Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 16, Issue 3, 2016
PRINT ISSN 2284-7995, E-ISSN 2285-3952

REASONS BEHIND SUCCESS AND FAILURE OF BIOGAS TECHNOLOGY: A CASE OF DISTRICT DERA ISMAIL KHAN (PAKISTAN)

Syed Muhammad AMIR, Liu YONGGONG

College of Humanities & Development Studies, China Agricultural University, Beijing, China, Yuanmingyuan Xilu No. 2, Haidian District, Beijing, 100193, China, Phones: 0086 15718822512, 0086 1062733098, Emails: amirrd876@gmail.com, liuyg@cau.edu.cn

Corresponding author: liuyg@cau.edu.cn

Abstract

This paper's aim is to determine the success and failure status of bio gas technology (BGT) in one purposively selected district in Khyber Pakhtunkhwa (Pakistan). Five villages were selected randomly as a sample out of all villages in the district. Data were collected by using qualitative methods involving secondary sources, community transect walks, informal interviews, group interviews from February to April 2015. Results reveals that overall BGT success rate was not very good (i.e. 69%) in the context of available resources. Proper bio digester (BD) operation was the main reason of success characterized with sufficient as well as regular feeding of substrate to bio digesters and eventually it resulted in better maintenance level. In addition, farmers' rationality and activeness were found significant factors in BGT success regarding their attempts to know about highly recommended bio digester construction and operation procedure. Another reason of success was experienced masons who knew the design of BD construction but unfortunately they were not good enough for the whole project area, some were good while others were careless. The main reasons of BGT failure were use of poor quality of construction materials and inexperienced masons, poor quality of construction materials, improper and irregular feeding to bio digesters, poor monitoring of The Foundation for Integrated Development Action (FIDA) field staff, improper need assessment of beneficiaries by FIDA, improper site selection for building BD and 100 % subsidization rate by FIDA to provide bio digesters.

Key words: *bio digester, biogas technology, Pakistan, qualitative methods, success & failure*

INTRODUCTION

Pakistan is a country facing energy crises. The country depends mostly on the imported oil and gas that is subjected to disruptions and price instability (Harijan et al., 2009) [3]. Nearly 31% of the country's energy requirement is relying on imports (Asif, 2011) [2]. The oil import bill of Pakistan increased in recent years. The aggregate energy supplies in the country amounted to 64.5 million tonnes of oil (TOE) equivalent and registered a growth of 2.3 % over the previous year (HDIP, 2010-2011) [4]. One percent of the energy is supplied through renewable energy sources as compared to conventional energy sources supplying 99% of the energy (Sheikh, 2010) [11]. The gap between energy demand and supply continues to increase (Shah et al., 2010) [10]. Statistics suggest that gap between energy demand and supply in Pakistan has increased six times over the last thirty six years (Asif, 2011) [2].

Pakistan's geo-morphological setup, climatologic cycles, geo-locations and agricultural activities contain a great potential of renewable resources which if brought into practice efficiently can play a key role in achieving energy sustainability and security in the country (Ibrahim, 2009) [5]. The Alternative Energy Development Board has been established for the development, promotion and facilitation of renewable energy technologies and aims that by 2030, 5% of the energy consumption of the country will be met through renewable sources. In fact, renewable energy sources have a great role in bridging the gap between energy demand and supply in the country (Sheikh, 2010 and Amjid et al, 2011) [1, 11].

Biogas, as a type of renewable energy makes proper use of locally available biomasses such as livestock dung and by-products of crops. It produces clean fuel for household cooking

and provides an enriched bio-fertilizer as residual by product for improving fertility of agricultural lands. Promotion of biogas technology is considered as best option which on one hand can reduce wood consumption and on the other hand facilitate recycling of agro-animal residues into bio-fertilizer. Furthermore, it also contributes towards environmental protection. Experts have calculated that anaerobic fermentation of dung, through installation of about 5.0 million family sized bio digesters, could fulfill the cooking needs of 50 million people. It is calculated that biogas can meet about 50% of the cooking requirement of the rural masses, along with the production of 96.6 million kg of bio-fertilizer per day or 35.04 million tons of bio-fertilizer per year (Sheikh, 2010 and Asif, 2011) [2, 11].

Achieving the effective utilization of biogas in rural vicinities depend mainly on successful BGT adoption capability of farmers. There are a number of research studies related to BGT with regard to its different socioeconomic aspects. Talukder (2010) [12] found that the reasons behind better inspiration towards BGT are its lower operation costs, more income saving, environment friendliness, reduced use of chemical fertilizers and increased agricultural production. According to a study conducted by Remais et al. (2009) [9], public health can be made better with diffusion of rural energy sources. They found that after the installation and successful operation of the bio digester, the expenditure on buying coal, wood and crop residues reduced by 68%, 74% and 6% respectively. Clean kitchens and improved sanitation were seen as benefits by the users over the non-users. However, the main motivating factor for adoption of BGT was the subsidy provided by government for biogas digesters. Ilyas (2006) [6] investigated that the main motivating factors of popularity and growing demand of biogas included reduction of the workload for women and girls due to wood collection, dung cake making and cooking and increased crop production because of bio slurry usage as an organic nutrient rich fertilizer. Raven and Gregaseen (2005) [8] found three key factors for the successful adoption of biogas plants, namely the bottom-up strategy and support by the government, a dedicated social network for continuous development of biogas plants without interruptions, and specific local circumstances.

Innovations are important for rural development and there is evidence of many studies on success and failure of different innovations but, especially, such studies are few regarding biogas technology as mentioned in above literature. Such studies have not been found at all in Pakistan especially in Khyber Pakhthunkhwa province. Various government and non government organizations running projects to implement BGT in KPK. However, such projects result in successful installation and operation of BGT while others upon completion result in failure. Therefore, this research was considered important to pinpoint the main reasons of success and failure of biogas initiatives in order to make BGT more effective weapon for reducing energy crises in the country.

The study was based on the following objectives:

(i)To find out the socioeconomic, ecological and resource endowment features of the research area.

(ii)To determine the main reasons of success and failure of biogas initiatives in the area.

MATERIALS AND METHODS

This study was carried out in rural areas of KPK well known to be typical farming area with low energy consumption. The study site is characterized as famous district in Khyber-Pakhtunkhwa Province, Pakistan. It is situated at 31.83° North latitude, 70.9° East longitude and 166 meters elevation above the sea level. Dera Ismail Khan has a hot desert climate with hot summers and mild winters. Spoken languages include Saraiki, Pashto, Urdu and English. It has historically strategic location and has traditionally been a crossroads for many cultures and trading routes. It has an area of more than 7,326 s. km. with an estimated population of more than 1.0 million. The urban ratio of the

population is 14.7% while the rest is rural. The ratio of the population below poverty line is 24.4% (KPK GOVT, 2013) [7].

At the first stage of sampling, district Dera Ismail Khan was selected purposively because it was the only district where the number of bio digesters was highest compared to other districts where the number was too less. In addition, success and failure phenomena of BGT were common in the area. At the second stage of sampling, five villages were selected randomly as a sample out of all villages in the district. The list of biogas users were obtained from the NGO named as FIDA (Foreign Integrated Development Action). Data were collected by using qualitative methods involving secondary sources, community transect walks, informal interviews, group interviews from February to April 2015. An attempt was made to develop a complete picture of the major activities and processes involved in success and failure of bio gas technology. The data collection was ended when no more new relevant information on activities and processes became apparent. Finally, the collected data were summarized and presented for drawing conclusions.

RESULTS AND DISCUSSIONS

The Socioeconomic, Ecological and Resource Endowment Features

A group interview containing five key informants (1 key informant from each village) was conducted for getting social economic data of villages. The resource map was used as a tool that helped us to learn about the community and its resource base. The main purpose was to learn the villagers' perceptions of what natural resources were there in their community. The resource map was found as a good tool to begin with and it was found easy and fun for the participatory group. Overall, in study site, fuel sources included wood, fan gas and other crop residues for bio gas non users while bio gas users mainly were dependent on bio gas as fuel source. Grazing lands were more because there were more fallow lands due to insufficient irrigation water availability. The area was plain but sanitation of rain water was found as a big problem of the area. Farmers used water pumps to evacuate rain water from their fields. There were five villages in union council "Kech" named as Ghulami Wala, Sardari wala, Jabbari wala, Muqeem shah and Kech. The total population was 62,350 persons & 6,135 households in this union council. These figures were verified by a nearby school head teacher (Mr. Rafeeq Sahib) who had been in census department for a long time. Pakhuns and saraikies were found as two main ethnic groups. Most commonly they are in contradictions. Pakhtuns are more offensive in every matter and they dominate the saraikies. Women - men ratio was almost 40%-60%.

Important historic events included the flood (2010) in which there was a huge threat to the whole union council and surrounding areas. Nearly 50% of the homes, crops and food stocks were damaged; and livestock were also died. Consequently, people migrated to other areas. Drinking water was found unhygienic and of bad smell, with limited number of borings (of 300 feet depth) had drinkable water, the rest of the water was not good. So, people got drinking water from those houses. The livestock also do not drink such water and they have to be walked to the rivers. People cannot make tea in such water.

The villagers' profession was mainly agriculture i.e. they are cultivators and they work on daily wages at farms (labour) and some cultivate in their own lands while few people have government jobs. Nearly 15,815 acre of land was under cultivation out of which 35% - 40% was rainfed while the rest was irrigated but rainfed lands were found more fertile than irrigated lands. It also included 15 orchards. The widely grown crops included wheat, rice, sugarcane, gram, barley, maize, oat, millet, buck-wheat, paddy, mustard, field pea, sugar beat, tomatoes, mint and onion.

Livestock include cows (majority), then buffalos, sheep, goat and poultry. Infrastructure was found very poor characterized as streets were found not cemented. Water sanitation from houses and farms especially rain water is a big issue in the area. Irrigation water was found

insufficient to cover the whole irrigated lands. The water channels were not cemented making the water to be absorbed by the soil. Therefore, some of the farmers installed small tube wells which draw underground water and they irrigate their rest of the lands. There were 24 small tube wells for rainfed and 22 for irrigated lands. In addition, the big farmers got advantage by having good relations with the irrigation department, thereby providing enough water to their lands.

There were considerable number of schools, shops and hujraz. In hujras especially social interactions happens in happy and sad occasions. There were many private dispensaries and one Basic Health Unit as well. There were village organizations, community organizations and one LSO (local support organization) all working with some NGOs such as FIDA (Foreign Integrated Development Action). Socio cultural features include local celebrations like Eid and Maila Span (racing contest of cattle).

The Reasons of BGT Success

Success of BGT in this study meant production of bio gas after installation of bio digesters and the successful operation and maintenance of BD. Data from survey results shows that overall BGT success rate was not very good (i.e. 69%) in the context of available resources. Successful BD users who had properly operated their bio digesters were producing enough bio gas. Proper BD operation was characterized with sufficient as well as regular feeding of substrate to bio digesters and eventually it resulted in better maintenance level. One BD was found a mysterious case which was producing gas without being fed for the last 10 years. The researcher observed personally and there was still fluid inside outlet of that BD. In addition, those farmers' rationality and activeness were found significant factors in BGT success. These characteristics led them to demand better quality technical support services from FIDA and communicated with them properly during BD building process. In addition, they got more information from other BD users in rest of the country in order to follow highly recommended bio digester construction and operation procedure. Another reason of success was experienced masons who knew the design of BD construction but unfortunately they were not good enough for the whole project area, some were good while others were careless.

The Reasons of BGT Failure

Failure of BGT in this study meant no productions of bio gas either immediately after installation of bio digesters (i.e. since first day of BD operation) or after using bio digesters for some time period. Among the first form of failure, 24 bio digesters out of 150, did not start working since first day of BD operation and consequently were broken by households. The main reasons of such case were use of poor quality of construction materials and inexperienced masons. Actually, the households were expected to buy construction materials by themselves which raised ambiguity about its quality and masons were trained and provided by FIDA. However, masons were not experienced which explains that FIDA selected improper masons. They did mistakes in measurement of BD design which resulted in improper bio digester construction.

The households completed initial feeding of water-dung mixture in four days rather than in one day time which was recommended for optimum gas production initiation. In addition, some households did not feed bio digesters fully during initial feeding which caused lower production rate and finally closed. In addition, monitoring of FIDA officials for those bio digesters was not proper compared to others. During the group interview, FIDA social organizer "Mr. Sadiq Awan" stated, "during first and second phase of project implementation, the service quality of FIDA organization was not good due to the interference of political and other pressure groups on selection of beneficiaries".

The poor planning of FIDA was also result of such form of failure. At first phase of BD provision, FIDA paid cost of BD construction in advance to households and they were expected to build BD under monitoring and technical support of FIDA. Consequently, the first 20 households got money but they did not start bio digester construction and used that amount for their daily expenditure.

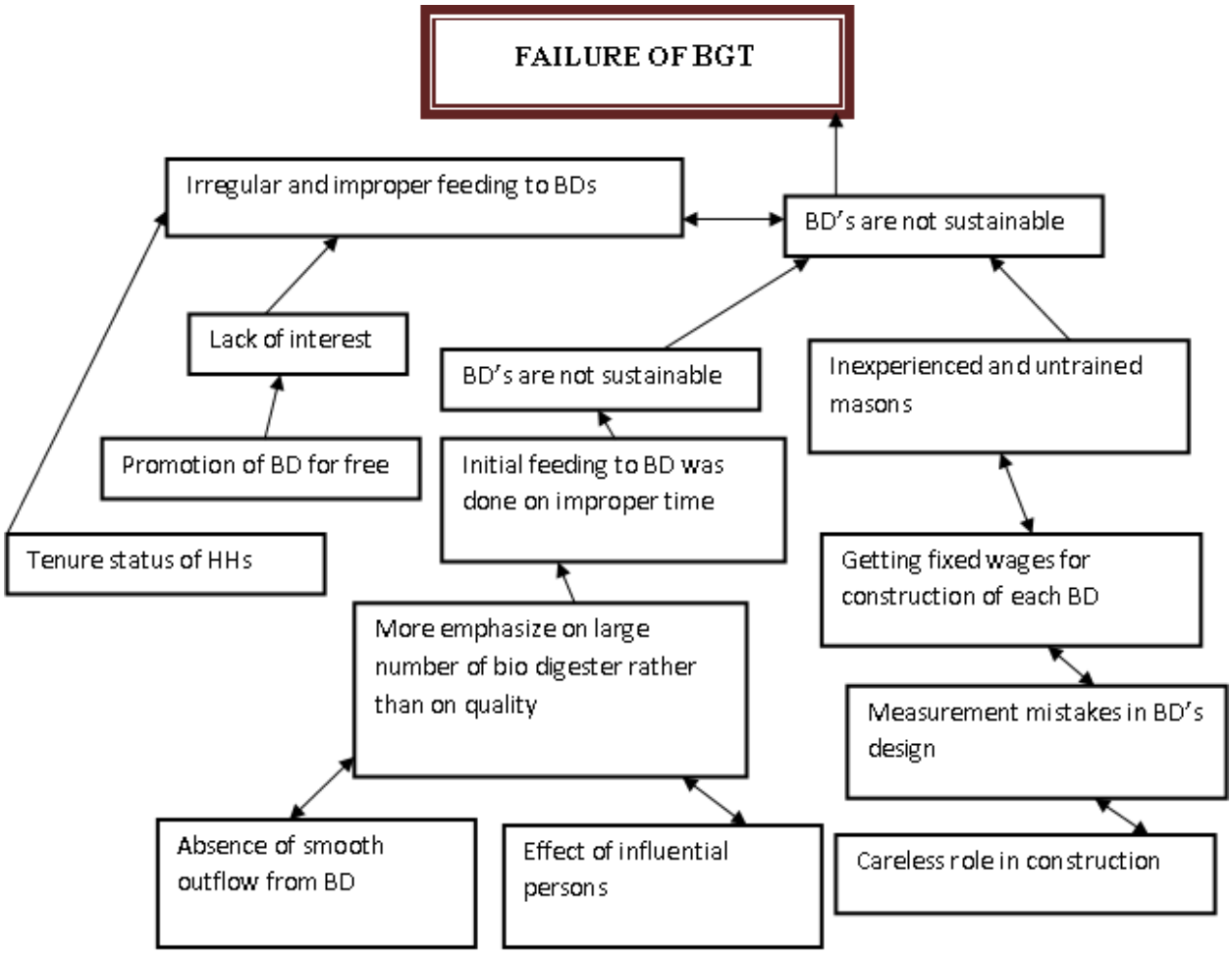

Fig. 1. Problem Tree Analysis Diagram
Source: Group Interview

At this, FIDA changed their payment mechanism and decided to pay BD costs after completion of BD building process. In fact, FIDA did not notice individual fuel sources' characteristics properly because households having increased amount of fuel wood were found to have low interest towards BGT.

Among the second form of failure, 23 bio digesters were working well since first day of operation but later on with the passage of time, the production rate of bio gas gradually decreased and eventually stopped working any more. The main reasons of such kind of failure included provision of bio digesters to large family sized households who were found that they had insufficient amount of gas according to their daily energy consumption needs which lost their interest about proper operation and maintenance of BGT and consequently their bio digesters were categorized under failure case. Improper content of water-dung proportion, its improper mixing and irregular feeding was another factor. Improper site was selected for building BD which caused bio digester not exposed to full amount of sunlight, thereby reduced production rate of bio gas as well as some households broke down their BD with the fact that they choose to build room at that place. In this context, it was found that 100 % subsidization rate by FIDA was found one of the major reasons of farmers' careless attitude.

Some of the land owners who were bio gas users and were not associated with farming activities took help of their tenants to do daily feeding operation of BD which reduced the quality of BD operation and maintenance and gradually resulted in low production. Three bio digesters blasted due to high bio gas pressure which indicated that the households were not having sufficient skills in order to

estimate the amount of dung required against the amount of biogas utilized for cooking (over dozing of dung to bio digester was reported).

However, some technical reasons of failure were also noted such as one household claimed that his BD was not working for the last 5-6 months and the problem was when the dung was fed in the inlet tank, it came out again in inlet tank and thereby very little production of bio gas and no outflow was seen.

Problem Tree Analysis was done to verify the results from respondents regarding reasons of BGT failure by a heterogeneous group containing 6 intellectual persons related to BGT.

According to Problem Tree Analysis results (Fig. 1), the inexperienced and untrained masons who built bio digesters, the poor performance of FIDA providing BGT and irregular and improper feeding to bio digesters by households, were among major reasons.

There were found sub reasons of this which included their careless role, mistakes in measurement of BD design and provision of fixed payment per building BD not on daily wage basis. The masons choose to build more bio digesters and thereby to earn more money. On the other hand, outflow from bio digesters was not smooth which was positively linked with mistakes in measurement of bio digester design which was further linked with FIDA's more emphasize on large number of bio digester rather than on quality. In some cases, FIDA field workers recommended to households to feed BD just after 2 days of completion of BD building.

However, it was found that FIDA's project activities were affected by influential persons in the area. In addition, the irregular and improper feeding of bio digesters by households was due to 100% subsidization to BD building to household which resulted in their lower interest level.

CONCLUSIONS

The study's major objectives were to determine the Socioeconomic, Ecological and Resource Endowment Features and success and failure status of BGT in one purposively selected district in KPK (Pakistan). Results reveals that overall BGT success rate was not very good (i.e. 69%) in the context of available resources. Proper BD operation was the main reason of success characterized with sufficient as well as regular feeding of substrate to bio digesters and eventually it resulted in better maintenance level. In addition, farmers' rationality and activeness were found significant factors in BGT success regarding their attempts to know about highly recommended bio digester construction and operation procedure. Another reason of success was experienced masons who knew the design of BD construction but unfortunately they were not good enough for the whole project area, some were good while others were careless.

The main reasons of BGT failure were use of poor quality of construction materials and inexperienced masons, poor quality of construction materials, improper and irregular feeding to bio digesters, poor monitoring of FIDA field staff, improper need assessment of beneficiaries by FIDA, improper site selection for building BD and 100 % subsidization rate by FIDA to provide bio digesters.

ACKNOWLEDGMENTS

The authors are grateful to the Chinese Government Scholarship Program as source of funding that helped to produce this article.

REFERENCES

[1]Amjid, S.S., Bilal, M.Q., Nazir, M.S., Hussain, A., 2011, Biogas, renewable energy resource for Pakistan, Renewable and Sustainable Energy Reviews, 15(6), 2833–2837

[2]Asif, M., 2011, Energy Crises in Pakistan., Pakistan, Oxford University Press.

[3]Harijan, K., Memon, M., Uqaili, M.A., Mirza ,U.M., 2009, Potential contribution of ethanol fuel to the transport sector in Pakistan, Renewable and Sustainable Energy Reviews. 13(1), 291-295

[4]HDIP, 2011, Pakistan Energy Yearbook, Islamabad, Ministry of Petroleum and Natural Resources Government of Pakistan

[5]Ibrahim, S., 2009, Renewable Energy Resources of Pakistan, Economic Review, 40(12)

[6]Ilyas, S.Z., 2006, Biogas Support Program Is a

Reason for its success in Pakistan. American-Eurasian Journal of Scientific Research, 1(1), 42-45
[7]KPK, Government, 2013, District Profile of Dera Ismail Khan. http://www.khyberpakhtunkhwa.gov.pk
[8]Raven R. P. J. M., Gregersen K. H., 2005, Biogas plants in Denmark: successes and setbacks, Renewable & Sustainable Energy Reviews.
[9]Remais, J., Chen, L., Seto, E., 2009, Leveraging Rural Energy Investment for Parasitic Disease Contol: Schistome Ova Inactivation and Energy Co-Benefits for Anarobic Household bio-digesters Rural China. PLOSONE, 4(3)
[10]Shah, S., Rashid, A., Bhatti, M.K.L., Khattak, S., Khan, L., 2010, Crisis of electrical energy in Pakistan and future guidelines for policymakers, Canadian Journal on Electrical and Electronics Engineering, 1(3)
[11]Sheikh, M.A., 2010, Energy and renewable energy scenario of Pakistan, Renewable and Sustainable Energy Reviews, 14, 354-363.
12]Talukder, M.F.S.I., 2010, Impact assessment of biogas household bio-digesters: A case study of Bangladesh. M. Eng dissertation, University of Flensburg, Germany