

Working Paper 2016/03

**Socio-Economic Impact of Renewable Energy  
Technologies in Tribal Villages of Gujarat**

*S. S. Kalamkar, M. Swain & S. Vahora*

November 2016



**Agro-Economic Research Centre**

*For the States of Gujarat and Rajasthan*

(Ministry of Agriculture & Farmers Welfare, Govt. of India)

**Sardar Patel University**

**Vallabh Vidyanagar, Dist. Anand, Gujarat**

---

Working Paper 2016/03

# Socio-Economic Impact of Renewable Energy Technologies in Tribal Villages of Gujarat

S. S. Kalamkar, M. Swain & S. Vahora



**Agro-Economic Research Centre**  
*For the States of Gujarat and Rajasthan*  
(Ministry of Agriculture & Farmers Welfare, Govt. of India)

**Sardar Patel University**  
Vallabh Vidyanagar, Dist. Anand, Gujarat

November 2016

---



AERC Working Paper 2016/03


© Agro-Economic Research Centre, Vallabh Vidyanagar 388120, Dist. Anand, Gujarat, India.

***About the Centre:***

The Agro-Economic Research Centre (AERC) for the states of Gujarat and Rajasthan was established in July 1961 at the Sardar Patel University, Vallabh Vidyanagar by the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, New Delhi. AERC has been working as an associate institution of S. P. University and enjoying autonomy status in its working. The Centre has completed 55 glorious years (1961-2016) of its journey marked by both achievements and challenges. During these years, the Centre has emerged as a strong policy feedback centre of the Ministry of Agriculture, Government of India due to hard work and strong commitment of the staff in the Centre. The focus of research effort in the initial stage was on comprehensive village surveys and resurveys in order to understand the process and direction of change at the village level. Subsequently, the emphasis of research has shifted to problem oriented studies. The Centre has by now completed 167 problem-oriented studies, 21 village surveys and 4 village resurveys. During its long journey, the Centre has brought remarkable improvement in every aspects of research including methodological base of the studies. The studies have come out with useful findings and policy implications for agricultural and rural development of the states of Gujarat and Rajasthan.

***Working Paper Series:***

The Working Paper Series provides an opportunity for AERC and CCS faculty/staff, invited guest speaker, visiting fellows and Ph.D. scholars to discuss their ideas and research work before publication and to get feedback from their peer group. Papers selected for publication in the series present empirical analyses and generally deal with wider issues of public policy at a sectoral, regional or national level. These working papers undergo review but typically do not present final research results, and constitute works in progress.



# Socio-Economic Impact of Renewable Energy Technologies in Tribal Villages of Gujarat\*

S. S. Kalamkar<sup>1</sup>, M. Swain<sup>2</sup> & S. Vahora<sup>3</sup>

## *Abstract*

*Renewable energy (RE) technologies are clean sources of energy that have a much lower environmental impact than conventional energy technologies. Growing scarcity of non-renewable resources and consequent increasing cost and inaccessibility of conventional energy technologies at various remote locations have paved the way to renewable energy technologies. In this context, the present study was undertaken to analyze the extent of adoption of renewable energy technologies and impacts of renewable energy technologies in selected tribal villages of Gujarat state (India). The benefits accrued by the rural households and constraints faced by them have been aptly assessed in the paper. The study finds that there is high demand for renewable energy technology based devices such as Solar Lantern, Glass Roof Tiles, Side feeded Biomass Cook Stove and Biogas Plant in survey areas. However, inadequate supply, lack of sufficient service points, unavailability of spare parts/accessories of these devices in local market, sometime delay in repairing of the devices, long procedure in getting the damaged devices repaired have resulted in lower adoption rate in these areas. There is also a need of improving some technologies such as solar dryer and solar cooker so as to improve the adoption rate. Efforts should also be made by Government, NGOS and related organization to increase awareness among the people to use renewable energy devices.*

*Key words: Renewable Energy Technologies, Adoption, Access and Constraints*

*JEL Classification: Q42, Q43, Q41, Q48*

---

\* This is a part of research report undertaken by SPRERI, VVN with support of DST, Ministry of Science and Technology, Government of India, New Delhi and was carried out by Agro-Economic Research Centre (Ministry of Agriculture and Farmers Welfare, Govt. of India), Sardar Patel University, Vallabh Vidyanagar, Anand, Gujarat

<sup>1</sup> Director/Professor, Agro-Economic Research Centre (AERC), Sardar Patel University, Vallabh Vidyanagar, Anand, Gujarat

<sup>2</sup> Assistant Professor (SS)/Research Officer, Agro-Economic Research Centre, Sardar Patel University, Vallabh Vidyanagar, Anand

<sup>3</sup> Senior Scientist, Sardar Patel Renewable Energy Research Institute, Vallabh Vidyanagar, Anand



## 1. Introduction

Rising world fuel prices, the growing demand for energy and concerns about global warming are the key factors driving the increasing interest in renewable<sup>4</sup> energy sources (Rosegrant et al., 2006). The shifting to renewable energy can help us meet the dual goals of reducing greenhouse gas emissions, thereby limiting future extreme weather and climate impacts, and ensuring reliable, timely, and cost-efficient delivery of energy. Investing in renewable energy can have significant dividends for our energy security (Omar, et.al, 2014). Therefore, there is considerable interest within the international community in the socio-economic implications of moving society towards the more widespread use of renewable energy resources. Renewable energy replaces conventional fuels in four distinct areas: electricity generation, hot water/space heating, motor fuels, and rural (off-grid) energy services (REN21, 2010). Harnessing clean and green sources of energy on a large scale in the country is a necessity to ensure sustainable economic development without seriously damaging the environment while also addressing the need for energy security (SPRERI, 2014).


Renewable energy markets– electricity, heating and transportation have been growing sharply over the last five years. The deployment of established technologies, such as hydro, as well as newer technologies such as wind and solar photovoltaic, has risen quickly, which has increased confidence in the technologies, reduced costs and opened up new opportunities. It is estimated that global electricity generation from renewable energy sources is expected to grow by 2.7 times between 2010 and 2035 (Omar et al, 2014). Renewable energy resources are innovative options for electricity generation and their potential is enormous as they can, in principle, meet the world's energy demand many times over. Renewable energy supplies around 19 percent of global final energy consumption counting traditional biomass, large hydropower, and “new” renewables (small hydro, modern biomass, wind, solar, geothermal & biofuels)

### *Status of RE in India*

India has a vast availability of renewable energy resources, and it has one of the largest programs in the world for deploying renewable energy products and systems. The role of new and renewable energy has been assuming

---

<sup>4</sup> Renewable energy is generally defined as energy that comes from resources which are naturally replenished on a human timescale such as sunlight, wind, rain, tides, waves and geothermal heat (Omar et al., 2014).



increasing significance in recent times in India with the growing concern for the country's energy security. Energy self-sufficiency was identified as the major driver for new and renewable energy in the country in the wake of the two oil shocks of the 1970s. The country has experienced the sudden increase in the price of oil, uncertainties associated with its supply and the adverse impact on the balance of payments position (<http://www.mnre.gov.in>). Therefore, government had established Commission for Additional Sources of Energy in the Department of Science and Technology in March 1981 with responsibility of formulating policies and their implementation, programmes for development of new and renewable energy apart from coordinating and intensifying R&D in the sector. India was the first country in the world to set up a Ministry of Non-conventional Energy Resources<sup>5</sup>, in early 1980s.

The power generation from renewable sources is on the rise in India, with the share of renewable energy in the country's total energy mix rising from 7.8 per cent in FY 2008 to 12.3 per cent in FY 2013. India's renewable installed capacity has reached 35.49 GW, as of February 29, 2015. The Cumulative grid tied wind power capacity has reached 22644 MW's, while solar grid tied power capacity has reached 3382 MW's. Also during the month of February 2015, wind power, contributed largest share of new installed power capacity, while small hydro power ranked in a close second. How India develops will have widespread implications for global energy markets. India has the fifth-largest power generation portfolio worldwide. The country transitioned from being the world's seventh-largest energy consumer in 2000 to the fourth-largest one within a decade. This rapid growth of power capacity and a subsequent rise in demand can be attributed to several factors, such as (a) economic growth and increasing prosperity; (b) growing rate of urbanization; (c) rising per capita energy consumption; (d) widening access to energy in the country. Thus, there is an emerging energy supply–demand imbalance. The renewable energy sources in India are wind energy; solar energy; biomass, and small hydro.

## **2. RE Technology introduced by SPRERI in Tribal Gujarat**

Sardar Patel Renewable Energy Research Institute (SPRERI) continues its research and development in renewable energy technologies. Many renewable energy devices and systems developed at SPRERI are now

---

<sup>5</sup>The Ministry of New and Renewable Energy (MNRE) is the nodal Ministry of the Government of India for all matters relating to new and renewable energy. The broad aim of the Ministry is to develop and deploy new and renewable energy for supplementing the energy requirements of the country. Creation CASE and Ministry: Commission for Additional Sources of Energy (CASE) in 1981; Department of Non-Conventional Energy Sources (DNES) in 1982; Ministry of Non-Conventional Energy Sources (MNES) in 1992; and Ministry of Non-Conventional Energy Sources (MNES) renamed as Ministry of New and Renewable Energy (MNRE) in 2006.

manufactured by selected industries for meeting requirements of the end users. The manufacturing and marketing rights of the SPRERITECH improved biomass cook stoves have been transferred to three firms. These cook stoves are now available commercially in three different models to meet the requirements for domestic as well as community/small commercial applications. The Institute continued working actively in five selected tribal villages of Chhota Udaipur (Vadodara) and Dahod districts for the fifth consecutive year. Therefore, it is important to study the impact of introducing useful renewable energy technologies such as biogas plants, improved biomass cook stoves, solar light, provision of the natural sun light into the tribal homes though glass roof tiles, etc. on the socio-economic life of the communities.

### 3. Data and Methodology

The study is based on the primary data collected from the two selected tribal districts in Gujarat, where RE devices were set up by the agency (SPRERI), i.e. Dahod and Vadodara/Chhota Udaipur<sup>6</sup>. There were two villages (Simal Faliya, Raysingpura/Oliamba) from Chhota Udaipur taluka of Chhota Udaipur/Vadodara district and total three villages from Dahod district [i.e. two villages (Chilakota, Chaidiya) from Limkheda taluka and one village (Dageria) from Zalod taluka] covered under the scheme. The study covered the total ten RE devices, viz. (a) Improved Biomass Cook Stove – Ceramic liner, (b) Improved Biomass Cook Stove – Air Insulated- Top feeding, (c) Improved Biomass Cook Stove – Air Insulated - Side feeding, (d) Solar Light LED, (e) Solar Light CFL, (f) Solar Light HLS, (g) Biogas Plant, (h) Solar Cooker, (i) Solar Dryer, (j) Glass Roof Tiles.

The village-wise RE devices-wise list of beneficiary was obtained from the SPRERI. As per the proportion of RE devices set up on subsidy rate in respective village, the 20 percent of total beneficiary households for selected RE device in that village were drawn as a sample selected beneficiary households for the study. The data were collected on 166 RE devices from the selected 105 beneficiary households from these five villages (Table 1 and 2).

Table 1: Coverage of Sample Households

Particulars	Dahod district	Chhota Udaipur	Total
Number of beneficiary households	70	35	105
Number of non-beneficiary households	29	13	42
Total	99	48	147

Source: Field survey data.

<sup>6</sup> Chhota Udaipur district (also known as Chhota Udepur district) is the 28th district of Gujarat which was carved out of the Vadodara district on January 26, 2013.


Table 2: Distribution of Sample Households according to devices

Sl. No.	Particulars	Beneficiary Households							Grand Total	Non Beneficiary households
		Vadodara/ Chhota Udaipur			Dahod					
		Simal Faiya	Raysingpura / Oliamba	Total	Dageriya	Chediya	Chilakota	Total		
1	Biomass Cook Stove – Ceramic	14	0	14	10	11	12	33	47	42
2	Biomass Cook Stove – Air Insulated- Top feeding	2	3	5	3	0	8	11	16	
3	Biomass Cook Stove – Air Insulated- Side feeding	4	2	6	9	0	10	19	25	
4	Solar Light LED	3	0	3	2	1	5	8	11	
5	Solar Light CFL	8	2	10	7	0	12	19	29	
6	Solar Light HLS	8	2	10	0	0	5	5	15	
7	Biogas Plant	1	1	2	1	1	5	7	9	
8	Solar Cooker	0	0	0	0	0	3	3	4	
9	Solar Dryer	0	0	0	0	0	2	2	2	
10	Glass Roof Tiles	0	0	0	3	0	5	8	8	
Total		40	11	51	35	13	68	115	166	42

Source: Field survey data

In order to get some idea about demand and feedback on these RE devices from non-users, the data were collected from 42 non-beneficiary households (25 percent of total number of beneficiary units) from same villages (Table 1). Besides formal survey through filling up of schedules, informal group discussions with beneficiaries and non-beneficiaries were also held. The conscious efforts have also been made to get the views of women and non-beneficiary households. The required data have been collected by canvassing a pre-designed and pre-tested schedule during the period from January to February 2015. The due care was taken in selecting beneficiary





households in order to avoid the effect of one device<sup>7</sup> on other. The simple tabular analysis was carried out to know the change in various parameters related to livelihood in the selected villages.

## **4. Results and Discussions**

### **4.1 Socio-Economic Profile of Selected Households**

The SPRERI targeted to provide benefits of renewable energy (RE) technologies to underprivileged rural people in selected two districts of Gujarat (Dahod and Chhota Udaipur) on pilot basis. The 147 sample households were interviewed from five study villages which are scattered in nature and non-remote. The major RE devices that SPRERI had provided to tribal households were solar light, biomass cook stove, glass roof tiles, biogas plant, solar cooker and solar dryer. Out of 887 RE devices set up in five villages of two districts (Dahod and Chhota Udaipur), about 31 per cent were solar light, 26.4 per cent were ceramic liner biomass cook stove, 23 per cent were air insulated biomass cook stove, 9.8 per cent were glass roof tiles and only 5 per cent were biogas plant.

#### **4.1.1 Occupation, Literacy and Caste Structure**

The sample consisted of beneficiary (105 HHs) and non-beneficiary households (42 HHs). The 71.4 per cent of total sample households were beneficiary households and remaining 28.6 per cent were non-beneficiary households. The average age of head of a beneficiary household was 45.4 years while that of non-beneficiary households was 41.3 years (Table 3). About 93.3 per cent of heads of beneficiary households and 100 per cent heads of non-beneficiary households were male. The majority of both beneficiary (94.3%) and non-beneficiary households (100%) had agriculture as their main occupation, while dairy was identified as subsidiary occupation in both groups. The education of heads of beneficiary households and non-beneficiary households were 7.2 & 5.2 years respectively. Thus, beneficiary household heads were relatively younger and more educated than non beneficiary heads.

---

<sup>7</sup> The beneficiary households had used more than one RE devices. In order to avoid effect of one RE device on other, due care was taken while selecting beneficiary households for particular RE device. The sample for three types of cook stove was selected separately as well as cook stove and biogas were kept different. Same procedure was followed for Solar light and glass roof tiles.

Table 3: Socio-economic status of sample households

Sl. No.	Particulars	Beneficiary HHs	Non-Beneficiary HHs
1	Age of Head of households (year)	45.43	41.29
2	Head of household (%)	Male (%)	93.33
		Female (%)	6.67
3	Main occupation (% to total HHs)	Crop farming	94.29
		Dairy	0.95
		Service	2.86
		Farm labour	0.95
		Others	0.95
4	Subsidiary Occupation (% to total HHs)	Crop farming	6.74
		Dairy	48.31
		Service	10.11
		Farm labour	32.58
		Others	2.25
5	Farming experience (year)	20.60	20.07
6	Education (year of schooling)	7.24	5.21
7	Caste Category (% to total HHs)	SC	3.81
		ST	96.19
		OBC/ Others	0.00
8	Have Ration card (% to total HHs)	Yes	99.05
		APL	0.95
		BPL	58.10
		AAY	40.95
9	Have Saving Accounts (% to total HHs)		88.57
		Bank	11.43
		Post office	83.81
		Cooperative society	3.81
10	Toilet at home (% to total HHs)	50.48	28.57
11	LPG at home (% to total HHs)	15.24	4.76
12	GEB grid at home (% to total HHs)	95.24	90.48

Source: Field survey data

The caste composition of our sample beneficiaries revealed that the proportion of ST population was the highest among the sample selected households, i.e. 96.2 per cent for beneficiary HHs and 83.3 per cent for non-beneficiary HHs, while remaining population belongs to SC category (3.8 and 16.7 per cent respectively). The proportion of BPL HHs were more among non-beneficiaries (50.0%) compared to beneficiaries (41.0%). The average family size of a beneficiary household was smaller (5.5) than that of non-beneficiary households (6.3) (Table 4). Overall, the dependency rate (% non working members) was found more in case of beneficiary households (41.7% male and 43.2% females) compared to that in non-beneficiary households (38.0% male & 39.8% females).

Table 4: Family background of Sample households

(Average of all household members)

Sl. No.	Particulars	Beneficiary HHs	Non-Beneficiary HHs
1	Family Size (No./hh)	5.52	6.31
	Male	2.92	3.38
	Female	2.60	2.93
2	Age (Years)		
	Male	28.00	26.44
	Female	27.39	27.43
3	Education (Years)		
	Male	7.26	4.87
	Female	4.46	3.42
4	Working in agriculture (% to total no. family members)		
	Male	54.07	54.23
	Female	53.48	55.28
5	Working in other area (% to total no. family members)		
	Male	5.86	4.23
	Female	4.03	0.81
6	Not working (% to total no. family members)		
	Male	40.07	41.55
	Female	42.49	43.90

Source: Field survey data

#### 4.1.2 Livestock Holding, Production and Consumption Pattern

As discussed in previous section, the livestock was found the major subsidiary source of income and employment for the sample HHs. Since agriculture in the both districts is highly risky venture depending on vagaries of rainfall, livestock holding provides the main platform for risk sharing. The details of livestock holding by the sample households have been presented in Table 5. The livestock holding by beneficiary and non-beneficiary HHs was mainly consist of cows and buffalos. The average number of cows held by a beneficiary and a non-beneficiary HH was 1.85 and 1.10 respectively. The average number of buffalos held by beneficiary and a non-beneficiary HH was 1.37 and 0.81 respectively. The beneficiary households were found to hold more livestock and poultry compared to that by non-beneficiary households.

Table 5: Livestock holding of Sample household

(No. of livestock/HH)

Sl. No.	Particulars	Beneficiary HHs	Non-Beneficiary HHs				
			Local	Cross bred	Total	Local	Cross bred
1	Cow:						
	Milch	0.14	0.02	0.16	0.21	0.05	0.26
	Dry	0.30	0.00	0.30	0.21	0.00	0.21
	Young	0.90	0.00	0.90	0.38	0.00	0.38
	Male/Draught	0.48	0.00	0.48	0.24	0.00	0.24
	Total	1.83	0.02	1.85	1.05	0.05	1.10
2	Buffalo:	0.00	0.00	0.00	0.00	0.00	0.00
	Milch	0.40	0.02	0.42	0.29	0.00	0.29
	Dry	0.45	0.00	0.45	0.38	0.00	0.38
	Young	0.29	0.00	0.29	0.07	0.00	0.07
	Male/Draught	0.22	0.00	0.22	0.07	0.00	0.07
	Total	1.35	0.02	1.37	0.81	0.00	0.81
3	Sheep	0.00	0.00	0.00	0.00	0.00	0.00
4	Goat (He)	0.29	0.00	0.29	0.00	0.00	0.00
5	Goat (She)	0.74	0.00	0.74	0.29	0.00	0.29
6	Poultry	0.50	0.00	0.50	0.00	0.00	0.00

Source: Field survey data

The details of production and consumption of livestock products by the sample households indicate that the average amount of livestock products and income generated from them was higher in case of beneficiary households compared to non-beneficiary households. The average annual income generated from livestock products was found to be about Rs 36430/- from cow and Rs 58305/- from buffalos in case of beneficiary households. Whereas in case of non-beneficiary households, the average amount of income generated from cow and buffalos was Rs 16860/- and Rs 19065/-, respectively.

#### 4.1.3 Land Ownership Pattern and Sources of Irrigation

The net sown area (NSA) and gross cropped area (GCA) of a beneficiary household was found to be 3.54 acre and 5.68 acre, respectively which imply that the cropping intensity was 160.6 per cent (Table 6 and 8). On the other hand, the net sown area (NSA) and gross cropped area (GCA) of non-beneficiary household was 3.21 acre and 4.10 acre, respectively which imply that the cropping intensity for non-beneficiary households was 127.8 per cent. Thus, the agricultural lands had been utilized more intensively by the beneficiary households.

Table 6: Land Ownership Pattern

(Area in acre)

Sl. No.	Indicators	Beneficiary	Non-Beneficiary
1	Total own land	3.43	3.13
	Irrigated	1.74	1.38
	Un-irrigated	1.69	1.74
2	Leased-in-land	1.57	1.75
	Irrigated	1.07	1.50
	Un-irrigated	0.50	0.25
3	Leased-out-land	0.00	0.00
	Irrigated	0.00	0.00
	Un-irrigated	0.00	0.00
4	Operational holding	3.54	3.21
	Irrigated	1.81	1.45
	Un-irrigated	1.72	1.76

Source: Field survey data

The size of available own area for cultivation for beneficiary households and non-beneficiary households was 3.43 acre and 3.13 acre, respectively. The size of operational holding for beneficiary households and non-beneficiary households was 3.54 acre and 3.21 acre respectively. It can be noted that the area under irrigation for beneficiary households and non-beneficiary households was 51.1 per cent and 45.2 per cent of total operated area, respectively (Table 7). There was no farmer from large farm holdings size group in our sample. As far as different sources of irrigation are concerned, as high as 63.9 per cent of total operated area of beneficiary farmers was irrigated by open well or dug wells followed by tube wells (24.5%), usually energized by electricity and/or diesel.

Table 7: Source of irrigation of sample household

(Area in acre/HH)

Sl. No.	Indicators	Beneficiary		Non-Beneficiary	
		Area	(%)	Area	(%)
1	Farm pound	0.01	(0.5)	0.05	(3.3)
2	River	0.03	(1.6)	0.10	(6.6)
3	Tank	0.00	(0.0)	0.00	(0.0)
4	Well	1.15	(63.9)	0.94	(64.8)
5	Tube well	0.44	(24.5)	0.32	(22.1)
6	Any other	0.17	(9.5)	0.00	(0.0)
7	Total area under irrigation (Ha per hh)	1.81	(100.0)	1.45	(100.0)
8	Area under irrigation (percent of NSA)	51.11		45.27	

Note: Figures in parentheses are the percentages of total area under irrigation.

Source: Field survey

#### 4.1.4 Cropping Pattern

The cropping pattern of the sample household (HH) presented in Table 8 shows that the distribution of area under different crops and under different crop groups. The GCA per HH of a beneficiary household and non-beneficiary household was estimated to be 5.68 acre and 4.10 acre, respectively. Overall, the per-HH area under Kharif and Rabi crops cultivated by a beneficiary household was 3.72 acre and 1.90 acre, respectively. The per-HH area under Kharif and Rabi crops cultivated by a non-beneficiary household was 2.70 acre and 1.39 acre, respectively. The area under summer crops was meager in case of both categories. The share of kharif crop and rabi crop in GCA was 65.49 per cent and 33.45 per cent respectively for beneficiary households. The same for non-beneficiary households was 65.55 per cent and 33.57 per cent

respectively. The 51.5 per cent of total area under Kharif crops of beneficiary households was provided with protective irrigation whereas corresponding figure was 55.1 per cent for non-beneficiary households, which implies that the level of production risk induced by rainfall variability was quite high in the study areas.

Table 8: Cropping Pattern of Selected Households

Sl. No.	Crops	% to GCA	
		Beneficiary hh	Non Beneficiary hh
A	Kharif season	65.55	65.85
	Maize	26.54	33.41
	Paddy	17.40	14.63
	Soyabean	5.80	0.00
	Cotton	7.91	6.10
	Tur	4.22	6.59
	udad	1.23	3.17
	Groundnut	1.23	1.71
	Vegetables	1.23	0.24
B	Rabi Season	33.57	33.90
	Maize	10.54	18.05
	Wheat	14.76	12.20
	Jowar	0.18	0.49
	Gram	7.56	2.93
	Vegetable	0.53	0.24
C	Summer Season	0.88	0.24
	Maize	0.35	0.00
	Groundnut	0.00	0.24
	Watermelon	0.53	0.00
D	Gross Cropped Area	100.0	100.0
E	Cropping Intensity (%)	160.00	127.80

Source: Field survey data

#### **4.1.5 Asset Holdings and Facilities at Home**

The overall asset base and facilities available at home of the sample households in Chhota Udepur and Dahod districts indicate that non-beneficiary households were better off than beneficiary households in terms of having number houses and cattle sheds. However, beneficiary households had better position in terms of having two wheeler and four wheeler, tractors and other agricultural implements and infrastructures. About 92.4 per cent beneficiary households had houses (kuchha/pucca) against 95.2 per cent of non-beneficiary households. The number of kuchha houses was slightly more in case of non-beneficiary households, whereas the number of pucca houses was more in case of beneficiary households. About 11.4 per cent beneficiary households had pucca houses against 9.5 per cent of non-beneficiary households. On an average, a beneficiary household (HH) had 0.38 number of TV connection and 0.03 number of Local Cable connection (Table 12). The beneficiary households had used 4.6 number of cylinders per annum for which they had paid Rs 434/-. On the other hand, the non-beneficiary households had used 3.0 number of cylinders per annum for which they paid Rs 427/-. Almost every beneficiary household had mobile phones, where as corresponding figure was about 69 per cent for non-beneficiary households (for details, please see, Kalamkar et al., 2015).

#### **4.1.6 Sources of Borrowings**

The details on borrowing by the sample HHs indicate that the about 23 percent beneficiary HHs and about 17 percent non beneficiary households had taken loan. Beneficiary hh had succeeded to avail more credit compared to non-beneficiary HHs. A beneficiary HH had availed Rs. 9062/- of credit loans from various commercial banks and cooperatives as against of Rs. 48857/- of institutional loans by a beneficiary HH. Borrowings from informal sources such as landlord, employers and traders-cum-money lenders which are generally very costly were not found to prevail in study areas. As far as the purpose of borrowing is concerned, crop cultivation, tractor purchase, land reclamation and purchase of agricultural implements and livestock were the major purposes for which loans were taken. The average rate of interest paid was found slightly higher for beneficiary households (6.6%) compared to non-beneficiary households (5.1%) (for details, please see, Kalamkar et al., 2015).

#### **4.1.7 Consumption Pattern**

The per-household consumption of food and non-food items by the beneficiaries and non-beneficiaries were found to be reasonable in the study



areas. The beneficiaries had enjoyed better status with regard to consumption of different food and non-food items over non-beneficiary households. They had spent more on most items compared to that by non-beneficiary HHs. Among different kinds of food items consumed by beneficiary households, major proportion of expenditure was on rice, wheat, maize, tur, cotton and groundnut oils, milk and ghee for both categories of households. Beneficiaries were found to spend more on rice (Rs. 453.9 per month) compared to non-beneficiaries (Rs 386.4 per month). The amount spent on loan repayment was Rs 17651.0 per annum by a beneficiary household against Rs 9532.1 by a non-beneficiary household (for details, please see, Kalamkar et al., 2015).

#### 4.1.8 Nature and Causes of Migration

Non-beneficiary households were more affected on migration front. Some members of about 42.9 per cent of non-beneficiary HHs as against 18.1 per cent of beneficiary HHs had migrated out to get wage employment and income. Out of households having migrated members, about 83.3 per cent of non-beneficiary HHs as against 73.37 per cent of beneficiary HHs had some members migrated out every year. About 16.7 per cent of non-beneficiary HHs and 26.3 per cent of beneficiary HHs had migrated out during bad monsoon years. The duration of migration was much higher for non-beneficiary households (129.7 days) compared to 85 days for beneficiary households. However, the non-beneficiary migrants earned better wages (Rs. 245.5 by males and Rs 242.5 by females) than beneficiary migrants (Rs. 235.5 by males and Rs 234.4 by females). The majority of migrant workers were engaged in labour intensive works. As far as causes of migration is concerned, it was observed that majority of sample migrant households had to migrate out for earning wages since they were not economically sound (Table 9). About 84.2 per cent of beneficiary households cited the motive to earn wages as a major cause of migration, whereas about 55.6 per cent of non-beneficiary households cited that their family had to migrate out since they were not economically sound (for details, please see, Kalamkar *et al.*, 2015).

Table 9: Causes of migration

(% of HHs migrated)

Sl. No.	Reason	Beneficiary	Non-Beneficiary
1	To earn wages	84.2	16.7
2	Economically not sound	21.1	55.6
3	Less land	10.5	11.1
4	Free of agriculture work	5.3	22.2
5	Drought	0.0	5.6
6	Heavy loan amount	0.0	5.6

Source: Field survey data

## 4.2 Cost and Subsidy on Renewable Energy Devices:

The details on numbers of unit set up and cost per unit paid by the beneficiary households after subsidy amount are presented in Table 10. It can be seen from the table that all the beneficiary households were using the renewable energy devices set up at subsidized cost by the SPRERI. The maximum numbers of RE devices set up among these households were improved biomass cook stove- ceramic liner, followed by solar light CFL and improved biomass cook stove-air insulated-side feeding. Solar dryer was the least preferred in selected study area. The RE devices were set up at very high subsidized rate<sup>8</sup> by the SPRERI. The amount paid by the beneficiary households after subsidy amount was ranging from 15 to 20 percent in case of cook stove, 24 to 27 percent in case of solar light, around 16 percent in case of biogas, 11 percent in glass roof tiles and about 7 percent in case of solar dryer.


Table 10: Renewable energy technologies used by beneficiary households

Sl. No.	Particulars	No. of unit purchased*	Cost per unit (Rs.)			
		Total	Units/ HH	Amount paid	SPRERI paid	Total cost
1	Biomass cook stove- Ceramic liner (BCS-CL)	47	0.45	200	800	1000
2	Biomass cook stove- Air insulated - Top feeding (BCS-AITF)	16	0.15	200	900	1100
3	Biomass cook stove- Air insulated - Side feeding (BCS-AISF)	25	0.24	200	1110	1310
4	Solar light LED (SL-LED)	11	0.1	1000	3095	4095
5	Solar light CFL (SL-CFL)	32	0.3	1000	3095	4095
6	Solar light HLS (SL-HLS)	16	0.15	1000	2675	3675
7	Biogas Plant (BIOP)	10	0.1	3500	19000	22500
8	Solar Cooker (SCOOK)	5	0.05	750	1450	2200
9	Solar Dryer (SDRY)	2	0.02	100	1300	1400
10	Glass Roof Tiles (CRT)	11	0.1	50	390	440

Note: \*All devices were provided by SPRERI.

Source: Field survey data.

<sup>8</sup> In order to have sense of usefulness and care attitude towards the use of these RE devices, the nominal amount was charged to the beneficiary households. The amount generated from the collection on account of beneficiary payment was kept aside and was used by SPRERI towards repair and maintenance of these RE devices.



The details on sources of information of the renewable technologies used by beneficiary households indicates that the SPRERI personnel was the major source of information about these RE technologies, followed by village level workers, fellow farmers as well as information received/collected by him on his own. It was very strange to note here that no other agency (viz., Newspaper, TV/Radio as well as NGOs) working in study area had extension/renewable technology dissemination programme. Most of the village workers identified by the implementing distributing agency were the first user of the RE devices.

#### **4.2.1 Improved Biomass Cook Stove and Domestic Chulha:**

It was observed that almost all the selected households are using improved Biomass Cook Stove and preferred same due its mobility (Table 11). However, in case of improved BCS Top Feeding, most of the households reported that it is very tedious/cumbersome to cook rotla (jowar thick chapatti/bhakri) on top feeding cook stove as every time one need to remove the fry pan. Thus, these households are still using domestic chulha for the purpose of rotla making and hot water purpose whereas BCS-TF is mostly used for preparation of tea, rice, sabji, dal, etc. The rotla is main item in food and therefore beneficiary households had kept both BCS-TF and domestic Chula in use. It can be seen from the table that fuel wood requirement for cooking was found almost fifty per cent less in case of BCS than domestic chulha. In case of agri waste and dung cake also, the requirement was found less in BCS than its counterpart. The need/consumption of Kerosene was also reduced to about half level in BCS. Therefore, costs of fuel item were found to be higher in case of domestic chulha than BCS. Despite of half reduction in requirement of fuel wood for BCS, the time for collection of wood had recorded marginal decline in BCS than domestic. This may be due to the fact that time for search, collection of fuel wood as well as preparing wood suitable for cooking purpose has done together by beneficiary households for both kinds of chulha and therefore, they could not separate it into two.

The cooking time requirement during day as well as night time was found less in case of BCS than domestic chulha. The saved time was used on field. The expenditure on health was found relatively similar in both the cases. The beneficiary households were asked about their willingness to pay for BCS, and it was observed that they are willing to pay around Rs. 350/- per unit. It was observed that some of the households were not using the cook stove, mainly BCS-CL (2.1% HHs) and BCS-AITF (6.3% HHs).

Table 11: Comparison among types of biomass cook stoves and domestic chulha

(% of HHs availing devices)

Sl. No.	Particulars	Units	Domestic hulha	BCS - CL	BCS-AI-TF	BCS-AI-SF	
			N=86	N=47	N=16	N=25	
1	Use of present stove	% of total HHs	100.00	97.87	93.75	100.00	
2	Place of kitchen	Inside	% of total HHs	98.84	95.74	68.75	36.0
		Outside		1.16	4.26	31.25	64.0
3	Place of stove	Inside	% of total HHs	94.19	14.89	43.75	12.0
		Outside		5.81	80.85	56.25	88.0
		Both		0.00	4.26	0.00	0.00
4	Mobility of stove	Movable	% of total HHs	15.12	100.00	100.00	100.
		Fixed		84.88	0.00	0.00	0.00
5	Height of stove	In mm	150.63	330.00	325.00	325.00	
6	Weight of stove	Kg	10.38	14.50	8.00	8.50	
7	Stove used for:	% of total HHs					
	Rotla making		100.00	80.85	68.75	84.00	
	Tea/Sabji/Rice/Dal		87.21	97.87	100.00	96.00	
8	Requirement of fuel for cooking (Approx.)	kg/week					
	Wood		24.54	13.72	12.31	16.40	
	Agri. Waste		11.69	7.07	6.77	7.71	
	Dung cake		11.94	8.06	6.30	10.30	
	Kerosene	lit/week	2.01	1.08	1.14	0.81	
	Any other	kg/week	0.00	0.00	0.00	0.00	
9	Costing of fuel –cooking	Rs./week					
	Wood		265.16	140.39	75.94	185.52	
	Agri. Waste		56.69	34.70	14.70	41.90	
	Dung cake		128.60	89.03	26.87	104.00	
	Kerosene		42.69	18.76	17.85	14.15	
	Any other		0.00	0.00	0.00	0.00	

Table 11: Continued...

Sl. No.	Particulars	Units	Domestic	BCS - CL	BCS-AI-	BCS-AI-SF	
			N=86	N=47	N=16	N=25	
10	Time in collection of fuel						
	Wood	Man	13.33	11.78	10.66	11.46	
	Wood	hrs./day	4.22	4.31	4.37	4.72	
	Agri. Waste		2.12	1.47	2.75	1.58	
	Dung cake		0.83	0.45	2.20	0.49	
11	Cooking time required	hours					
	Day time		1.83	1.21	1.06	1.33	
	Night time		1.72	1.08	1.03	1.15	
12	Expenditure on health	Rs./month	543.66	218.18	275.00	118.75	
13	Willing to Pay for stove:	Rs./HH					
	With subsidy		0.00	200.00	200.00	200.00	
	Without subsidy		0.00	342.31	343.75	345.00	
14	Working hrs on field	hours	4.25	4.07	3.41	3.79	
15	Income from field	(Rs./year)	21198	20574	20044	21200	
16	Income from wages		8357	9214	6791	9408	
17	Other business with saved	hours	0.00	0.00	0.00	0.00	
18	Increase in study hrs of children	hours	0.00	0.00	0.00	0.00	

Note: \* Estimated Costing of fuel for cooking (Rs./week); Approx-approximately.  
Source: Field survey data

These instruments were not used for about 3 months. The reason towards same was mentioned that these households' requirement was less and thus they did not use it regularly. The use of the BCS also depends on the training and maintenance provided by the agency.

It can be seen from the Table 12 that training was provided by the agency and maintenance back up was also provided as and when required. No equipment was transferred to other person and all were in use with selected households.

Table 12: Training, Maintenance and Transfer of Improved Biomass Cook Stove

(% of total HH)

Sl. No	Particulars	BCS-CL (n=47)	BCS-AITF (n=16)	BCS-AISF (n=25)
1	Training/Instructions provided by agency at the time delivery (Yes)	87.23	93.75	88.00
2	Maintenance backup provided as and when required (Yes)	46.81	75.00	52.00
3	Transfer of equipment (Yes)	0.00	0.00	0.00
4	Used by beneficiary (Yes)	100.0	100.0	100.0

Source: Field survey data

#### 4.2.2 Solar Light:

In order to have the impact of solar light on various aspect of life, it is important to have details on house of beneficiaries. It can be seen from the Table 13 that the selected houses were of mixed in nature, i.e. compact and spacious. The average number of rooms in selected households was around two having maximum windows as well as direction of house towards east-west. The adequate ventilation in house was observed in case of 49 percent houses. More than 40 percent houses of solar light beneficiary households were with mangalore roof whereas around 25 percent households were with desi roof. About half of the selected households had good ventilation, however during the rainy and cloudy days, they had made some arrangements to reduce the darkness. The use of solar light followed by kerosene and GEB electricity were the prominent source to reduce darkness in the house. After availability of solar light, it has been used heavily to reduce the darkness in the house. Thus, it must have saved the expenditure on kerosene.

The details on use of solar light by selected beneficiary households presented in Table 14 indicate that except one each in LED and CFL, all other LED and CFL as well as HLS units were in use at the time of survey. All the solar light units were charged for about 6 hours by solar recharge system, whereas supportive recharge was also provided by electric supply to some CFL and HLS units to the extent of 2.67 and 1.0 hour respectively. More than 86 percent of beneficiary households had done recharge every day. About 90.0 per cent beneficiary households of LED and 93.3 per cent beneficiary households of HLS had to recharge their solar light every day. About 36 percent and 16 percent beneficiary households of LED and CFL respectively mentioned that they themselves repaired the units, as and when they had faced problem in

same. About 48 percent CFL users, more than 63 percent LED and HLS users recorded that agency had provided them maintenance backup. No unit of solar light was transferred and all were with beneficiary household.

Table 13: Details on Houses of beneficiary of Solar Light

		(% to total HH)	
Sl. No	Particulars		Solar Light (n=55)
1	Types of house	a) Compact	49.09
		b) Spacious	50.91
2	Average no. of room in house		2.38
3	Location of window:	a) East-West	54.55
		b) South-North	45.45
4	Average no. of window (Number)		1.78
5	Type of roof (% to total hh)	a) Desi	25.45
		b) Mangalore	40.00
		c) Asbestos	21.82
		d) Tin/ Terrace	12.73
6	Direction of house (% to total hh)	a) East-West	76.36
		b) South-North	23.64
7	Ventilation (% to total hh)	a) Adequate	49.09
		b) Inadequate	50.91
8	Average Height of roof (av. feet)		16.76
9	Arrangement of minimize darkness (multiple responses)	(i) Kerosene light	80.00
		(ii) Electric light	80.00
		(iii) Removal of tile/cowelu	1.82
		(iv) Use of glass roof tile	27.27
		(v) Solar light	100.00

Source: Field survey data.

Table 14: Use of Solar Light by Sample Households

Sl. No.	Particulars	Unit	LED (n=11)	CFL (n=29)	HLS
1	Presently using solar light:	% of HHs	90.91	89.66	100.00
2	Everyday recharge	Hrs/day			
	(i) By solar recharge system		5.55	5.31	5.43
	(ii) By electric supply		0.00	2.67	1.00
3	Recharge	% of HHs			
	(i) Everyday		90.00	86.21	93.33
	(ii) Alternative day		10.00	3.45	6.67
4	If problem, repaired solar light by self	% of HHs	36.36	15.38	0.00
5	Training provided by agency	% of HHs	100.00	68.97	100.00
6	Maintenance back up provided	% of HHs	63.64	48.28	66.67
7	Transfer of equipment to others	% of HHs	0.00	0.00	0.00
8	Self use		100.00	100.00	100.00

Notes: HLS: Home light system; LED: Light emitting diode; CFL: Compact fluorescent lamp

Source: Field survey data.


The impact of use of solar light on selected aspects is presented in Table 15. It can be seen from the table that before solar light situation, selected beneficiary households were used to have light for about 6 hours in a day, mostly through GEB electric supply and through use of kerosene. Whereas after use of solar light, total light hours had increased to around 8 hours and major source was solar light, supported by GEB supply and also use of kerosene.

Table 15: Impact of use of Solar light on selected aspects

Sl. No.	Particulars	Unit	Before solar light	After solar light		
				LED (n=11)	CFL (n=29)	HLS (n=15)
1	Power supply used in 24 hrs	Hrs/day/H H				
	a) Electric supply grid		3.98	3.68	2.92	3.20
	b) Kerosene		2.05	1.83	1.10	1.00
	c) Any other-solar		0.00	4.09	4.63	4.71
2	Kerosene use	Lit/month	3.79	1.33	0.78	1.38
3	Kerosene cost	Rs/month	56.81	44.15	35.40	29.25
4	Electricity bill		288.75	252.73	228.52	229.33
5	Cost of repair/replace		42.86	40.00	35.71	13.33
6	Study hours of children	Hrs/HHs	0.86	0.95	1.35	2.00
7	Total working hrs on field		4.54	5.12	4.44	4.35
8	Use of light:	Hrs/day				
	Studying		0.00	0.43	0.84	0.80
	House lights		0.00	1.39	1.56	1.85
	Cooking		0.00	0.95	0.62	1.02
	Travelling/outside work:	Hrs/day	0.00	0.00	0.09	0.03
	Agriculture field		0.00	1.32	1.46	1.00
	Handicraft work		0.00	0.00	0.07	0.00
9	Income from field	Rs./year	23536	24455	23448	23933
10	Willing to pay for solar light:	Rs./HH				
	With subsidy		0.00	1000.00	1000.00	1000.00
	Without subsidy		0.00	1475.00	1354.55	1611.11

Notes: HLS: Home light system; LED: Light emitting diode; CFL: Compact fluorescent lamp  
Source: Field survey data.





However, significant decline in use/consumption of kerosene has been noticed, i.e. from around 3.8 liters per month to around 0.8-1.0 lit per month. Thus, expenditure on kerosene has reduced by about two third of cost incurred earlier. The impact could be also seen in total electricity bill, which was declined from Rs. 289/- per month to less than Rs. 252/- per month. The increase in studying hours of their children was another positive feature of use of solar light. HLS system was first choice of children for studying followed by CFL, whereas households having LED experienced relatively less studying hours. In case of total working hours on the field, it was observed that there was increase in numbers of working hours on the field after having availability of solar light with beneficiary household. During the night hours, beneficiary households had used the solar light on field to complete some works. On the response to willingness to pay, beneficiary households opined that they would pay around Rs. 350-600/- extra than the subsidy amount paid by them to the agency. Thus, despite of having numbers of benefits from the solar lights, the willingness to pay amount seems to be lower.

#### **4.2.3 Glass Roof Tiles:**

The details on houses of beneficiary household of glass roof tiles are presented in Table 16 with average two rooms and adequate ventilation. The average height of the house was about 16 feet and 75 percent houses were with mangalore roof whereas 25 percent households were with desi roof. In order to reduce the darkness in house, besides use of glass roof tiles, use of kerosene and grid electric supply were the prominent sources. The details on glass roof tiles used indicated that half of the beneficiary households had used one tile whereas remaining had used two tiles (Table 17) and no one had faced any problem. Training and maintenance facility was provided by the agency and all the units were with beneficiary households. The selected beneficiary households mentioned that they are willing to pay Rs. 50/- for one tile and Rs. 100/- for two tiles with subsidy and Rs. 103/- for one tile and Rs. 150/- for two tiles without any subsidy.

The details on impact of glass roof tiles on various parameters are presented in Table 18. It can be seen from the table that before glass roof tiles, total light hours in beneficiary households due to use of GEB supply and use of kerosene were found around 6.3 hours, which had reduced to around 3.5 hours after use of glass roof tiles. Due to reduction in consumption of kerosene, the expenditure on same had reduced to one third of earlier one, i.e. from Rs. 45/month to Rs. 15/month.

Table 16: Details on Houses of beneficiary of Glass Roof Tiles (% to total HH)

Sl. No.	Particulars		Glass Roof Tiles
1	Types of house	a) Compact	25.00
		b) Spacious	75.00
2	Average no. of room in house		2.13
3	Location of window:	a) East-West	62.50
		b) South-North	37.50
4	Average no. of window (Number)		1.50
5	Type of roof (% to total hh)	a) Desi	25.00
		b) Mangalore	75.00
		c) Asbestos	0.00
		d) Tin/ Terrace	0.00
6	Direction of house (% to total hh)	a) East-West	62.50
		b) South-North	37.50
7	Ventilation (% to total hh)	a) Adequate	75.00
		b) Inadequate	25.00
8	Average Height of roof (av. feet)		15.75
9	Arrangement of minimize darkness (multiple responses) (% to total hh)	(i) Kerosene light	87.50
		(ii) Electric light	87.50
		(iii) Removal of tile/cowelu	12.50
		(iv) Use of glass roof tile	100.00
		(v) Solar light	50.00

Source: Field survey data

Table 17: Details of Glass Roof Tile used

Sl. No.	Particulars	Unit	Glass Roof Tiles (n=8)	
1	No. of Tiles used	Only One tile	% of HHs	50.00
		Two tiles		50.00
2	Faced any problem in using/handling (No)	% of HHs	100.00	
3	Training provided by agency (Yes)	Per HHs	100.00	
4	Maintenance back up provided (Yes)	Per HHs	100.00	
5	Transfer of roof tiles/ Used by beneficiary:			
		Self use	Per HHs	100.00
	Transferred		0.00	
6	Willing to pay for glass roof tile:	Rs./unit		
		With subsidy for one tile		50
		With subsidy for two tiles		100
		Without subsidy for one tile		103
	Without subsidy for two tiles		150	

Source: Field survey data

Table 18: Impact of Glass Roof Tiles

Sl.No.	Particulars	Unit	Before glass roof	After glass roof tile
1	Power supply used in 24 hrs:	Hrs.		
	a) Electric supply grid		4.00	2.88
	b) Kerosene (hrs.)		2.29	0.67
	c) Any other (hrs.)		0.00	0.00
2	Kerosene use	Lit/month	3.00	1.00
3	Kerosene cost	Rs./mont	45.00	15.00
4	Electricity bill (Rs./month)		253.75	203.75
5	Cost of repair/replace		0.00	0.00
6	Study hours of children	Hrs.	0.50	0.50

Source: Field survey data

#### 4.2.4 Biogas Plant:

The constructed family size solid state modified deenbandu biogas plant of 2 cum gas capacity and cattle dung based units. The feeding pipe was of PVC with small slurry dragging area. The water and dung requirement ratio suggested to be used was as 5 parts of dung and 2 part of water. Everyday around 23 kg dung was used for charging biogas, thus requirement of 9-10 liters of water for same (Table 19). The selected biogas beneficiary households had feeding the dung every day by spending about half an hour and thus no requirement of additional labour was mentioned by the beneficiary households. The dung feeding in biogas plant by sometime by male, female and even children of these households as per their availability and engagements. The digested slurry was used mainly for FYM purpose, as well as for making vermi compost. The use of digested slurry for FYM was preferred most because of the fact that digested slurry has no seed of weed or any unwanted crop and thus results in no problem of weeds after use of FYM of slurry made. The less expenditure on control of weeds thus benefits the beneficiary households during crop cultivation.

The agency had provided the training to all the beneficiary households on operation and use of biogas plant. Some of beneficiary households had faced problem in operation and they themselves had solved the same. One biogas plant was found non-working because of pipe was broken and same was informed to the agency for maintenance backup. The gas was used by beneficiary households for their uses and no one had shared to other nearby household. All the households had mentioned that they would continue with

the present biogas systems and their willingness to pay for biogas plant was upto the extent of Rs. 5000/- only. About 67 percent households had mentioned that they would like to go for toilet linked biogas plant, whereas remaining households mentioned that they would not to prefer for same.

Table 19: Details of biogas plant and its use

Sl. No.	Particular	units	Biogas plant (n=9)
1	Biogas plant area (size)	In meter	3.5 x 3.5
2	Biogas plant capacity	m <sup>3</sup>	2
3	Types of Biogas	Animal waste	100.00
		Human waste	0.00
4	Water requirement	Dung: Water	50:10
5	Daily Dung feeding	kg/day	22.78
6	Dung feeding and Slurry handling	minutes	0.35
7	Required any additional labour (No)	% to total	0.00
8	Who add dung and water (1st & 2nd) in day (multiple responses)	Male	11.11
		Female	66.67
		Children	22.22
9	Feeding pipe:	PVC	100.00
		RCC	0.00
11	Slurry drying area:	Small	100.00
		Large	0.00
12	Digested slurry used for:	Vermi compost	33.33
		FYM	66.67
	If any problem arise, self repair	Yes	11.11
13	Training provided by agency	Yes	100.00
14	Maintenance back up provided	Yes	77.78
15	Transfer to gas to others from biogas	Self use	100.00
		Transferred	0.00
16	No. of Plant not in use (n=1)	% to total	11.11
	If yes, since how many days	days	90
	Reason for same	Pipe broken	11.11
17	Continue with biogas	Yes	100.00
18	Willingness to Investment (Rs.)	With subsidy	Rs. 4667
		Without subsidy	Rs. 5000
19	Present working biogas	Yes	88.89
20	Would like to go for Toilet linked biogas plant	Yes	66.67
		No	33.33

Source: Field survey data

The details on effect of biogas use on time spend by selected households on cooking, field work and study hours of children are presented in Table 20 shows that drastic decline in cooking time was noticed after use of biogas, i.e. from almost 2 hours to 1 hour/day. Thus, cooking time was reduced by half because of biogas use. The time spent on field also increased use which may be due to time saved in cooking. Surprisingly, no change was noticed in case of study hours of children.

Table 20: Effects of biogas use on time spent by households

Sl. No.	Particular	Time spent (hrs/day)	
		Before Biogas	After Biogas
1	Cooking time	1.58	0.88
2	Time for field work	2.35	2.93
3	Study hours of the children	1.00	1.00

Source: Field survey data

#### 4.2.5 Solar Cooker:

The details on use of solar cooker use by the beneficiary households are presented in Table 21. It can be seen from the table that both conventional and solar cooker was used for preparation of rice and dal only mostly on every day afternoon. The use of conventional cooker was found throughout the year, whereas solar cooker was used mainly in winter and summer season. Because during the rainy season, non availability of adequate and high intensity sun light due to cloudy weather results in non use of solar cooker by beneficiary households. The cooking time required in solar cooker was found one and half times higher than the conventional cooker. No problem was faced by the beneficiary households in use of solar cooker. Also all of them mentioned that no change in food taste was realized by them in food cooked in solar cooker. The households opined to pay Rs. 813 per solar cooker as compared to Rs. 750/- per cooker paid by them as subsidy amount for getting the same. The training on use of cooker was provided by the agency and as no problem was faced by the users, no maintenance back was provided. All the cooker were found to be used by the beneficiary households themselves and no one transferred to other.

Table 21: Details on Use of Conventional and Solar Cooker

Sl. No.	Particulars	Unit	Conventional cooker	Solar cooker (n=4)
1	Cooker used for:			
	Rice/Dal	Per HH	100.00	100.00
	Any Other / Sp.Dish		0.00	0.00
	Boiling of pulses/other		0.00	50.00
2	Use of solar cooker:	Per HH		
	Every day afternoon		100.00	75.00
	Alternative day		0.00	25.00
	weekly		0.00	0.00
	Rainy	Hrs/day	1.75	0.00
	Winter		2.25	2.63
	Summer		1.50	2.50
3	Cooking time required:			
	Rainy (hrs/day)	Hrs/day	1.75	0.00
	Winter (hrs/day)		1.75	2.63
	Summer (hrs/day)		1.50	2.50
4	No change in food taste	Yes	0.00	0.00
	Training provided by agency			100.00
	Maintenance back up provided			0.00
	Transfer of cooker to other			0.00
	Used by beneficiary			100.00
5	During the rainy season:			
	If problems repair solar cooker	Per HH	0.00	0.00
6	Willing to pay solar cooker			
	With subsidy	Rs./HHs	0.00	750.00
	Without subsidy		0.00	812.50

Source: Field survey data

#### 4.2.6 Solar Dryer:

Another solar unit distributed by the agency was solar dryer. The details on same are presented in Table 22. The weight of the solar dryer was of 0.5 to 1.0 kg and it was found that solar dryer was mostly used for drying vegetables sometime every day or on alternative day. It was used heavily during summer followed by winter season, while during rainy season, it was used rarely.

Table 22: Details of Solar Dryers

Sl. No.	Particulars		Solar dryer (n=2)
1	Capacity of solar dryer (kg)		0.5 to 1.0
2	Use of solar dryer (% of hh):	Drying vegetable	100.00
		Any other use	0.00
3	Frequency of use of solar dryer (%)	Every day afternoon	50.00
		Alternative day	50.00
		Weekly	0.00
4	Frequency of use of solar dryer Hrs/day	Rainy	0.25
		Winter	1.25
		Summer	2.5

Source: Field survey data

The use of solar dryer had impact on saving time in drying the vegetables with no change in food taste (Table 23). The agency had provided training on use of solar dryer and no one had faced any problem in use of same. All solar dryer were used by beneficiary households and no one had transferred unit. Without subsidy, the beneficiary households mentioned their willingness to pay was Rs. 150/ per unit.

Table 23: Impact of Use of Solar Dryer on saving of time

Sl. No.	Particulars	Unit	Solar dryer (n=2)
1	Saving in drying time	% to total HH	100.00
2	time saved	(%)	50.00
3	Change in food taste (No)	% to total HH	100.00
4	During rainy season use	% to total HH	0.00
5	If any problem, self repair of solar dryer	% to total HH	0.00
6	Training provided by agency	% to total HH	100.00
7	Maintenance back up provided	% to total HH	0.00
8	Transfer of solar dryer to others (Yes)	% to total HH	0.00
9	Used by beneficiary	% to total HH	100.00
10	Pay for solar dryer	Rs/HH	
	With subsidy		100.00
	Without subsidy		150.00

Source: Field survey data

### 4.3 Benefits & Constraints in Use of RE Technology

#### 4.3.1 Improved Biomass Cook Stove

The major advantages and constraints in use of improved biomass cook stove set up by the agency presented in Table 24 indicates that more than 93 percent beneficiary households opined that use of improved biomass cook stove helped them in reduction of use of the fuel wood followed by reduction in indoor air pollution and consumption of kerosene (more than 84% hh). More than 70 percent of households mentioned that due to use of improved BCS, not only cooking time has reduced but also suffocation in kitchen and female hard work had reduced significantly. The other major benefits of improved BCS cited by the beneficiary households were reduction in time of wood collection, better cleanliness of kitchen and thus may be better livelihood/ better family life.

Among the major constraints in use of improved biomass cook stove, feeding of wood from top in case of top feeding BCS generally disturb the cooking thus results in more cooking time or less preference of unit for cooking. Also cutting of wood in small pieces which is requirement of top feeding cook stove was major constraints faced by beneficiary household. The major food items of selected beneficiary households was rotla (chapatti) which

can be cooked properly on BCS, for which they have to use domestic chulha is another constraint faced by the beneficiary households. This is one of the reasons why beneficiaries wanted more side feeding BCS. However, beneficiary HHs faced problem in moving the cook whenever necessary due to handles are broken in BCS-SF. About 4 per cent HHs of side feeding BCS raised this issue.

Table 24: Benefits and Constraints in use of biomass cook stove (% of HHs)

Sl. No.	Benefits and Constraints	BCS(all) N=88	BCS-CL N=47	BCS-TF N=16	BCS-SF N=25
A	Benefits				
1	Reduce female hard working/drudgery	72.73	72.34	87.50	72.00
2	Reduce fuel material collection time	67.05	72.34	62.50	64.00
3	Reduce wood usages	93.18	91.49	100.00	96.00
4	Reduce inside cooking smoke	67.05	72.34	68.75	60.00
5	Reduce suffocation in kitchen	75.00	78.72	75.00	72.00
6	Reduce indoor air pollution	89.77	70.21	87.50	100.00
7	Reduce use of Kerosene	84.09	70.21	81.25	76.00
8	Reduce cooking time required	78.41	65.96	68.75	84.00
9	Better kitchen cleanness	65.91	57.45	68.75	64.00
10	More time to work on field/home activities	23.86	17.02	18.75	28.00
11	Saved time used for home/other work	37.50	23.40	37.50	44.00
12	Reduce expenditure on health/medicine	13.64	8.51	18.75	16.00
13	Increase study hours of children	7.95	4.26	0.00	8.00
14	Easiness of use of cooker	28.41	27.66	18.75	36.00
15	Better lifestyle/livelihood	21.59	19.15	25.00	24.00
16	Use of dung for other purposes	17.05	19.15	12.50	8.00
17	Increase income from field	10.23	6.38	0.00	16.00
18	Increase income from wages	3.41	0.00	0.00	4.00
B	Constraints				
1	Top feeding- feeding of wood from top disturb the cooking which result in more cooking time	21.59	31.91	12.50	0.00
2	Top feeding- rotla cannot be cooked properly	32.95	42.55	37.50	0.00
3	Top feeding- cutting of wood in small pieces consume more time	44.32	59.57	56.3	0.00
4	Height of stand for vessel is high	1.14	0.00	0.00	4.00
5	Handle broken in BCS-SF	1.14	0.00	0.00	4.00
6	Smoke creates suffocation	1.14	0.00	6.25	0.00

Source: Field survey data



### 4.3.2 Solar Light

About 93 percent households opined that the use of solar light has benefited by significant reduction in consumption of kerosene, followed by reduction in darkness in the house (87.27 percent hh), reduced the dependency on GEB (Gujarat Electricity Board) supply (about 69.09 percent hh) and also reduced the electricity bills (Table 25). With the use of the solar light, house indoor pollution due to use of kerosene for lighting has reduced (69.09 percent hh), which resulted in better lifestyle/livelihood (49.09 per cent hh). Besides, reduction in cooking hours, reduction in fire incidents and health hazards, more time for field work (by using light on field during night time) are some of the benefits experienced by the beneficiary households.

Table 25: Benefits and Constraints in use of Solar Light (% of HHs)

Sl.No.	Benefits/Constraints	Solar light (all) N=55	LED =11	CLF=29	HLS= 15
A	Benefits				
1	Reduce uses of Kerosene	87.28	90.91	86.21	86.67
2	Reduce darkness hours in house	81.82	90.91	75.86	86.67
3	Reduce dependence on grid electricity	69.09	72.73	72.41	60.00
4	Reduce electricity bill thus saving	69.09	63.64	68.97	73.33
5	Reduce cooking hours	45.45	36.36	55.17	33.33
6	More time to work on field/home activities (time saving)	38.18	18.18	51.72	26.67
7	Increase study hours of children	29.09	45.45	27.59	20.00
8	Better lifestyle/livelihood	49.09	36.36	51.72	53.33
9	Increase income from field	7.27	0.00	13.79	0.00
10	Reduce pollution	65.46	72.73	62.07	66.67
11	Reduce fire and health hazards	41.82	36.36	51.72	26.67
12	Used it in field at night work	38.18	36.36	44.83	26.67
13	Used for social functions	23.64	36.36	24.14	13.33
B	Constraints				
1	Low battery back up	52.73	72.73	55.17	26.67
2	LED Low intensity of light	16.36	18.18	13.79	20.00
3	More weight of light	7.27	0.00	10.34	6.67
4	Frequent battery problem	41.82	45.45	41.38	33.33
5	Charging problem	3.64	9.09	3.45	0.00
6	major battery problem	3.64	0.00	6.90	0.00
7	nobody come for repair	1.82	9.09	0.00	0.00
8	Repaired, but not working	1.82	0.00	0.00	6.67
9	Time for repairing very long	1.82	0.00	3.45	0.00

Source: Field survey data

There were some of the constraints reported during the survey time by the beneficiary households in the use of solar light. The major constraint experienced by the more than 52 percent of beneficiary household was low battery backup, followed by frequent battery problem (41.82 %) and low intensity of LED lights. Besides, some of the households have reported that problem in charging of battery, no availability of immediate support from agency as well as no local repair experts were some of the problems faced by them. Among the suggestions given by the beneficiary households, majority of households opined that requirement of repair arrangement at local level (49.09%), followed by need to increase battery backup (43.64%) are the major one (Table 26).

Table 26: Suggestions on Solar Light

Sl. No.	Suggestions	% of HHs
1	Increase battery back up	43.64
2	Need repairing arrangement at local level	49.09
3	Damage in CFL Light due to power fluctuation need to be checked	1.82

Source: Field survey data

### 4.3. Glass Roof Tiles

The use of glass roof tiles had also brought some changes in the lifestyle of the beneficiary households. About 88 percent households had mentioned that use of glass roof tiles have reduced the darkness hours in house during day time which had given them feeling of increase in standard in living (Table 27). Not only use of kerosene had reduced but also electricity bill got reduced. The only one beneficiary household has made a suggestion that more number of tiles should be given to install in all four corners of the house.

Table 27: Benefit of glass roof tiles

Sl. No.	Benefits/Suggestion	% of HHs
A	Benefits	
1	Reduce darkness hours during day time	87.50
2	Reduce electricity bill thus saving	62.50
3	Reduce dependence on electricity	62.50
4	Reduce uses of Kerosene	75.00
5	Better lifestyle/livelihood	87.50
6	Increase study hours children	25.00
B	Suggestions	
1	More number of tiles should be given to install in all four corner of the house	12.50

Source: Field survey data

#### 4.3.4 Biogas Plant

The details on benefits experienced by use of biogas plant by beneficiary households are presented in Table 28. All beneficiary households had mentioned that biogas was found cheaper than LPG, reduction in cooking hours, advantage in use of biogas slurry for FYM as compared to FYM prepared by conventional method and reduction in dependence on wood/kerosene. More than 88 percent households mentioned that it has reduced/saved fuel wood collection and preparation time, better use in rainy season (as wood and other material got wet) which saves cooking time and wood. The other major benefits reported by beneficiary households were reduction in blackness of roof and outer side of utensils resulted in better lifestyle and livelihood, reduction in weeds and thus cost on weeding has reduced and income from agriculture has increased, easy to use pressure cooker for cooking the rice and dal, time saved in fetching wood/kerosene. The biogas beneficiary has faced some problems in operation and use of same. It can be seen from the Table 30 that about 22 percent households had faced choke-up problem, followed by lack of supply chain for components and spare parts in rural locations, difficulty in repair and maintenance, required more space to install and in some cases mosquito problem was also noted.

Table 28: Benefits and Constraints in use of biogas plant

Sl. No.	Benefits/ Constraints	% of HHs (n=9)
<b>A</b>	<b>Benefits</b>	
1	Reduced the fuel collection and preparation time	88.89
2	Reduce dependence on wood/kerosene	100.00
3	Reduce cooking hrs.	100.00
4	Reduce the blackness of roof and outer side of utensils	77.78
5	Time saved in fetching wood/kerosene	66.67
6	Better lifestyle and livelihood	77.78
7	Better use in rainy season as wood and other material get wet	88.89
8	Cheaper than LPG cylinder	100.00
9	Reduced use of wood	88.89
10	Increase in study hours of children	11.11
11	Reduction in weeds and thus cost on weeding reduced	55.56
12	Increase in income from agriculture due to use of FYM	55.56
13	Easy to use pressure cooker	66.67
14	Advantages in using biogas spent slurry as compared to FYM	100.00
<b>B</b>	<b>Constraints</b>	
1	Required more space to install (n=1)	11.11
2	Repair and maintenance is difficult	11.11
3	Choke up is main problem (n=2)	22.22
4	Water availability during summer is inadequate thus effect on plant (n=1)	11.11
5	Lack of supply chain for components and spare parts in rural area (n=1)	11.11
6	Mosquito problem (n=1)	11.11
7	Bad odor/smell (n=1)	0.00

Source: Field survey data

### 4.3.5 Solar Cooker

Among the various benefits experienced in use of solar cooker by beneficiary households, no wastage due to overflow (due to more heat as generally happen in case of conventional cooker) and no smoke were major one opined by all of them (Table 29). More than 75 percent of households had mentioned that as there is no wastage due to more heat (as generally it happens in case of conventional cooker), no monitoring is required. About half of the households mentioned that we could keep hot food available for long time as well as dependence on wood and kerosene was reduced and it is very easy to handle. However, no benefit in reduction in cooking hours was recorded. The major and only constraint faced by the 25 percent beneficiary households was solar cooker takes more time during rainy and winter seasons. It is obvious because solar cooker decency on sun ray during rainy season affects due to cloudy weather and during winter, low temperature takes more time to cook food in solar cooker.

Table 29: Benefits and Constraints in use of Solar Cooker

Sl. No.	Benefits	Solar Cooker
A	Benefits	
1	No monitoring required	75.0
2	No wastage due to overflow (due to more heat)	100.0
3	Long time hot food ready to serve	50.0
4	Reduce dependence on wood/kerosene	50.0
5	No smoke	100.0
6	Easy to handle	25.0
7	Better lifestyle/Livelihood	25.0
8	Reduce to cooking hours	0.0
B	Constraints	
1	More time taken during rainy and winter seasons	25.0

Source: Field survey data

### 4.3.6 Solar Dryer

The major benefit of solar dryer experienced by users was no inspection required and no change in taste, colour of material (Table 30). Around half of the beneficiary households mentioned that in case of solar dryer, other benefits were reduction in losses during drying though bird/animal/handling wastage, reduction in drying time and important one was dust free drying of material. The only constraint faced by half of the selected households was solar dryer net got damaged during its use, which needs to be repaired /replaced by the agency in time.

Table 30: Benefits and Constraints in use of solar dryer

Sl.No.	Benefits and Constraints (n=2)	% of HHs
A	Benefits	
1	No inspection required	100.00
2	Reduce losses in drying though bird/animal/handling wastage	50.00
3	No change in taste and color	100.00
4	Reduce drying time	50.00
5	Dust free drying of material	50.00
B	Constraints	
1	Net got damaged (n=1)	50.00

Source: Field survey data

## 5. General Suggestions to Improve Working of the RE Technologies

All the beneficiary households were asked to give their suggestions on improvement of RE technologies, whether same household has used or not used all RE technologies. Thus, we got responses from the household who had not used the technology may be because of this or any other reason. The highest number of households have suggested that battery quality of solar light need to be improved (16.2 percent hh), followed by opinion to make available more side feeding stove as it is better than top feeding cook stove (Table 31). Stabilizer should be provided with light (due to fluctuation in electric voltage charging to light not possible). Instead of LED, HLS should be provided (battery backup is more in HLS than led). More number of glass roof tiles should be provided and weight of ceramic cook stove need to be reduced. The agency should take into account the suggestion made by the beneficiary household and if work on the possible suggestions, the households would realized more impact and benefits of RE technologies.

Table 31: Suggestion to improve working of the RE technologies

Sl.No.	Suggestions	% of
1	Improved battery quality	16.2
2	Make available Side feeding stove as it is better than top feeding cook stove	10.5
3	Due to fluctuation in voltage electric charging to solar light not possible, thus	1.0
4	Provided home light (HLS) instead of LED because HLS Battery backup is more	1.0
5	Provided more number of glass roof tiles	1.0
6	Weight of ceramic cook stove should be reduce	1.0

Source: Field survey data

## 6. Non-Beneficiary Preference and Causes of their Exclusion

The non-beneficiary households were asked about their level of awareness and preferences for various solar renewable technologies available in their villages. Their choice pattern and willingness to pay is presented in Table 32. Majority of them revealed their preferences for sided fitted biogas stove and glass roof tiles (76.2% each), solar light-HLS (50%) and biogas plant (11.9%). The major sources of information for them were SPRERI personnel and fellow farmers. There were no major differences between willingness to pay with subsidy and without subsidy for various instruments except bio gas plants and solar lights. The non-beneficiaries' willingness to pay with subsidy and without subsidy for bio gas plants was Rs. 5000 and Rs. 7500 respectively.

Table 32: Interest to Use Renewable Technologies by Non-beneficiary HHs (N=42)

Sl. No.	Particulars	BCS-Ceramic	BCS-Top Feedi	BCS-Side Feedi	Solar Light-LED	Solar Light-CFL	Solar Light-HLS	Biogas Plant	Solar Cooker	Solar Dryer	Glass Roof Tiles
1	Source of information (% of HHs):										
	Own	0.0	0.0	19.0	0.0	2.4	16.7	9.5	0.0	0.0	19.0
	Fellow Farmers	0.0	0.0	21.4	0.0	9.5	4.8	0.0	0.0	0.0	21.4
	Village level worker	0.0	0.0	4.8	2.4	2.4	9.5	0.0	0.0	0.0	4.8
	NGOs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SPRERI Personnel	0.0	0.0	28.6	4.8	4.8	16.7	2.4	0.0	0.0	28.6
	News paper	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TV/Radio	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	NABARD awareness programme	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Sarpanch	0.0	0.0	2.4	0.0	0.0	2.4	0.0	0.0	0.0	2.4
2	% of HHs interested to purchase	0.0	0.0	76.2	7.1	19.0	50.0	11.9	0.0	0.0	76.2
3	No. of unit to purchase (per HH)	0.0	0.0	0.8	0.1	0.2	0.5	0.1	0.0	0.0	0.8
4	Willingness to Pay(Rs./unit):										
	a) With Subsidy	0.0	0.0	212.5	1000	1000	871.4	5000.0	0.0	0.0	212.5
	% of HH Purchase with subsidy	0.0	0.0	76.2	7.1	19.0	50.0	11.9	0.0	0.0	76.2
	b) Without Subsidy	0.0	0.0	247.4	1500	1250	922.2	7500.0	0.0	0.0	247.4
	% of HH Purchase without	0.0	0.0	45.2	7.1	19.0	21.4	4.8	0.0	0.0	45.2

Source: Field survey data

As far as the causes of exclusion of rural households are concerned, about 54.8 per cent non-beneficiaries expressed that they were not aware about the benefits of solar instruments (Table 33). About 52.4 per cent non-beneficiaries expressed that the financial constraints were the major constraint for them that prevented them in buying those instruments. Since these instruments were available on limited basis for a short period of time, many rural families failed to arrange money at the time of availability. Thus, about 23.8 per cent non-beneficiaries could not purchase solar instruments because of limited stock. Majority of them requested to make arrangements to have sufficient stock of these instruments at local level, so that these families can purchase at their convenient time.

Table 33: Exclusion from the Programme


Sr. No.		% of HHs
1	Not Aware about the technology	54.76
2	Financial Constraint	52.38
3	Limited Stock with SPRERI	23.81
4	Biogas- Stringent criteria (no animals, etc.)	4.76
5	Biogas- Small family size, no need	0.00
6	First come first serve basis of SPRERI	11.90

Source: Field survey data

## 7. Conclusions and Policy Suggestions

The present study examined the extent of adoption of renewable energy technologies, impacts of renewable energy technologies and constraints faced by the users in selected tribal villages of Gujarat. The study finds significant usefulness of these devices and has found out some constraints such as inadequate supply, lack of sufficient service points, unavailability of spare parts/accessories of these devices in local market, sometime delay in repairing of the devices, long procedure in getting the damaged devices repaired have resulted in lower adoption rate in these areas. The study has brought out following policy suggestions for the policy makers:

- There is high demand for some of SPRERI's devices such as Solar Lantern HLS, Glass Roof Tiles, Side feeded Biomass Cook Stove and Biogas Plant in survey areas, but due to short supply of these devices, some households could not be benefited with same. Therefore, these solar devices should be made available in adequate number by the agency, if needed by having collaboration with private agencies. There is also a need to make these devices available in adequate number with local coordinators/service points. This will help in enabling the rural people to



purchase the item/s at their own financial convenience. Since these devices are highly subsidized and has demand, normally people close to local authority thus got the benefit, which should be avoided.

- The agency should take into account the suggestions made by the beneficiary household (e.g. Top Feeding Stove, Solar light-battery, etc) and should work on the possible corrections in the devices so that households would realize more impact and benefits of RE technologies.
- More awareness among rural women about important RE device as well as handling of these devices need to be made since devices are mostly handled by women and thus mishandled very often cause damage to the system/device. In some cases, it was observed that women could not start plugging the charger (Solar Lantern-HLS) because of fear of electricity.
- One of the reasons of low adoption of some devices was the unavailability of effective service points at local level. The unavailability of spare parts/accessories of these devices in local market, sometime delay in repairing of the devices, long procedure in getting the damaged devices repaired<sup>9</sup> and quality of the service provided have been the major constraints in generating confidence among rural people. These constraints should be addressed by the service provider in a timely manner.
- There is a need to train the local people to repair the systems in effective manner. The quality training should be provided to the local coordinator/service provider since they are found not to have sound knowledge about repairing of the devices.
- In case of Bio-gas plant, the technical problems were found to continue for a long period in Simal Faliya, causing spread of negative impression/rumors about the system and partial abandon of the system. Thus, the technical faults should be corrected within a reasonable time period.
- The number of solar cookers set up was found very less due to less adoptability. It can be mainly help in boiling the foods. In some cases, the users have never used such devices since it took much time and its use was not preferred/liked by rural women. Thus, agency should make some improvement in same.
- Solar Dryer was also not found that much useful for rural households. It was not found to be effective in saving time, though it was found effective in maintaining the taste and colour of the dried food better and cleaner compared to open drying.

---

<sup>9</sup> If any device gets damaged, as per instructions given to user by agency, they deposit the same with Sarpanch/Local coordinator. Then local coordinator informs to SPRRI personnel. SPRERI personnel visit the village/household as per their convenience/programme. Sometimes, it takes more than couple of months time to address the issue.



- It is suggested to check the design of these two products (Solar cooker and Solar Dryer) so as to raise the level of efficiency. It is the only way to promote these devices. Frequent problems in battery of Solar Lantern HLS were observed in some study villages. Thus, it is necessary to undertake proper quality checks on these products before distributing them and the supplier of the battery should be cautioned about the technical faults.
- Efforts should be made by Government, NGOS and related organization to increase awareness among the people to use renewable energy devices. Efforts should be also be made by Government to make available these devices at commercial basis at lowest possible rate so the opportunity cost of same would enhance use of RE devices.

## References

---

- Kalamkar S.S., M.N. Swain and Samir Vohara (2015), ‘Socio-Economic Impact Analysis of Introduction of Renewable Energy Technologies in Five Tribal Villages of Gujarat’ Agro-Economic Research Centre, Sardar Patel University, Vallabh Vidyanagar, Research Report No. 159, March.
- Omar Ellabban, Haitham Abu-Rub, Frede Blaabjerg (2014), “Renewable Energy Resources: Current Status, Future Prospects and their Enabling Technology”, *Renewable and Sustainable Energy Reviews*, 39, pp. 748–764.
- REN21 (2010), *Renewables 2010 Global Status Report*, Renewable Energy Policy Network for the 21st Century, Paris (Available at [http://www.harbertaxgroup.com/wp-content/uploads/2014/07/REN21\\_GSR\\_2010\\_full\\_revised-Sept2010.pdf](http://www.harbertaxgroup.com/wp-content/uploads/2014/07/REN21_GSR_2010_full_revised-Sept2010.pdf)).
- Rýo, Pablo del, and Mercedes Burguillo (2009), “An empirical analysis of the impact of renewable energy deployment on local sustainability”, *Renewable and Sustainable Energy Reviews* 13 (2009) 1314–1325.
- Rosegrant, Mark W., Siwa Msangi, Timothy Sulser and Rowena Valmonte Santos (2006), “Bioenergy and Agriculture: Promises and Challenges Biofuels and the Global Food Balance”, 2020 Focus 14, International Food Policy Research Institute (IFPRI), Washington and The Energy and Resources Institute (TERI), New Delhi, December.
- SPRERI (2014), *Annual Report 2013-14*, Sardar Patel Renewable Energy Research Institute (SPRERI), Vallabh Vidyanagar.
- <http://www.mnre.gov.in/mission-and-vision-2/achievements/> (Accessed on March 22, 2015)

## Working Papers published

Sr. No.	WP No.	Paper Title	Author/s	Month of publication & pages
01	2013/01	“Price Support and Market Intervention Scheme in Rajasthan”	S.S. Kalamkar, M. R. Ojha and T. B. Parihar	October 2013, pp. 1-40.
02	2014/01	“Problems and Prospects of Oilseeds Production in Gujarat”	Mrutyunjay Swain	May 2014, pp. 1-52
03	2015/01	“Adoption of recommended doses of fertilizer on soil test basis by farmers in Gujarat”,	Mrutunjay Swain, S. S. Kalamkar and Kalpana Kapadia	May 2015, pp. 1-36.
04	2015/02	“Impact of National Food Security Mission (NFSM) on Input use, Production, Productivity and Income in Gujarat”	R.A. Dutta, S. S. Kalamkar & M. R. Ojha	June 2015, pp.1-42.
05	2015/03	“Relationship between Wholesale Prices, Retail Prices, and Details of Contributing factors for the Price difference of Onion in Gujarat”	S.S. Kalamkar and M. Makwana	Sept. 2015, pp. 1-52.
06	2016/01	Marketed and Marketable Surplus of Major Food grains in Rajasthan	V. D. Shah and Manish Makwana	July 2016, pp. 1-38.
07	2016/02	Socio-Economic Impact of Tarakpur Check Dam in Khambhat Area of Gujarat	S. S. Kalamkar, H. P. Trivedi, S. R. Bhaiya and D. J. Chauhan	October 2016 pp. 1-38
08	2016/03	Socio-Economic Impact of Renewable Energy Technologies in Tribal Villages of Gujarat	S. S. Kalamkar, M. Swain and S. Vahora	November 2016 pp. 1-38



aerc vallabh vidyanagar working paper

aerc vallabh vidyanagar working paper

aerc vallabh vidyanagar working paper

aerc vallabh vidyanagar working paper

aerc vallabh vidyanagar working paper

aerc vallabh vidyanagar working paper

aerc vallabh vidyanagar working paper

aerc vallabh vidyanagar working paper

aerc vallabh vidyanagar working paper

aerc vallabh vidyanagar working paper

aerc vallabh vidyanagar working paper



## **Agro-Economic Research Centre**

For the States of Gujarat and Rajasthan  
(Ministry of Agriculture & Farmers Welfare, Govt. of India)

H.M. Patel Institute of Rural Development

Opp. Nanadalaya Temple, Post Box No. 24

**Sardar Patel University**

**Vallabh Vidyanagar 388120, Dist. Anand, Gujarat**

Ph. No. +91-2692-230106, 230799; Fax- +91-2692-233106

Email: director.aerc@gmail.com; director.aercgujarat@gmail.com

Websites: www.aercspu.ac.in; www.spuvvn.edu

aerc vallabh vidyanagar working paper

aerc vallabh vidyanagar working paper

aerc vallabh vidyanagar working paper

aerc vallabh vidyanagar working paper

aerc vallabh vidyanagar working paper