

## 321. Cooking and Heating Energy Need Assessment of Kalkani Village of Kohlu District, Balochistan, Pakistan.

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### Abstract

“This paper presents the cooking and heating energy need assessment of Kalkani village of Kohlu district in Balochistan, Pakistan. The paper also presents the availability of biomass energy resources for cooking and heating energy needs of the village. The questionnaire based survey method is applied for the collection of energy consumption and related data. This rural village heavily relies on biomass for cooking and heating energy needs due to limited access of modern fuels. Among the different fuels, dung meets about 44% of the total cooking and heating energy demand. The contribution of other biomass fuels for domestic use is 30% agricultural waste and 23% firewood. Other than biomass, LPG and coal has 1.7% and 0.6% share in cooking and heating energy needs of the village. The analytical observation found that the annual average primary energy demand of the village for meeting cooking and heating energy needs is 6.82 GJ per capita. The production of dung is calculated in the village is 3901850 kg/year. It is observed that the expenses on energy changes as the income level increases. The village has substantial potential of biomass energy resources in the form of animal dung, wood and agricultural waste which can be used for meeting cooking and heating energy needs of the village using environment friendly efficient cooking systems.”

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**Keywords:** Biomass, Cooking, Heating, Energy need, Kalkani, Balochistan.

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### 1. Introduction

Mostly all rural areas of Pakistan and especially province of Baluchistan are going under energy crisis either lack of resources or availability of biogas plants. In the economical point of view Baluchistan is poorest province of Pakistan. In whole province, people are using old techniques for cooking and heating. The research was conducted at Kalkani village of district Kohlu, Baluchistan. People of village are poor and do not change their methods of cooking and heating into modern methods. Biomass resources were available there in huge quantity such as cow dung, firewood and agricultural waste. People of kalkani used biomass for cooking and heating and that's why it was observed that they were suffering from different types of diseases. It was also observed that people of village want modern stoves and utilization of biomass, which will be environmentally and best for human health. In a study it is assessed that the potential of conversion of biomass through dissemination of efficient cook stoves in Pakistan [1]. This work estimated potential of ICS in rural and urban areas of Pakistan, moreover, he concluded that population in rural areas meets their domestic energy needs by burning biomass in traditional inefficient cook stoves which results in deforestation and indoor air pollution. The natural fuels such as firewood, dung, and agricultural wastes are the biggest sources of energy in rustic areas of Pakistan. Most of the people of Pakistan are still residing in villages, where renewable energy like fire wood is being used at high level for the purpose of heating and cooking. At very low level agricultural wastes and animal dung are used instead of firewood. In a survey of Household Energy Strategy Study (HESS) 1991-1993 it was acknowledged that 19,256 TOE energy approximately 27% of total energy supply of Pakistan had been taken from biomass resources (1992). About 60% of this energy supply was getting from firewood,

included agricultural wastes (21%), animal dung (18%) and Charcoal (1%). US Energy Information Administration, issued that Pakistan is going towards modern energy resources with fire wood, animal dung, and biogas (one third of total energy) by the year 1988. Being an agriculture country Pakistan is blessed with large resources of renewable energy in different shapes. It only gets 10 million tons of biogas and 50 million tons of sugar cane from the production of sugarcane in a year, and a study shows that some 80 mills of sugar cane produce approximately 3000 MW. But unfortunately only 700MW electricity is in production. In the field of Livestock there are 159 million animals existing in Pakistan and their dung and waste materials can be used in production of biogas, 4% per annum [2]. Getting renewable energy by the dungs of animal is three dimension; 1) it is cheaper way of generating energy, 2) its environment friendly and 3) it is also accepted by the society. An estimate shows that there are some 65.2 million cattle and buffaloes in Pakistan and the production of dung from a cow is some 10kg in a day. According to a study it is assumed that some 20kg dung can produce one cubic meter biogas, so if 50% (326 million kg) manure is taken and brought into use then at about 16.3 million cubic meter biogas could be generated in a day, which will be enough for cooking and energy demands of rustic areas of Pakistan. Biogas is the largest source of energy in the world, and is lies in rural areas of world; most of developing countries are using biogas to fulfill the needs of energy. Saad Butt in his article` Bioenergy potential and consumption in Pakistan “presents the increasing requirement of biomass in struggling countries, tries to illustrate the current biomass resources with up-to-the-minute energy corps and farms and gives an account of proficient biomass energy and alteration tools. The use of biomass will help in raising the level of economy, energy and healthy environment. Pakistan is gifted with biomass and biogas sources which are needed to be taken on a wide scale/level and government should support such intuitions then there will be better usages of biogas and biomass.

## **2. Material and Methods**

### **2.1 General Information of “Kalkani”**

Kalkani is the village, where survey was conducted and it is situated in district Kohlu, Balochistan. The village has 35 houses and 15km away from Kohlu city. The transportation sources are bicycle, bike, rickshaw and personal vehicles from village to city. Male and female respondents were interviewed separately. About 85% male and 15% female responded from different income group. For getting data regarding alternative energy use, cost of energy, health consequences, use of cooking technology etc. were also surveyed. Pakistan is an agricultural country with cotton and wheat being their main crops. During the survey, villagers of Kalkani were asked to identify their sources of income either agricultural or livestock, if they have more than one source of income, then they were asked to rank them in the order of their importance. It was observed that more than 70 % of the household in the village have more than one source of income.

### **2.2 Data Collection**

A questionnaire based survey method applied for data collection. Primary data collected directly from field through applying door to door interview approach. Interview session was placed during November-December, 2015. Questionnaire was constructed with great care so that it should include the entire questions related to the study. Questions were made essay so that a lay man could answer it correctly, because the participants were not highly educated. Different types of questions were kept in test like direct questions for qualitative answers about monthly income, amount of wood as fuel use in per month, and there knowledge about biogas technology. Secondly questions were based on ranking of the basic income source and preferences, income expenditure, and the reason of changing current type of fuel. Diseases associated with burning of firewood, agricultural waste and animal dung. Order of questions was kept according to the need of study of related parameters for example monthly income, occupation and importance of expenditure, but at some places the sequences of questions was modified.



**Fig. 1. Kalkani village**

The questionnaire comprises different sorts of questions e.g. it covers direct question to know exactly quantity of fuel of wood, facts about biogas technology and monthly income. It also contains questions which can give the first choice & rank information obligatory e.g. grade of the vital income sources, importance of the revenue expenditure, level of the reasons for changing the current types of fuel etc.

The collection of data of this study is done through a door-door survey in Kalkani village of district Kohlu, Balochistan. The key goal of this study was to analyse each and every type of the people having low or rich economy and to show a comprehensive analysis of such types of incomes and their consumption pattern. The sampling size in the village of Kalkani is 35 and sampling was done in the month of January 2016 covering most of the existing homes/households. By following the prepared questionnaire the survey was done and questions were asked from each and every respondents. All the questions were asked in local language by one of our fellow student and accompanied by a Khetrani surveying partner, both of these were examined by myself at each and every step. All the villagers of Kalkani village were asked to gather at one place on the interviewing day.

### 3. Results and Discussions

#### 3.1 Educational and Social Economic Status of Kalkani

The population of surveyed village is 687 with average family members of 19 persons per house. Astonishingly the number of female respondents were in same number as the male, in such male dominant society. The presences of native fellow make it quite easy to communicate with the people. A positive aspect of equal number of female is that the better know the fuel need and could easily estimate their fuel need the detail of the households in the village. It is also a positive aspect for the survey because women are the one who are responsible for the cooking, so being the end user they have a better idea about the amount of cooking fuel is consumed. Other general information's regarding village is given in Table 1.

**Table 1. Basic information of kalkani**

S. No.	Description	Values
1	No of house holds	35
2	Total population	687
3	Average family members	19
4	Percent of male respondent	65%
5	Percent of female respondent	35%

The education rate of kalkani village given in the fig. 2. Total 56% population of kalkani village was uneducated. Population primary (1st to 5th class) level education of village was 16.70% and high (6th to 10th) level education was 10.50%. College and university level education the only 4.70% and other 12.30% of population were studying in madrasa (Islamic Education).

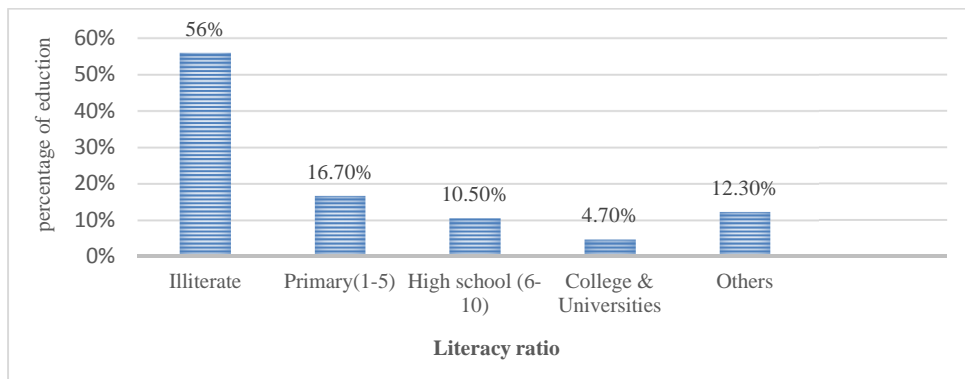


Fig. 2. Literacy Ratio

The major source of income generation sector is agriculture. About 50% of income generates from agricultural activities, Monthly income of the kalkani villagers. 23% of villagers depend on livestock and 5% of people have own private jobs. Government employees were 3% and 7% of population has own shops. 10% population were labor and 2% were retired government employee, to getting pension The income expenditures of the households in low, medium and high income groups and their monthly income was Rs.2950.00/house. Medium level have 20 houses and their income was Rs.4450.00/house. High level houses were 5 and their monthly income was Rs.18030.00/house.

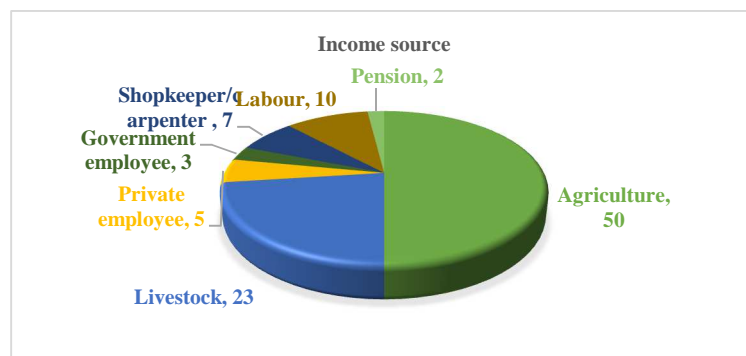


Fig. 3. Income source

According to the need of people, their income sources spend on the basis of demand. The study also realized the relation between income and expenses of a family. The observation found that priority of income expenditure of a rural family is mainly limited to fulfilling basic living needs. According to collected information from respondent, the major percentage of expenses goes to food, clothes and health care purposes which are considering least needs of rural people. After that the priority goes to education and energy, from which residents prefer to pay less for energy than education specially, the poor resident seeks the benefit of free biomass energy use for cooking. About expenses on cooking energy, poor and medium income household has limitation on budget. Low income group almost unable to pay and medium income household able to pay least amount compared to rich household. The people of kalkani first spend for food and second for clothes to cover body. Thirdly they spend on the health and care of peoples and fourth they spend on need of energy and heat for cooking purpose. On the fifth position, they spend money on education purpose and sixth number they spend on the religious functions and welfare works. At last seventh position they spend money on the entertainment for the enjoyment, as shown in the fig. 3.

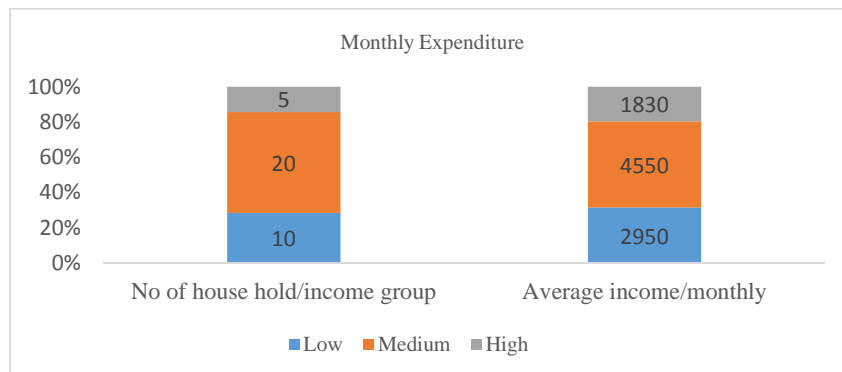


Fig. 4. Monthly Expenditure

### 3.2 Energy Utilization for Cooking and heating

The rural household seems to spend lowest percentage on energy from their monthly income considering amount of usage and monetary cost of biomass. Most of the household collects biomass from their own production or homestead which is almost free of cost. The villagers of kalkani used mostly 44% of animal dung for the cooking and heating purpose. 30.30% of people were using agricultural waste for the heating and cooking purpose. Firewood was used 23.50% and usage of LPG was 1.7%. The use of coal was 0.6% for the cooking and heating purpose, as shown in the fig 3.5. The energy consumption trend significantly increased from low to high income family. Lowest and medium household group using equal quantity of fire wood and the usage is bit high among rich group. Dung use varies between low and medium economic group and the medium and high economic group is consuming pretty much close. Use of agricultural waste and tree branches and cooking energy are gradually increased among the three consumer group. Obtaining bio energy and non-bio energy consumption situation, it is realized that the energy consumption made by the study population is 6.82 GJ per person/year. However the perception to get hold of the fuel easily in the village increases with increase in the income level in the village. The reason for such an increasing trend is because in the high income group the people own cattle as well as they have more land and we see that higher income group is mostly associated with agriculture. So for the households with the higher income group, it is comparatively easier to have access to the fuel rather than the medium and higher income group. It also has to deal with the collection of the biomass from the fields or the neighbors, because for the households with less number of old member and small kids, it is difficult to go and collect the biomass. But in the high income group, the issue of collection is not that big as they usually have to collect from their own fields and they mostly have cattle of their own.

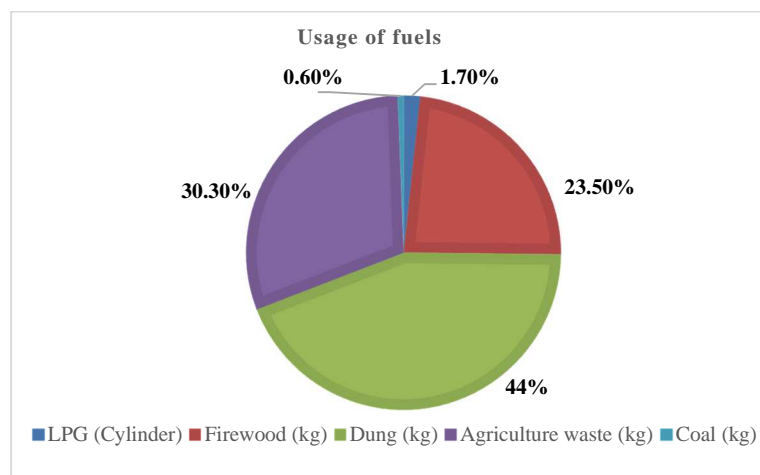


Fig. 5. Usage of fuels

It was also asked from participant that how many and which kind of stove they were using for cooking at their homes. Results showed that around 94% of houses were using mud cooking stoves and the reason behind this was that they could not pay for modern or improved cooking stoves. 5% of the households

were using improve mud stove for the cooking. Remaining 1% of houses were using advanced cooking stoves as their first priority (LPG cylinder).The usage of biomass in the village of kalkani creates different types of diseases, such like Respiratory problems, skin problems, infections, eye irritation, lungs infection, blindness, various types of allergy and TB etc. The percentage of effected of man, woman and children given the fig 3.6. The effected percentage of men was 4.46%, because men were out of house entire day time. The effected percentage of children's from diseases was 39%, because they spend half time out of house and remaining half spend at home. The effected percentage of women was 57% because they spend their time at home.

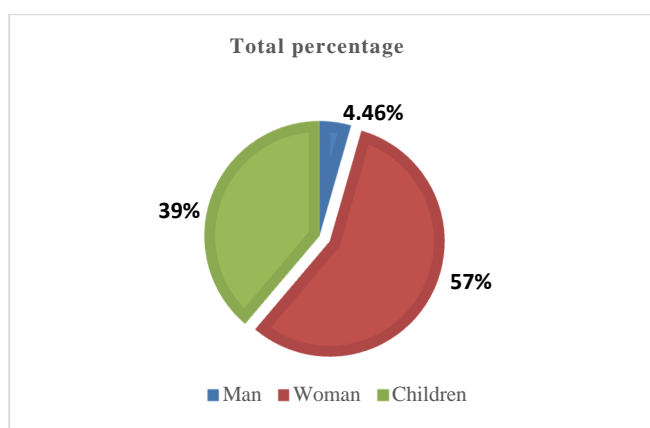


Fig. 6. Effected from diseases

## 4. Biomass Energy Resources

### 4.1 Agricultural Biomass

The kalkani village is mainly rich of the agricultural production wheat, cotton, vegetable and potential crops of this village. Among the different types of crops wheat cantinas, the majority of total agriculture production. Production of wheat has 41%, cotton has 25%, vegetables has 21%, dry chilly has 5%, sunflower has 2% and other have 6% of the total production per year. The collection of residue potential available for the biogas production agriculture sources. As the data collected through the survey contained the amount of final product of each crop the household's production throughout the 238522 kg/year. So the residue calculation is based on the residue to product ratio. Different amount of residue is obtained from different crops e.g. the ratio of residue to product in the case of wheat is 1.6 and for the rice is 1.8 [3]. From these RPR values, the amount of residue generated from the final production of the crops is calculated. Residue to product ratios of wheat, sunflower and cotton are 1.8, 0.5 and 6 respectively. These residues potential collected data on the agricultural production 685213per year, total residue generation for each product investigate for counting with the residue generation rate.

Table 2. Agriculture Production

Agriculture potential Crops	Amount (Kg/yr.)	Residue to product ratio	Total residue (kg/yr.)
cotton	59280	6	355680
wheat	97700	1.8	175860
sunflower	3900	0.5	1950
vegetables	50520	2	101040
Dry chilly	11922	1.5	27883
others	15200	1.5	22800
Total	238522		685213

### 4.2 Animal Resources

The available animal percentage of village kalkani are given in the Table 3. The table showed that sheep are 54.6%, greater than other animals. On the second position goats are 19% and 0.38% are buffalos. The percent of cow was 12.09%, hens were 13.31% and other animals were 0.56%. All of the cows of this village are local cow. A local cow generally produces 10 kg dung each day. Therefore, total cow dung potential available in the village is 938050kg/year. The number of buffalo dung potential in a village is 43800kg/year .it is investigated for available potential calculation in a village horse 43800kg/year. Total

goat/sheep compost in the village is calculated 2857950kg/year and poultry18593.1kg/year. The production of dung is calculated in the village is 3901850 kg/year.

**Table 3. Available Animals**

Type of animal	Livestock in village	Dung production(kg/day)	Total potential of dung (kg/year)
Cow	257	10	938050
Buffalo	8	15	43800
Goat/sheep	1566	5	2857950
Hen	283	0.18	18593.1
Horses	12	10	43800
Total	22126		3901850

## 5. Biogas Demand and Production Potential

### 5.1. Biogas demand

The overall demand of energy in Kalkani village. As shown in the below table dung is used as the major fuel generation source in the village. Most of the villagers use it to generate fire for cooking and other purposes. After dung wood is used for generating the fire. Other sources which are used to generate fire for cooking and other purposes are agricultural waste, LPG and Coal. All the values are expressed in MJ/day. In a year dung energy demand is 1905300MJ/year, while the values of wood, agricultural waste, LPG and coal. Useful cooking energy demand in the case of surveyed village comes out to be 4534833 MJ/year. Based on this useful cooking energy demand total cooking gas demand in the village is calculated. The estimation is based on the assumption that households cook two meals a day throughout the year, which is also the case for most of the surveyed households. The total cooking energy for the whole village is calculated 4534833 MJ/year including the fuel efficiency and then total useful energy demand of the village is obtained MJ/year considering the value of cooking stove efficiency.

**Table 4. Efficient cooking energy demand of the village.**

S.NO	Biomass resource	Total Energy Demand (MJ/day)*	Cooking Stove Efficiency (%)	Efficient Cooking Demand (MJ/year)	Energy
1	Dung	1905300	12%	228636	
2	Fuel wood	1127120	15%	169068	
3	Agricultural waste	1222020	12%	146642	
4	LPG	244258	45%	109916	
5	Coal	36135	18%	6540	
6	Total	4534833		660766	

### 5.2 Biogas Production Potential

The sum of biogas potential from the available biomass deposit in the village has taken from the animal's dung main resources. The biogas generation from the cow dung is calculated in the equation number one suggested by (Biswas & Lucas, 1996) and given as follows.

$$(m^3) = kg \times s \times (m^3/kg)$$

Biogas ( $m^3$ ) = raw material (kg)  $\times$  total solid content  $\times$  gas generation rate per unit of solid ( $m^3/kg$ ) eq. 1 [4]. The total solid content for the cow dung is taken as 17% and gas generation rate is 0.34  $m^3/kg$ . The Table 5, shows the amount of available dung in the village is 3901850  $m^3$  kg/yr., so by using the above relation with total solid content 65.25% and gas generation rate 0.89  $m^3/kg$ , the amount of biogas that could be produced is 35889.61  $m^3/yr$ . The total biogas production is 825461.03 MJ/year, total useful cooking energy demand of the village is 660766 MJ/year. That the biogas production by all the cattle dung is large number of animals' resource source in the village.

**Table 5. Biogas generation from available from cattle and goat/sheep**

Type of animals	Total livestock's in a village	Dung kg/day	Dung kg/year	Total solid content	Gas production rate( $m^3/kg$ )	Biogas production rate( $m^3/kg/year$ )
Cow	277	10	2770	17	0.34	160.106
Goat/sheep	1566	5	7830	18.25	0.25	35724.37
Hens	283	0.18	50.94	30	0.3	4.584
Total		3901850				35889.061

## 6. Conclusion

The research investigation based on the household survey of Kalkani village, District Kohlu, Balochistan province, Pakistan. The purpose of survey was finding out the total energy demand (cooking and heating), Cooking energy consumption of households is observed to increase with an increase in income of households. The village has various biomass potential in the form of animal dung, fuel wood and agricultural waste which can be used for cooking or serve as the basis for other energy carriers. Among the different fuels, dung meets about 44% of the total cooking and heating energy demand. The contribution of other biomass fuels for domestic use is 30% agricultural waste and 23% firewood. The other fuels like, LPG and coal has 1.7% and 0.6% shares in cooking and heating energy needs of the village. In this study it has been estimated that biomass and no biomass energy consumptions for cooking and heating is 6.82 GJ per person/year for Kalkani village. The total cooking energy for the whole village is calculated 4534833 MJ/year including the fuel efficiency and then total useful energy demand of the village is obtained 660766 MJ/year considering the values of cooking stove efficiencies of all fuels. The production of dung is calculated in the village is 3901850 kg/year. So by using the above relation with total solid content 65.25% and gas generation rate 0.89 m<sup>3</sup>/kg, the amount of biogas that could be produced is 35889.61 m<sup>3</sup>/yr. The total biogas production is 825461.03 MJ/year total useful cooking energy demand of the village is 660766 MJ/year. The remaining biogas 164695.03 MJ/year is storage.

The majority of households need new advance facilities for cooking. The burning of cow dung and fire wood produce high rate of smoke, which highly effects human health and their eyes as well. The villagers need smoke free resources for the cooking purposes.

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