

Research Article



Choice of Alternative Energy Sources of Farm Households for Cooking in Rural Areas of Peshawar

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Abstract | Energy sources for cooking play an important role in rural areas of Pakistan. Unfortunately, most of the farm households in Pakistan still use traditional energy sources for cooking. The present study is based on choice of alternative energy sources for cooking in rural areas of district Peshawar. The main objective of the study was to examine what factors determine the choice of alternative energy sources of farm households for cooking in the study area. Primary data were collected from 512 farm households using simple random sampling. The sample size constituted 5 percent of total farm households in selected villages of district Peshawar. A multinomial logistic regression model was used for choice of alternative energy sources for cooking purpose. Results of the study showed that income of farm households, education level of household head and cooking cost had significant effect on the use of electricity, firewood and natural gas as against animal dung cakes for cooking purpose which was the base category. The study concluded that the use natural gas for cooking was less expensive as compared to other alternative energy sources such as firewood, electricity and animal dung cakes. The study also concluded that family size has negative relationship with the use electricity and firewood while income of farm households and education level of household head has positive relationship with the use of electricity, natural gas and firewood for cooking purpose in the study area. The study recommended that the government should provide natural gas in rural areas of Peshawar. Sample farm households facing problem regarding severe shortage of natural gas in the study area. So the concerned departments should take remedial measure to address the concerns needs of the rural people.

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Introduction

Energy sources play an important role in domestic consumption as well as national productivity of a country. Energy is also an important component to expand and sustain economic activities in the fields of agriculture, electricity generation and industry, services and transportation. Energy lies in the heart of economic security in a country as energy is the

requirement to generate any economic activity in the country on sustained basis. In this way energy is a key determinant of growth and development of a country like Pakistan. It is observed that over two billion people of the world largely use and are dependent on traditional biomass fuels as a source of energy for cooking. Farm households in developing countries use such traditional energy sources for cooking (Kowsari and Zerriffi, 2011).

Despite global efforts to promote world wide access to the modern sources of energy, 1.30 billion people of the world lack access to use electricity and 2.60 billion people globally don't have access to clean cooking facility (International Energy Agency, 2010). Energy services in developing countries of the world are one of the most crucial challenges of the time. Energy services have direct impact on livelihood, environmental sustainability and health at domestic and global levels. In the developing world more than 90 percent farm households in rural areas use energy sources for cooking. It is evident that biomass smoke damage increases the risk of childhood respiratory infections (Bruce et al., 2002).

The traditional use of animal waste has a significant negative effect on the environment and economic development in case of deforestation and domestic and global climate change. The use of traditional use of biomass system leads to increase pollutant emissions, resulting high greenhouse gases (GHG), which affect health per unit of useful energy (Smith and Haigler, 2008). The use of energy sources for consumption has not been uniform across the members of the community, because the choice of other energy types of firewood are driven by a host of factors. The ever growing pace of modernization has stimulated different research studies which highlights that the energy fuel has shifted from traditional to modern energy sources such as, electricity, paraffin and gas (Kituyi et al., 2001; Vermuelen et al., 2000; Alarm et al., 1998).

There is consistent increase in the prices of oil and there is also increased awareness regarding large scale deforestation in many parts of the world. This situation also modifies utilization and choice of energy types. It is highlighted that substitution and preferences regarding fuel types are regulated more by cleanliness and convenience. The farm households obtain modern energy sources such as cooling fans, gas stoves, electric cooking, fridge, radio and television (Leach, 1987).

Many rural areas of Pakistan have no power facilities and the main reason is increased cost related to connecting national grid power supply to remote country side covering a large distance. The impact of energy poverty has thus been highlighted as having harmful effects on agriculture productivity, education, human welfare, water, health care services and job

market. Thus energy sources play an important role in the development of a country, without energy sources we cannot promote health care facilities, education and agriculture productivity. The study suggested that an increase in the electrification facilities especially in rural areas of Pakistan, should improve the education level of farm households and agriculture productivity of farmers (Zaigham and Nayyer, 2005).

The persistent economic growth and development rely on energy. Energy is very important concept in today's life. Energy has become an integral part of life. It is required for quality human life and as well as for the sustainable economy. Pakistan faces huge shortage in energy sector. Pakistan has been the importer country of energy for decades. Most of the rural people have little access to the modern energy sources. In Pakistan the demand for electricity has increased with each passing year. The study concludes that the supply of electricity is not satisfactory. The demand for electricity has increased at exponential rate and supply rate of electricity has not fulfilled the demand for electricity (Memon et al., 2014). The consumption of electricity in Pakistan is 12000 mw to 13000 mw and natural gas consumption is 42.9 billion cubic meters, (The Asian, 2013).

The research gap of this study is that no particular work has been done on choice of alternative energy sources of farm households for cooking in rural areas of district Peshawar.

The major objective of this study is to investigate what factors determine choice of alternative energy sources of sample farm households for cooking in the study area?

Materials and Methods

Sampling design of the study

All the rural villages in district Peshawar of Khyber Pakhtunkhwa was the universe of the study. A sample survey of the study was conducted in selected rural areas of district Peshawar. The data related to the study variables was collected from the farm households in rural villages of district Peshawar. Primary data was collected from farm households in rural villages through interview schedule. The survey was carried out using multi-stage cluster sampling technique. In the first stage of sampling technique, primary sampling units of rural union councils were

purposely selected in the study area. In the second stage of sampling, the rural villages were chosen from each selected rural union councils. In third stage, the farm households were selected for information regarding the choice of alternative energy sources, which were used for cooking purpose in the study area. In this study sample respondents of the study were farm households in the selected rural villages. There are total 56 rural union councils in district Peshawar. We have selected purposely three rural union councils and further among these rural union councils, three rural villages were selected, while among these rural villages, 5 percent farm households were chosen randomly (Ali et al., 2014).

The Table 1 shows sample and total farm households in the study area. These were 10,242 total farm households in the study area and 512 farm households were taken as sample for this study. This sample constituted 5 percent of the population. Some other studies (Ali et al., 2014) also 5 percent sample of the population.

Table 1: Total and sample farm households in the study area.

| Name of selected villages | Total farm households | Sample farm households |
|---------------------------|-----------------------|------------------------|
| Babu Zai | 4210 | 210 |
| Dub Bunyady | 3120 | 156 |
| Bela Baramad Khel | 2912 | 146 |
| Total | 10242 | 512 |

Source: Survey (2018).

Econometric Model for empirical testing

Multinomial logistic regression model explains the relation between the polytomous and unordered dependent variable with different explanatory variables. Multinomial logistic regression was used to find out the probabilities of the different possible results of a categorically distributed regressand explained by the independent variables (Greene, 2012). The marginal effect was obtained by running Stata version 12.

The multinomial logistic regression model can be written as;

$$P_{ij} = \frac{\exp(\beta_j X_i)}{1 + \sum \exp(\beta_j)} \dots (1)$$

In the above model, P_{ij} shows the probability associated with the farm household choice for different energy

sources, if $P_{ij} = 1$ the i^{th} individual farm household select the j^{th} energy sources and otherwise if $P_{ij} = 0$. In this study multinomial logistic model was used for cooking purpose.

The following model was used for cooking purpose.

$$Y = \ln\left(\frac{\Pi_i}{\Pi_j}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \gamma_1 D_1 + u_i \dots (2)$$

Y_i = choice of i^{th} energy sources for cooking purpose such as;

- Electricity
- Firewood
- Natural Gas
- Animal dung cakes (base category)

Π_i shows choice of i^{th} energy sources for cooking from the given available sources; Π_j = j^{th} energy source for cooking, i.e. animal dung cakes as a reference category; β_0 = Intercept of the model; β_i = represents coefficients of the explanatory variables; X_1 = Age of the farm households (years); X_2 = Income of the farm households in rupees (Rs/month); X_3 = Cooking cost of selected energy source used in rupees (Rs / month); X_4 = Education level of the farm households (years); X_5 = Family size of farm households (No. of persons); X_6 = Distance between the home and the nearest market (kilometers); D_1 = Dummy Variable for gender of the head of farm Household ($D_1 = 1$ if male and 0 otherwise); u_i = Random error.

Results and Discussion

This section is related to multinomial logistic regression model which was estimated for choice of alternative energy sources of farm households in the study area. Multinomial logistic regression model was used to find out the effect of choice energy sources (electricity, natural gas, firewood and animal dung cakes) for cooking on income level of farm households, education level, gender, age, family size, cost on cooking and distance from the nearest market. Exponential β reported the odds ratio in the analysis. The multinomial logistic regression was performed by using SPSS.

Estimated coefficients of multinomial logistic regression model for cooking source

Table 2 shows detailed analysis of the estimated coefficients of the multinomial logistic regression model for cooking. It indicates that electricity, firewood and natural gas were used as source for

cooking purpose as compared to animal dung cake. Animal dung cake was used as a reference category in the analysis because animal dung cakes energy source is a traditional source and their use is very rare in the study area. Further marginal effect shows that the quantity of change in dependent variable, when a unit change occurs in the explanatory variables. Odds ratio measure the association between explanatory variable and the categorical dependent variable. Odds ratio is the log value of odds and it is always positive. Odds ratio is the exponential function of the regression coefficients. The overall significance of the model at 0.05 levels is indicated by the Chi-Square value, which were 276.408 with P-value 0.000. It means that the overall model is good fit to the data. The pseudo R^2 value shows that the variation in dependent variable (energy sources for cooking) in terms of explanatory variables was predicted by 46 percent.

Age of farm household head

The value of log odds of age means that keeping other variables constant, an increase of one year in the age of sample farm households were more keen and likely to use electricity rather than of dung cakes by 1.008, which means that it increases the log odds by 0.8 percent. So it reveals that when the age of farm households increases, they will prefer to increase the usage of electricity than animal dung cakes. On the other hand, an increase of one year in the age of farm households was less likely to use firewood for cooking purpose instead of dung cakes by 0.923, which decreases the odds by 7.7 percent. In case of natural gas one year increases in the age of farm households, the odds increase by 1.014. It means that the use of natural gas as a source for cooking rather than animal dung cakes by 1.4 percent. So age of farm households was found to have significant effect on firewood and insignificant effect on electricity and natural gas for cooking source.

Education of farm household head

Education level of the farm households was found to have a significant effect on firewood, electricity and natural gas rather than animal dung cakes for cooking source. Keeping other variables remain constant, so one year increase in education level of farm households was more likely to use electricity instead of animal dung cakes by 1.305, which increases the odds by 30.5 percent. [Zaigham and Nayyar \(2005\)](#) also found the similar results. It showed that education level and income has positive relationship with the use of

electricity rather than animal dung cakes for cooking purpose. The study also concludes that when education level and income farm households have risen up then the use of electricity as compare to animal dung cakes has also risen for cooking purpose. In case of firewood an increase of one year in the education of farm households were more likely to use firewood rather than animal dung cakes by 1.386, which increases the use of firewood instead of dung cakes by 38.6 percent, other variables remain constant, an increase in one year of education level of farm households were more likely to use natural gas instead of animal dung cakes by 1.491, which increases the odds by 49.1 percent. So the result shows that education level has positive and significant effect on the use of alternative energy sources for cooking. Earlier in 2012, [Nnaji et al., 2012](#) also found the same results that there was positive relationship between education level and the use of firewood for cooking purpose. It means that one year increase in education level of farm households then the use of firewood has increased rather than animal dung cakes. The study summed up that when education level improves then the households use more firewood as compare to animal dung cakes for cooking purpose.

Family size of farm household

The findings of family size of farm households show that an increase of one person in the family the study area, the use of electricity was less likely instead of animal dung cake by 0.790, which decrease the odds by 21 percent. In case of firewood, an increase of one person in family size, they were less likely to use firewood rather than animal dung cakes by 0.787, which means that there a decrease in the odds ratio by 21.3 percent. [Alam et al. \(1998\)](#) also found that there is a positive relationship between family size and use of bio mass. The study further explains that one member of a family increases then use of firewood and animal dung cakes also increases. In case of natural gas the family size also less likely to use natural gas than animal dung cakes, it means that one member added in the family size the use of natural gas has increased by 0.3 percent.

Distance from market of farm households

[Table 2](#) shows that other variables remain unchanged, in case of distance (per kilometers) from the nearest market, an increase by one kilometer the household heads were more likely to use electricity instead of animal dung cakes by 23.4 percent for cooking

purpose. Similarly, in case of firewood, one kilometer of distance from the nearest market has increases then the farm households were more likely to use firewood rather than animal dung cakes by 12.5 percent. In case of natural gas the distance from the nearest market has increased by one kilometer, and then the farm households has less likely to use natural gas for cooking purpose instead of animal dung cakes by 0.924. It means that when one kilometer distance from the nearest market has in increases then the farm households have decreases the use of natural gas by 7.6 percent. It concludes that when the distance from nearest market per kilometer has increases then the use electricity and firewood has also increases, but the use of natural gas has decreases for cooking purpose in the study area.

Table 2: *Estimated coefficients of multinomial logistic regression model for cooking.*

| Explanatory variables for cooking source | | β | Stand-ard error | Wald | Df | Sig. | Exp (β) |
|--|--------------|---------|-----------------|--------|----|------|-----------------|
| Electricity | Intercept | -2.886 | 1.874 | 2.373 | 1 | .123 | |
| | Age | .008 | .029 | .066 | 1 | .797 | 1.008 |
| | Education | .266 | .085 | 9.822 | 1 | .002 | 1.305 |
| | Family Size | -.235 | .126 | 3.516 | 1 | .061 | .790 |
| | Income | .025 | .014 | 3.106 | 1 | .078 | 1.025 |
| | Distance | .210 | .170 | 1.538 | 1 | .215 | 1.234 |
| Gender | Cooking cost | .001 | .001 | 2.143 | 1 | .143 | 1.001 |
| | [Male = 1] | -.020 | .626 | .001 | 1 | .975 | .980 |
| | [Female = 0] | 0 | . | . | 0 | . | . |
| Firewood | Intercept | 2.502 | 1.164 | 4.618 | 1 | .032 | |
| | Age | -.080 | .019 | 18.472 | 1 | .000 | .923 |
| | Education | .327 | .071 | 21.066 | 1 | .000 | 1.386 |
| | Family Size | -.239 | .073 | 10.711 | 1 | .001 | .787 |
| | Income | .027 | .010 | 6.588 | 1 | .010 | 1.027 |
| | Distance | .117 | .116 | 1.033 | 1 | .309 | 1.125 |
| Gender | Cooking cost | .003 | .001 | 30.793 | 1 | .000 | 1.003 |
| | [Male = 1] | -.564 | .411 | 1.882 | 1 | .170 | .569 |
| | [Female = 0] | 0 | . | . | 0 | . | . |
| Natural gas | Intercept | -2.114 | 1.200 | 3.104 | 1 | .078 | |
| | Age | .014 | .018 | .598 | 1 | .439 | 1.014 |
| | Education | .399 | .070 | 32.390 | 1 | .000 | 1.491 |
| | Family size | .080 | .055 | 2.072 | 1 | .150 | 1.003 |
| | Income | .030 | .010 | 8.789 | 1 | .003 | 1.031 |
| | Distance | -.079 | .111 | .514 | 1 | .473 | .924 |
| Gender | Cooking cost | .001 | .001 | .991 | 1 | .320 | 1.001 |
| | [Male = 1] | .056 | .389 | .021 | 1 | .885 | 1.058 |
| | [Female = 0] | 0 | . | . | 0 | . | . |

Source: Survey (2018). *LR Ch² (21): 276.408; P-value: 0.000;*
Note: Significance level at 0.05 levels and 0.1 level respectively;
Pseudo R²: 0.463; Dung Cakes was a Reference category.

Income of farm households

The results of income of farm households show that an increase of one thousand in the income of farm households, they were more likely to use electricity rather than animal dung cakes by 2.5 percent. Similarly, in case of firewood when one thousand income increases then the farm households were more likely to use firewood for cooking purpose instead of animal dung cakes by 2.7 percent, while in case of natural gas an increase of one thousand in the income of farm households, then they were more likely to increase the use of natural gas for cooking purpose rather than animal dung cakes by 3 percent in the study area. It concludes that when income of farm households increases; they were increasing the use of natural gas, firewood and electricity instead of dung cakes in the study area.

Cost on cooking of farm households

Table 2 also indicates the results of cost on cooking. In case of cooking cost, one rupee increases in the cost of cooking then the farm households were more likely to use electricity for cooking purpose instead of animal dung cakes by 0.1 percent, while in case of firewood, one rupee increases in cost of cooking, the farm households were more likely to use firewood rather than animal dung cakes by 0.3 percent. Similarly, in case of natural gas, one rupee increases in cost of cooking the farm household s were more likely to use natural gas instead of animal dung cakes by 0.1 percent.

Gender of farm household head

Gender was a dummy variable in this research study and the reference category for gender was female, holding other variables constant, the odds of male were less likely to use electricity rather than dung cakes with value 0.980, which was less than the female and the odds decreases by 2 percent. Conversely, in case of firewood the farm household if male preferred less to use firewood than animal dung cakes by 43.1percent than a female. In case of natural gas, the odds of male of farm households were more preferred to use natural gas instead of animal dung cakes by 1.058, which was more than of female by 5.8 percent. So the results of the Table 2 conclude that in case of electricity use education level of farm households is significant at 0.05 level, while income and distance from the nearest market of farm households were found to have significant at 0.1 level. In case of firewood, age of farm households, education, family

size, income and cost on cooking source were found to have significant at 0.05 levels. In case of natural gas education level and income of household heads (per month in rupees) were found significant at 0.05 level, while age of household heads, family size, distance, cooking cost (per month in rupees) were found insignificant at 0.05 level for cooking purpose in the study area.

Marginal effects of multinomial logistic regression model parameters for cooking

Table 3 shows the marginal effects of independent variables. Marginal effects indicate the effects of

individual variable on the dependent variable while keeping other explanatory variables constant. The multinomial logistic regression model was estimated for their marginal effects. The marginal effect of gender (male) was found insignificant and negative for the use of electricity, natural gas and animal dung cakes energy sources while significant and negative for the use of firewood at 0.1 levels. It means that when the number of males increases then the use of electricity, animal dung cakes, firewood and natural gas decreased in the study area. The marginal effect of age of sample farm households was found insignificant and positive effect for the use of firewood and negative effect on

Table 3: *Marginal effects of independent variables.*

| | Variables | dy/dx | Standard error | Z | P>z | X |
|--------------------|--------------|---------|----------------|-------|-------|---------|
| Electricity | Gender | -.00759 | .02497 | -0.30 | 0.761 | 1.2505 |
| | Age | .00139 | .0011 | 1.27 | 0.205 | 52.0685 |
| | Education | -.00354 | .00218 | -1.63 | 0.104 | 4.5675 |
| | Family size | -.00636 | .0046 | -1.38 | 0.167 | 8.8063 |
| | Distance | .00923 | .00666 | 1.39 | 0.166 | 3.9178 |
| | Income | -.00010 | .00047 | -0.22 | 0.828 | 48.1966 |
| | Cooking cost | -.00001 | .00003 | -0.42 | 0.674 | 878.258 |
| | Gender | .14255 | .0715 | 1.99 | 0.046 | 1.20505 |
| Firewood | Age | -.02172 | .00299 | -7.27 | 0.000 | 52.0685 |
| | Education | -.00566 | .0054 | -1.05 | 0.295 | 4.56751 |
| | Family size | -.05243 | .00966 | -5.43 | 0.000 | 8.80626 |
| | Distance | .03923 | .01869 | 2.10 | 0.036 | 3.91781 |
| | Income | -.00008 | .00092 | -0.09 | 0.928 | 48.1966 |
| | Cooking cost | .00062 | .00008 | 7.58 | 0.000 | 878.258 |
| | Gender | -.12395 | .07314 | -1.69 | 0.090 | 1.20505 |
| | | | | | | |
| Natural gas | Age | .01898 | .00309 | 6.14 | 0.000 | 52.0685 |
| | Education | .02983 | .00577 | 5.17 | 0.000 | 4.56751 |
| | Family size | .05280 | .01013 | 5.21 | 0.000 | 8.80626 |
| | Distance | -.04771 | .01914 | -2.49 | 0.013 | 3.91781 |
| | Income | .00180 | .00097 | 1.86 | 0.063 | 48.1966 |
| | Cooking cost | -.00051 | .00009 | -5.99 | 0.000 | 878.258 |
| | Gender | -.01102 | .02039 | -0.54 | 0.589 | 1.20505 |
| | | | | | | |
| Dung cakes | Age | .00134 | .001 | 1.35 | 0.177 | 52.0685 |
| | Education | -.02063 | .00336 | -6.14 | 0.000 | 4.56751 |
| | Family size | .00135 | .00407 | 1.47 | 0.142 | 8.80626 |
| | Distance | -.00075 | .00589 | -0.13 | 0.899 | 3.91781 |
| | Income | -.00162 | .00066 | -2.44 | 0.015 | 48.1966 |
| | Cooking cost | -.00009 | .00003 | -2.70 | 0.007 | 878.258 |
| | Gender | -.01102 | .02039 | -0.54 | 0.589 | 1.25049 |
| | | | | | | |

Source: Survey (2018). **Note:** dy/dx show the marginal effect in dependent variable (y) by independent variable (x).

the use of animal dung cakes, while highly significant and positive effect on the use of electricity and natural gas. It means that one year increase in the age of farm households keeping other variables constant, the use of electricity, natural gas and animal dung cakes has been increased by 0.14 percent, 1.9 percent and 0.13 percent respectively.

The result of education level of household head was found highly significant at 0.05 level to the use of natural gas and animal dung cake while insignificant to the use the electricity and firewood for cooking. The relationship of education is negative with the use of electricity, firewood and animal dung cakes and positive relationship with the use of natural gas. The marginal effect of family size was found a significant at 0.05 level and positive relationship with use of natural gas and animal dung cakes in the study area, while highly insignificant at 0.05 level and a negative relationship with the use of electricity but highly significant at 0.05 level and negative relationship with the use of firewood for cooking purpose. It indicates that if one person of a family increases then the use of natural gas and animal dung cakes has increases by 5.28 percent and 0.135 percent respectively, while the use of electricity and firewood has decreases by 0.636 percent and 5.23 percent respectively. [Alam et al. \(1998\)](#) found similar results. Family size was noted significant and negative relationship with the use of firewood and insignificant but a positive relationship with the use of animal dung cakes at 0.05 levels.

The marginal effect of income indicates that the relationship of income and use of electricity, animal dung cake and firewood were negative but positive with use of natural gas in the study area. The results of [Sher et al. \(2014\)](#) revealed opposite to the current study. The result of cooking cost was found to has significant effect on the use of firewood, natural gas and dung cakes while for electricity it was found insignificant. The relationship of cooking cost with the use of electricity, natural gas and dung cakes were negative and were positive with the use of firewood for cooking purpose.

Conclusions and Recommendations

This study concluded that the choice of alternative energy sources for cooking had been practiced in the rural areas of district Peshawar. It is concluded that

mostly farm households were males and illiterate. The study noted that most of the farm households had used natural gas for cooking purpose where the natural gas was available, because natural gas is less expensive as compared to other energy sources. It is concluded that education level of farm households had a significant and positive effect on the use of electricity rather animal than dung cake while age of farm households, income, family size, monthly cost on cooking and distance from the nearest market has insignificant effect on the use of electricity instead of animal dung cakes. In case of firewood education level, age of farm households, family size, income and cost on cooking had significant and distance from the nearest market had insignificant effect on the use of firewood rather than of animal dung cakes. In case of natural gas education level and income of farm household has significant and positive, but age of farm households, education level, family size, cost on cooking and distance from the nearest market had insignificant effect on the use of natural gas instead of animal dung cakes in the study area.

- The government should make out all efforts to ensure availability of natural gas for the use of cooking purpose in the study area.
- Sample farm households facing problem regarding severe shortage of natural gas in the study area. So the concerned departments should take remedial measure to address the concerns needs of the rural people.

Novelty Statement

Novelty of this study is to find-out margins effects of energy sources in rural area of District Peshawar. Before this research, no study was conducted on cooking sources of energy.

Author's Contribution

Mahfooz Khan: Principle author who conducted the research analysed the data and wrote the first draft.

Himayatullah Khan: Major supervisor who provided technical support throughout the studies and approved the manuscript.

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