land, 23 ha is revenue area, 277 ha is cultivated land and 21.56 ha is uncultivable waste land . The average annual rainfall is 550 mm. mainly in erratic showers. Total population of the hamlet is 183. The literacy percentage of women is 43.71% and that of men is 56.29% (baseline data).

Since Narlewadi falls in the drought prone Marathwada region of Maharashtra, water for both agriculture and for domestic use was very scarce. Agriculture was mainly rainfed with the irrigated area being restricted to the lower most reaches of the watershed. Narlewadi is a hamlet of the Jogeshwarwadi group gram panchayat. It's solitary gram panchayat representative could not wield government schemes in Narlewadi's direction. Access to information, awareness about development schemes, illiteracy, sanitation, were some of the key problems. Hence, when WOTR proposed to implement the WOTR WASUNDHARA project in their hamlet, the villagers willingly accepted it, even though there were demands and local contribution. With the signing of the agreement, watershed work began in April 2005. The Jambuwant Gram Vikas Samiti (Village Development Committee-VDC) was set up, comprising of 7 members including

4 women. The Renuka Mata Samyukta Mahila Samiti (SMS) is the apex body of women SHG consisting of 6 members, representing the 3 SHGs that have been formed. These village institutions were formed on the basis of wealth ranking and to look after the village development. All the members are aware about WOTR WASUNDHARA project, the rules and regulations, their roles and responsibilities and also the impacts of the interventions.

Along with the technical interventions of soil and water conservation, different groups and committees were formed. These committees received capacity building through exposure visits, village meetings, gramsabhas (village general body meetings) and various trainings. Regular meetings are also conducted in order to obtain a better involvement of the villagers. Various records such as the payment musters, measurement books, bill books, attendance register, shramdan measurement book, proceedings of the meetings, etc were maintained and were regularly updated during project period.

In the pre watershed period, there was no horticulture in Narlewadi. Dry land horticulture with species such as sweet lime and custard apple were introduced during the watershed implementation on 30 ha. of land. The survival rate of these plants is about 90% today and 26 HHs have taken up horticulture cultivation as a major source of income.

Some of the developmental activities undertaken by SMS and VDC are:

S. No.	Activities	Units
1	Vermi Compost	6
2	Drip Irrigation	25
3	Lift Irrigation (from micro fin.)	6
4	Solar Home Lighting	34
5	Gobar Gas	29
6	Individual toilets	33

Observing the active interest and participation of the villagers in various village level activities and their overall enthusiasm, the renewable energy program was sanctioned by WOTR which was implemented between December 2006 and July 2007. Under this activity gobar-gas and individual toilets were constructed for 30 families (3 HHs already had a toilet).

Section 3: Energy Situation in Narlewadi

Energy for cooking: Providing a continuous supply of clean sources of energy for cooking is a major challenge in any renewable energy initiative. In Narlewadi it is found that in the pre RE intervention period the most common type of stove was a simple chula and the source of energy was generally fuel wood, cow dung and agricultural waste. Hence there was heavy dependence on trees and agri-wastes for cooking fuel.

Table 1: Types of Stoves Used in the Pre RE Period (Total HHs: 32)

S. No.	Types of stoves used	Very poor	Poor	Medium	Total HHs
1	Simple chula	5	5	21	31
2	Stove	1	2	6	9
3	Electric stove			1	1

Table 2: Sources of Energy for cooking in the Pre RE Period (Total HHs: 32)

S. No.	Source of Energy	No. of HHs
1	Fuel Wood	31
2	Dung Cakes	31
3	Kerosene	9
4	Electricity	1

Table 3: Sources of Energy for cooking in the Post RE Period (Total HHs: 33)

S. No.	Sources of Cooking	No. of HHs
1	Fuel wood	32
2	Agriculture Residue	33
3	Gobar Gas	20

Comparing Tables 2 and 3, it appears that the number of HHs using fuel wood has increased. However, as mentioned earlier, one of the HHs has been split into two. However, in the post period, none of the HHs are using cow dung/kerosene/electricity for cooking. Moreover, the amount of fuel wood used has also decreased, which will be shown later (See Table 13). Table 4 presents the average energy consumption of a single HH in the pre project period.

Table 4: Average Energy Consumption of a single HHs in Pre RE Period

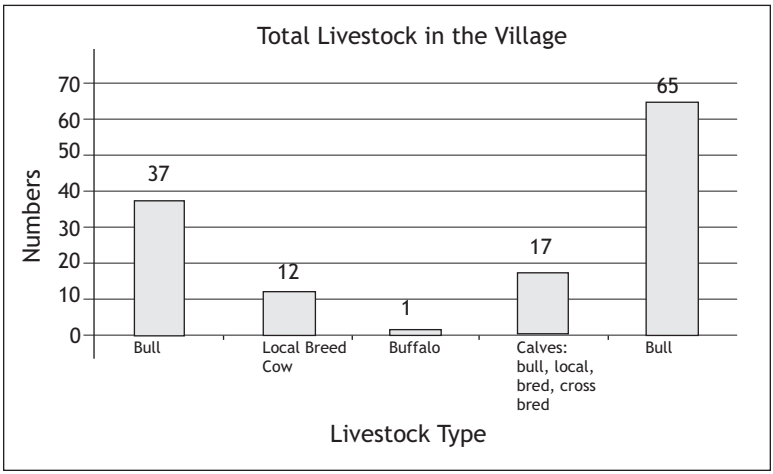
Fuel Type	Monthly Consumption	Cost per month (Rs.)	Annual Consumption	Annual Fuel Cost (expenditure / loss)
Kerosene	4.5 ltrs.	59	54 litres @ Rs. 13/- per litre.	Rs. 702
Fuel Wood	103 kg	721*	1236 kg	Rs. 8,652*
		300**		Rs. 3,000**
Cow Dung	26 kg	52	312 kg @ Rs. 2 per kg	Rs. 624
TOTAL expenditure / loss per annum				**Rs. 9,978**[a]
				Rs. 4,326[b]

** represents imputed values based on the cost of fuel wood @ Rs. 7 per kg*
***the opportunity cost of time spent in collecting fuel*
a) When they have to purchase fuel wood
b) When they have to collect the fuel wood themselves

Though the respondents do not spend hard cash on buying fuel wood, they still have to spend on an average of 10 hours a week for collecting it. If they were gainfully employed, it works out to be 5 working days in a month @ Rs. 60 as wage labour per day. Hence the values in the table for fuel wood are notional. It has to be borne in mind that we are calculating only the forgone

wages. There are additional costs to it in terms of lost trees, soil erosion, lost carbon sinks, addition to green house gases and its subsequent hazards, health hazards, etc.

The livestock situation in the pre RE period is as shown in the chart below. Currently there are merely 50 large ruminants for the 24 gobar gas plants, which is insufficient for a continuous supply of gas. This will be discussed in the following pages.



Hence, the average nominal cost of all the energy sources for cooking in the pre RE period for a single HHs works out to be approx. **Rs. 830** per month, if they were to purchase fuel wood from the market, which is substantial given the economic status of the HHs in the rural areas. If one were to add other related costs, then it is beyond their reach.

Table 5: Use of different sources of energy for cooking various items

Purpose	No. of HHs using fuel wood	No. of HHs using Kerosene	No. of HHs using agricultural residue	No. of HHs using gobar gas
Water Heating	26	0	30	4
Making Bhakar	14	0	6	0
Cooking Rice	0	1	0	3
Making Tea	1	1	0	7
Cooking Vegetables	0	1	0	7
Entire Cooking	11	1	12	13

Though the number of HHs using fuel wood and agricultural residue has not decreased in the post project period, we find (see table 5) that the purpose for which this energy source is used has changed. There are 13 HHs who are using the gobar gas for the entire cooking which implies that their dependence on dirty fuel has reduced to a large extent. However, the remaining HHs are still using these energy sources but primarily for heating water, making bhakars, etc. Hence, although still used, the overall dependence on unclean fuel has considerably reduced.

In Narlewadi, 29 gobar gas units were installed, of which only 24 are in regular use. There are 2 HHs with a gobar gas unit but at the time of data collection, they had moved to live in their fields and are therefore not using the gobar gas unit. The remaining 3 HHs had some problems in terms of construction of the units or the pipeline for the gas at the time of the study. Of the 24 HHs that are using the gobar gas unit, 11 are also using other sources of energy for cooking (see table 5).

Energy for Lighting: There is a huge gap between the demand for and supply of electricity in India. The brunt of this shortfall is borne mainly by the rural areas. This has severe implications on rural life since their movements and activities are restricted in the early dark hours of the day. Moreover, overall development is also hampered. However, the implications are different for different groups in the village with women and children being majorly affected. It is with this background that solar home lights (SHL) were introduced in Narlewadi.

Of the 33 HHs in Narlewadi, 29 took a SHL, 3 did not take it and there was no response from one HHs. Table 6 presents the change in use of sources of lighting in the pre and post RE program in Narlewadi. It is clearly observed that in the post RE program, none of the HHs are using kerosene for lighting purposes. In fact, most of them are using SHL and electric bulbs. The presence of a reliable source of light has major advantage in terms of time saved for cooking, gives freedom in deciding how to use the early dark hours, etc. These are discussed in the later part of the study (See tables 10, 11). Table 7 presents the use of SHL at different locations in the house.

Table 6: Lighting sources before and after RE program

Energy Sources	Before RE Program		After RE Program		No Response
	No	Yes	No	Yes	
Kerosene Lamp	27	5	32		1
Kerosene Chimney	1	31	32		1
Candle	32	0	32		1
(MSEB) Tube	31	1	31	1	1
(MSEB) Bulb	2	30	2	30	1
SHL	-	-	3	29	1

The women opined that with the availability of SHL in the kitchen area cooking has become easy and effortless. Hence the gobar gas units and SHL are complementary products. Table 8 lists some of the non economic benefits of using SHL in the kitchen.

Table 7: Use of different lighting types at various places in a house

Purpose	HHs using MSEB tube light	HHs using MSEB bulb	HHs using SHL
House lighting	1	25	28
Kitchen	0	19	22
Cattle shed Lighting	0	1	1
Lighting in open space of HHs	0	5	11

Table 8: Non Economic benefits of having a SHL in the kitchen

Response	No. of HHs
Easy Cooking	28
Reduction in time required for work due to availability of light	17
Availability of time for activities other than household work	16

Section 4: Impacts of the Renewable Energy Intervention

4.1 Time Saved

For Women: With the availability of gobar gas units and SHL the women are not in a rush to go home, leaving their farming activities incomplete, before sunset. This is a significant improvement for them as was opined in the FGD. Because there is an assurance of a steady source of energy for lighting and cooking even after dusk, they are mentally relaxed and free from this mundane stress.

Table 9 provides the change in time spent in cooking from pre to post RE intervention.

Table 9: Time spent in cooking in Pre and Post RE Intervention

Time spent in cooking	Before using gobar gas		After using gobar gas	
	No. of HHs	Percentage	No. of HHs	Percentage
Up to 1 hour	9	27	23	70
Up to 2 hours	18	55	10	30
More than 2 hours	6	18	0	0
TOTAL	**33**	**100**	**33**	**100**

One of the women had a big smile on her face when she said, "*atta laukar chaha milto*" meaning "now we get tea easily" and that too without tears. The women not only save time that is spent in cooking but also collecting fuel for the same. Time is also saved because they no longer have to clean the walls and

utensils which are covered with soot from using dirty fuel. As was mentioned earlier, each HHs spends an average of 8 to 10 hours a week collecting fuel. However, they still collect fuel wood which is used for heating water, but this is much less now. Hence the introduction of alternate energy sources has reduced their dependence on dirty fuel but has not been able to completely replace the traditional dirty fuels.

For Family: In the absence of SHL, the movements were restricted and most of the time was consumed in carrying out daily chores which could otherwise be completed faster. Hence, the introduction of SHL left some time for the members of the family to spend quality time with each other. Table 10 shows the changes observed due to the availability of alternate energy sources.

Table 10: Changes due to availability of clean energy like gobar gas and SHL

Changes	No. of HHs
Family has time to be together during early dark hours	18
Parents have time to look after the children	11
Parents are able to sit with their school going children	5
Men can prepare tea due to easy lighting of the gas stove	9
Children study together and help each other in study	12
Family accepts cooking on gas generated through cow dung and linked to the toilet	19

4.2 Social

As mentioned in the previous section, women are able to save some time from their daily chores because of the utilization of alternate energy sources. Here attempt is made to understand the utilization of this time in various activities. Of all the HHs that are using the RE sources 17 are said to use their time in

social activities and attend the meetings of SHG, SMS, VDC and gram sabhas. They also participate in religious activities like bhajans. Because of these meetings interaction between the women has increased and they feel more confident. Table 11 lists the various social activities they participate in.

Table 11: List of social activities

Social activity	No. of HHs
Involved in SHG meeting	17
Involved in SMS meeting	5
Attend Gram Sabha	6
Attend VDC meeting	6
Participate in Community Functions	5
Participate in Religious Activities	4

With the renewed confidence, women are able to move out of their houses and participate in meetings, trainings and exposure visits which are sometimes out of the village. Hence the mobility of women has increased within and outside the village. They have planned to build a gobar gas unit in the school premises so that mid day meals can be cooked on the school unit itself. The women are proud that they participated in this decision making process.

In some homes, the time saved is used for resting during the day, a respite for women who otherwise work from 12 – 14 hours during the day. Some of them spend this time watching television and sometimes learning new things of interest. It becomes extremely difficult to exactly quantify the value of this time and is beyond the scope of the study.

One of the components of the gobar gas unit is the presence of a toilet at home. There are two major advantages of it. It promotes sanitation, free from open defecation, and helps women maintain their dignity. Further, the number of visitors for exposure to Narlewadi adds to the confidence of the residents.

4.2.1 Health

One of the aims of an intervention like renewable energy is drudgery reduction and making positive impacts on the health of women and children. If one were to use the traditional sources of energy for cooking and lighting it affects their health by creating respiratory problems and various kinds of irritation. Now, with the use of alternate energy sources, the health of the users is protected. This can be corroborated with the data for women presented in table 12.

Table 12: Changes in the health related problems before and after using gobar gas

Health problems	Before using Gobar gas		After using Gobar gas		
	No	Yes	No	Yes	Reduced
Eye Irritation		18	5		13
Nose Irritation		19	5		14
Cough		12	4		8
Problems related to Respiratory Tract		6	2		4
Headache		7	4		3
Irritations		5	3		2

As mentioned earlier, women save time on cooking which means they spend less time in front of the stove. Further, there is no indoor pollution because gobar gas units are smokeless. Hence there is no direct negative effect on their health. Assuming that the women are engaged in gainful employment, the use of gobar gas has economic benefits because they save time, there is no negative impact on their health, which means less health care expenses and no loss of wages as days of ill health are reduced. From the environment point of view as well, it is environmental friendly and hence it is a win-win situation for the users.

Table 13: Change in the average quantity of fuel used from Pre to Post RE Intervention Period

Energy Sources	Average quantity consumed before RE intervention		Average quantity consumed after RE intervention	
	Unit/day	Unit/month	Unit/day	Unit/month
Fuel wood (kg)	3.44	103.13	2.05	61.41
Cow dung (kg)	0.88	26.31	0	0
Kerosene (ltr)	0.15	4.89	0.02	1.53
Gobar gas (time spent)			1hr 15 min	34 hr 15 min

From the above table we infer that the use of all the traditional energy sources has reduced in the post RE intervention period. Therefore we can safely conclude that the negative effects of dirty fuel are showing a decreasing trend. Around 60 per cent of the women perceive that there has been a positive change in their health because of the use of gobar gas unit for cooking.

4.2.2 Education

The renewable energy initiative, especially the SHL, has benefitted the school going children as well. SHL is a better substitute for erratic power supply. The children are able to study in the early dark hours and their study hours have improved. However, we do not know if this has resulted in better performance at school. One of the positive impacts of using SHL is the absence of indoor pollution and it does not strain the eyes of the users. More than half the HHs that are using a SHL perceive that it has helped their children to study for longer duration (by an hour or two).

4.3 Economic

There are direct and indirect monetary benefits of using renewable energy sources. The direct benefit is the expenses saved on the reduction of fuel wood usage. In table 12 we see a reduction in the usage of all dirty fuel in the post RE intervention. On an average, there is a direct saving of **Rs. 830** per month on fuel. The slurry from the gobar gas is used as manure in the farms, especially for horticulture. This has a direct economic benefit, one in terms of increasing the productivity of the soil there by increasing the yield and two in terms of costs saved by not having to buy chemical fertilizers @ Rs. 350 a bag per acre. In addition to this, the indirect savings are in terms of saved expenses on medicines and other health care related to indoor pollution because of the usage of traditional dirty fuels. No lost wages because of ill health and all the added benefits of saved trees leading to prevention of soil erosion, carbon sequestration, etc.

By shifting from the usage of traditional sources to gobar gas and also the reduction in usage of fuel wood, women are able to save time and some have taken up other livelihood activities. Hence the income earned from these activities would add up as an economic benefit. The benefits accrued by some women who utilize their spare time in taking rest or watching television or learning new things are invaluable. Finally, if we take into account the self esteem and dignity they achieved as perceived by these women, the total benefit would be difficult to quantify in monetary terms.

Table 14 presents a list of income generating activities taken up by women and their average monthly income from these activities.

Table 14: Income generating activities by Women

Activity	Approx. Monthly Income in Rs.	No. of HHs
Work as farm labour	633	3
Work as wage labour	571	7
Initiated small scale HH business	500	1
Other	200	3

4.4 Environmental

With the introduction of the gobar gas units in the village the cutting of trees in the vicinity has reduced and people are conscious of the ill effects of using dirty fuels. Though we have not used any scientific method to check the amount of reduction in smoke levels in the village, it is perceived by almost every gobar gas user that it has declined to a large extent. This has resulted in cleanliness within the house and the village environment in general. Table 15 presents some of the observed changes within the house because of the use of a gobar gas unit.

Table 15: Observed changes in the kitchen when fuel wood and agro wastes are replaced to a great extent by gobar gas and the kerosene lamp with solar home lights.

Cleanliness in kitchen	No. of HHs
Kitchen is free from smoke	14
Kitchen is free from soot	13
Kitchen walls are free from soot	19
Free space in kitchen	20
Cleaner utensils	16

A strong case can be made in favor of the gobar gas unit if we consider the amount of time and effort put in by the women to keep their houses clean. Hence it is a very good intervention in terms of drudgery reduction, besides its positive impact of cleanliness in the home and the village. Since a gobar gas unit is linked with a toilet it has inculcated the habit of using the toilet instead of open defecation.

During the watershed implementation plantation of 22,150 tree saplings was done in the village area. As of now the survival rate of these plants is 90%. In order to maintain this survival rate, the gobar gas unit relieves households of the dependency on trees, thus the tree cover can be conserved. The use of slurry in the 30 ha of horticulture plantation, has a positive effect on the quality of the soil. Hence, it not only increases the yield but also helps maintain soil productivity.

Section 5: Energy Security

One of the primary objectives of any renewable energy initiative is to ensure a smooth and sustained supply of energy to meet all cooking needs throughout the year. In Table 5 it is observed that only 13 households use the gobar gas for the entire cooking; 20 HHs use fuel wood and agro-wastes for making bhakar and only 4 HHs use gobar gas for heating water. Despite having a functioning gobar gas plant, HHs still depend on fuel wood for heating water and making bhakars.

In an attempt to find out the gaps in the energy security from the perspective of the people with respect to gobar gas it was unanimously opined by the women that there are seasonal fluctuations in the availability of gas in Narlewadi. It is observed (refer the graph in Section 3) that in Narlewadi there are only a few large ruminants, less than the optimum number of cattle head required for the household gobar gas plant to be viable. Besides, according to the people, there are seasonal variations with the gas production. The reasons given by the people for the insufficient gas production, are as follows: during summer the reduction in the supply of fodder and water leads to reduced cow dung which affects the supply of gas; in the cold season as heat is required to produce gobar gas, the temperature is insufficient, which affects gas production. While the gobar gas tank may be sufficient for the number of cattle-head, the size of the plant is not sufficient for all the cooking needs of the household. Of course this depends on the size of the household. They would have preferred a larger size tank. Hence energy security in Narlewadi cannot be achieved by introducing gobar gas alone.

It is found that the fuel efficiency of the traditional chula is approximately 5 to 10%. In table 5 it is observed that the

women use traditional chula and fuel sources to heat water, make bhakar, etc. The gap can be addressed by introducing the hot water chula. The energy efficiency of the hot water chula is about 4 to 6 times that of the traditional chula, depending on the type of fuel used. (*Source: A Comparative Study on the energy efficiency of the smokeless hot water chullah and the traditional chullah by J.R.Pawar*)

With the availability of SHL in the village people are not very concerned about the erratic power cuts and their regular life is unperturbed. However, as the SHL is dependent on the availability of sunlight, there are fluctuations when it comes to its usability during monsoons.

Section 6: Conclusions

The sustainability of watershed development can be ensured only when the natural resources (trees in this case) are protected, for which, the energy needs of the community should be adequately addressed. The means should be acceptable to the people. When an outside agency provides alternatives, renewable sources of energy such as gobar gas, solar home lights or other energy sources and equipment as in Narlewadi, the energy need may not be completely addressed. It is when an assessment study is done, will one understand the ground reality. Gaps will be identified, people's perspectives and needs will be understood and the response will now be more appropriate.

Section 7: Recommendations

In order to meet the energy needs the clean and sustained way; the following are the suggestions that have emerged from this study:

In order to respond to any need appropriately, a study of the fuel requirements for lighting, for the various types of cooking, and for heating water of the household and for a village, should be done. While one may not be able to address all the requirements, being aware of the need is a help. One should also understand that the energy demands during the different seasons vary. The quantity of gas required for heating water is greater during the cold season when the gas production is low.

The preparation of bhakar (the sorghum bread) and heating water cannot generally be met by a gas stove. Hence another appropriate stove should be promoted simultaneously. In this case, we would suggest the hot-water chula that has proven fuel efficiency and where one can cook while having water heated simultaneously.

When planning for the gobar-gas plant, the availability of gobar (cow-dung) and the cattle head is necessary so as to obtain the required gas for household cooking. Care must be taken too that sufficient fodder for cattle is available as also sufficient water for the plant during the summer months.

For the various types of products introduced into the village (SHL, gobar gas plants, hot-water chulas, agro-waste pellet stoves, or any other), the users should be given clear instructions regarding the good use of the same. Possibilities for repairs and maintenance should also be available in the village or near-by. It is only then that the initiative will continue to be used. Having local service providers will also increase income opportunities within the village.

The most important success factor is the motivation of the household and the village to make this their own project, and are willing to maintain it.