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Factors Leading to Adoption of Biogas Technology: A case Study of District Faisalabad, Punjab, Pakistan

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ABSTRACT:
Biogas is an alternate energy source; the main objective of this study is to analyze the prospects of biogas adoption in rural Pakistan by considering the constraints and opportunities. This study is restricted to district Faisalabad Punjab, Pakistan. Total data consisted of 100 respondents out of them 47 were biogas adopter and the remaining were non adopter of biogas. The list of adopters of biogas was taken from a regional institute and data were collected from the Faisalabad district by using the random sampling technique. The binary logit model is applied to get the appropriate results. It was found that there were positive association between the adoption and the number of livestock, age and land. This research study helps us to make policy options and to understand the factors behind the adoption of biogas technology.

JEL: - O13, O14

Key words: Biogas Adoption, Faisalabad, Binary Logit Model

1. INTRODUCTION

Biogas originates from biogenic material; it is a type of bio-fuel which primarily consists of methane and carbon dioxide. Biogas can be used as a low-cost fuel for heating, cooking and power generation. Biogas can also be compressed like natural gas, and we can also use it to run motor vehicles. Being a renewable source of energy, biogas qualifies for renewable energy subsidies in some parts of the world. Biogas offers a highly cost-effective and decentralized energy-production option at community and household levels (Khurshid, 2009). Biogas is a renewable and a hygienic form of energy that is a supplement to traditional and commercial

energy sources because of its environmental friendliness permitting for well-organized waste utilization and nutrient recycling (Bhat et al., 2001). Normally, biogas digesters have an approach to indicate access to new forms of alternate energy services in rural areas and significantly improve health, environment and pertains socioeconomic benefits to the society (Srinivasan, 2008).

Biogas technology lead to a reduction in greenhouse gas emissions (Han et al., 2008), In fact, a proper functioning of biogas system in particular can provide multiple benefits to the users and the community resulting in resource conservation and environmental protection (Yadvika, 2004). The livestock sector plays a key role in the agricultural economy of Pakistan. Whereas agriculture contributes 24.5 percent to the country's GDP, employs 50 percent of the labor force, and about 60 percent of export earnings, the livestock sub-sector's share of agriculture is around 49 percent, participating up to 11.4 percent in overall GDP. Income from livestock and livestock products is the main source of cash income (43 percent) at the national level followed by remittance (34 percent) and crops (20 percent) ([1]SEBCON 2006).

The Livestock Census which has been carried out every ten years since 1956 shows that the livestock population has been steadily growing in the country, with large growth in numbers of buffaloes, sheep and goats and phenomenal growth in poultry. The variables which can influence the adoption decision are; number of live stock, the age of the household head, education, income, household size, land owned and other fuels' cost (Somda et al., 2002).

Faisalabad district the third big district of the Pakistan is chosen for this study. Secondly, this district is also characterized with large number of small farmers and such type of farming community is assumed to be more involved in dairy farming. All these factors are favorable in adoption of biogas. Moreover, a program is initiated by the Punjab Rural Support Program (PRSP) to provide information, financial assistance and technical knowledge regarding installing biogas plants.

1.1 OBJECTIVES

- To identify the socio-economic characteristics for the adoption of biogas technology.
- Policy formulation.

2. REVIEW OF LITERATURE

The purpose of the literature review is to become familiar with the related research efforts that were commenced in the past period at national and international level regarding socio-economic determinants and factors at the back of the adoption of biogas.

Srinivasan (2008) calculated cost benefit analysis through process mapping technique to bring out the differences between the pre- and post-biogas scenarios. He also summarizes the private (health, education and productivity), local and global benefits and beneficiaries from the large scale installation of biogas digesters.

[1] Socio-Economic & Business Consultants Pvt ltd.

Wim, (2006) described the outcomes of a case study on the monetary and social benefits of domestic biogas plants in Shipai (Jianshi County). More than 90 percent of households have installed a biogas unit which produces 1.0–1.2 m^3 on a daily basis amount. Biogas gas has been used for both lighting (1.0–1.5 hours per day) and cooking. Mary Renwick (2007) discussed on financial and economic cost-benefit analysis. According to Renwick the success of biogas program and decision making is purely based on financial and economic analysis.
According to Smith et. al (2009) the health effects of three short-lived greenhouse pollutants, namely, black carbon, ozone and sulphates, by conducting meta-analyses. This study provides estimates of effects of mortality from long-term exposure to elemental carbon, which is an indicator of black carbon mass.
Zheng et al. (2010) investigated efficient utilization of abundant biogas energy in rural China to improve the rural environment and the villagers' income. Abort and Vancil (1977) conducted a study on economic feasibility and concluded that there were so many socio economic factors behind the adoption of biogas. Hall et al. (1992) explored that developing countries should adopt and improve the technologies for modern bio-fuels but the controversial problems were with their economic conditions.

3. DATA AND METHODOLOGY

Econometric methods are used to provide empirical evidence to economic problems. In it statistical and mathematical methods are applied so that appropriate policy implications can be extracted on the basis of results to solve the confronted socio-economic problems.

3.1 RESEARCH AREA

Faisalabad is the third big city of the Pakistan, Secondly this district is also characterized with large number of small farmers and such type of farming community is assumed to be more involved in dairy farming. All these factors are favorable in adoption of biogas. Moreover, a program is initiated by the Punjab Rural Support Program (PRSP) to provide information, financial assistance and technical knowledge regarding installing biogas plants.

3.2 DATA

Primary data are used in this research study, list of total adopters or biogas user was collected from the office of [2]Rural Support Program Network (RSPN). The questionnaire was developed to collect all the necessary information via face to face interviews. The sample includes information about both biogas adopter and non adopter to know the reasons behind the biogas adoption and non adoption. The total data of 100 responded were collected through random sampling technique in which 47 were adopters and rest of them was non-adopters.

3.3 DEFINITION AND CHOICE OF VARIABLES

In this study Binary logit Model is applied to find the responsible factors of biogas adoption. Many socio-economic continuous, dichotomous and categorical variables were incorporated in

[2] A Non Government Organization

the analysis as independent variables while dependent variable was categorized into two categories. The detail of dependent and independent variables are given below.

3.4 DEPENDENT VARIABLES

BioGU (Bio gas user) It is taken as 1= if the respondents is biogas user other wise 2

3.5 INDEPENDENT VARIABLES

(Age) Question about Age was asked in the questioner and that was converted further in four dummy variables with different categories showing four different stages of life. Age (28-45) years = 1, Age (46-56) years = 2, Age (57-67) years = 3, Age (68-82) years = 4. SOL (Size of Land) Question about total land holding was asked in the questioner and that was converted further into four dummy variables with different categories. SOL (0-3 acre)=1, SOL (4-9) = 2, SOL (10-15) = 3, SOL (16 and above) = 4. IncomeH (Income of the house hold) Question about total income of the house hold was asked in the questioner and that was converted further into four dummy variables with different categories. IncomeH (1-25000) = 1, IncomeH (25001-50000) =2, IncomeH (50001-80000) = 3, IncomeH (80001 and above) = 4

HHEdu (Household Head Education) Question about the household head's was asked in the questioner and that was converted further into four dummy variables with different categories, (1= No education, 2=primary middle and matric, 3=inter and graduation, 4=higher education).

NL (Number of Livestock), Question about the household head's was asked in the questionnaire and that was converted further into four dummy variables with different categories. NL (0-3) = 1, NL (4-9) = 2, NL (10-20) = 3, NL (21 and above) = 4

(FamilySize) Question about the family size was asked in the questioner and that was converted further into three dummy variables with different categories. FamilySize (less than 5) = 1, FamilySize (6-8) = 2, FamilySize (9-13) = 3

3.6 BINARY LOGISTIC REGRESSION ANALYSIS

Logistic regression is helpful in situations in which one can forecast the presence or absence of attributes. In theory such a model is a univariate binary approach applied to the data. The regressed variable Y_i taking the value of only one or zero.

$$p(y_i) = \frac{e^{(\alpha+\beta_i x_i)}}{1+e^{(\alpha+\beta_i x_i)}} \quad \text{.....(1)}$$

Where: α = the constant of the equation and β = the coefficient of the predictor variables.

An alternative form of the logistic regression equation is:

$$\log it[p(y_i)] = \log[\frac{p(y_i)}{1-p(y_i)}] = \alpha + \beta_i x_i \text{.....(2)}$$

Where: i= 1,2,- - - - - - - - n.

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4. RESULTS AND DISCUSSIONS

Logistic regression is useful for situations in which one can predict the presence or absence of a characteristic or outcome based on values of a set of predictor variables. It is similar to a linear regression model suited to models where the dependent variable has dichotomous in nature.

Results of Binary logit Model

Variables	Coefficient	Standard Error	Wald	Odd Ratios
Constant	1.689	1.386	1.485	5.415
AgeH(1)	-0.148	0.717	0.043	0.862
AgeH(2)	-0.098	0.699	0.020	0.907
AgeH(3)	-0.016	0.732	0.000	0.984
AgeH(4)	Reference category			
SOL(1)	-0.308	0.759	0.165	0.735
SOL(2)	0.263	0.829	0.101	1.301
SOL(3)	0.266	0.717	0.138	1.305
SOL(4)	Reference category			
IncomeH(1)	-0.048	1.032	0.002	0.953
IncomeH(2)	0.322	0.840	0.147	1.379
IncomeH(3)	-0.780	0.734	1.128	0.459
IncomeH(4)	Reference category			
HHEdu(1)	-1.601	1.290	1.540	0.202
HHEdu(2)	-1.529	1.254	1.488	0.217
HHEdu(3)	-1.618	1.253	1.667	0.198
HHEdu(4)	Reference category			
NL(1)	-0.768	1.023	0.564	0.464
NL(2)	-0.238	0.863	0.076	0.788

NL(3)	0.427	0.814	0.275	1.532
NL(4)	Reference category			
FamilySize(1)	0.177	0.704	0.063	1.194
FamilySize(2)	0.357	0.616	0.335	1.428
FamilySize(3)	Reference category			

The table showed the result of the Binary logit Model, Age group 28 to 45 years of household heads found 0.13 times less likely to adopt the biogas in comparison to that people who were in the age interval of 68 to 82 years. Second Age group was found a bit more interested to adopt biogas than the first group. The peoples who were in the age of 46 to 56 years old was found 0.09 times less likely to adopt the biogas as compare to 68 to 82 years old peoples. While the age group from 57 to 67 were found 0.01 times less likely to adopt the biogas in comparison to the 68 to 82 years old peoples.

SOL (Size of Land) found positively related to the adoption of the biogas. It was found that the peoples who had 3 or less than 3 acre land 0.26 times less likely to incline towards the adoption of the biogas in comparison to the peoples who had more than 16 acre land. The peoples who had 4 to 9 acre land were found 0.301 times more likely to adopt the biogas as compared to the peoples who had more than 16 acre land. The peoples who had 10 to 15 acre land were found 0.305 times more likely to adopt the biogas in comparison to the peoples who had 16 or more than 16 acre land. As the results showed there was a positive association between the landholding and adoption of the biogas.

Income of household head was found a significant factor in the adoption of the biogas. It was found that the peoples who had up-to PKR 25000 incomes were noted 0.04 times less likely to adopt the biogas than the peoples who had the income more than PKR 80000. The second income group from PKR 25001 to 50000 noted more likely to adopt the biogas than other groups. It was noted second income group 0.37 times more likely to adopt the biogas as compare to that peoples who had more than PKR 80000 incomes. Astonishingly the third income group from PKR 50001 to 800000 was found 0.54 times less likely to adopt the biogas in comparison to the peoples who had more than PKR 80000 income levels.

House hold head education group one (no formal education) was noted 0.79 times less likely to adopt the biogas in comparison to that peoples who had higher education (16 or more than 16 years of schooling). The people who had a primary or middle level education were found 0.78 times less likely to adopt the biogas than that peoples who had higher education. Group third with matric and inter level of education were noted 0.80 times less likely to adopt biogas in comparison to that peoples who had higher level of education. As education of the household head increases the trend of the adoption of the biogas also increases.

NLS (Number of Live Stock) was found positively associated with the adoption of the biogas. The peoples who had 0 to 3 numbers of live stocks found 0.53 times less likely to adopt the biogas as compare to that peoples who had more than 21 live stocks. The peoples who had 4 to 9 numbers of livestock were noted 0.21 times less likely to adopt the biogas in comparison to

that people who had more than 21 numbers of live stocks. The peoples who had 10 to 20 numbers of live stocks were noted 0.53 times more likely to adopt biogas in comparison to that peoples who had more than 21 number of live stock. It also showed the positive association between the adoption of biogas and number of livestock.

Family size was also noted positively related to the adoption of the biogas the first group which contain less than five members was noted 0.19 times more likely to adopt the biogas, the second group that lie between the family members of six to eight was noted 0.42 times more likely to adopt the biogas as compare to those households which contain nine to thirteen members. It also showed the positive association between the adoption and family size.

5. CONCLUSIONS

The study shows that socio-economic factors significantly influence biogas technology adoption in Faisalabad. Specifically, the probability of a household adopting biogas technology increases with increase in age of head of household, size of land, number of cattle owned and household head education. In this research study, age of household head was noted to have a significant positive relationship with biogas adoption. Household income proved to be a key factor in influencing a household's decision to adopt biogas technology, it was also positively related to the adoption rate. The odd ratio of household head education tells us that as education increase adoption rate also increase. Family size also found positively associated with the adoption of the biogas.

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