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Training Needs of Biogas Plant Owners in Bangladesh

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Abstract:

The present study analyzes the training need of biogas plant owners of Bangladesh for maximize the gas production and proper maintenance of their plant. The survey was conducted in 20 villages of three districts of Bangladesh and 117 biogas plant owners (90 functioning and 27 non-functioning) were interviewed. A questionnaire was developed to gather information about respondents' socio demography, their knowledge and skill about biogas plant operation, their training need and finally in which areas they need the training most. SPSS 21 was used to analyze the data. Among the 117 respondents, 65.81% respondents had no training experience; only 25 and 15 respondent had short and medium training experience, respectively. Both the farmer's with functioning and non-functioning biogas plant has highest KI (knowledge index) on the use of biogas properly (261.11 and 248.15, respectively) and lowest KI on utilization of slurry pit (232.22 and 214.81, respectively). The majority of farmers with functioning biogas plant has medium (52.22%) to high (40.00%) training needs, while all farmers with non-functioning biogas plant thought they have medium (55.56%) to high (44.44%) training need. Farmers with functioning and non-functioning biogas plants ranked utilization of the slurry pit as the most important area for training. Careful consideration of the areas of biogas plant operation where farmers need training will enhance better management of biogas plants.

Keywords: Biogas Plant, Knowledge, Ranking, Skill

1. Introduction

Energy is key consideration for sustainable development of any country. Emerging nations are increasingly utilizing renewable energy as a substitute for fossil fuels as they expand their energy supply to combat energy deficiency. Renewable energy sources' abundance could potentially meet all predicted global energy demands over the next century (Field & Raupach, 2004; UNDP, 2000). Numerous studies indicate that transitioning to renewable energy sources in all sectors, including electricity, heat, transportation, and desalination, is technically and fiscally feasible (Bogdanov *et al.*, 2021; Teske, 2019; Ylenews, 2019; Gulagi *et al*., 2021). Unfortunately, Bangladesh has serious energy crisis as it has very limited nonrenewable energy resources of its own (Islam *et al*., 2008). Only 3–4% of the households have connection of natural gas for cooking purposes (Islam, 2000). Over 90% of people depend on biomass energy sources like plant leaves, wood, grasses, cow dung etc. for their energy needs in domestic cooking purposes (Khan, 2003). As an agricultural country, Bangladesh has 24.48 million cattle and buffalo, 21.6 million goats, 2.8 million sheeps, 212.5 million chickens and 39.8 million ducks (Tareque & Chowdhury, 2010). As a result, huge amount of livestock wastes generated daily. These renewable waste materials from livestock sources alone or together with other agricultural, industrial or domestic wastes could be converted to useful energy forms like biogas for sustainable growth of Bangladesh (Sreekrishnan *et al*., 2004; Amon *et al*., 2007; Momoh & Ify, 2008; Artanti *et al.,* 2012). This biogas is mainly composed of methane (50% - 70%), carbon dioxide (20% - 40%) and traces of other gases (Nitrogen, Hydrogen, Ammonia, Hydrogen sulfide, etc.) (Horvath *et al*., 2016).

The first biogas plant in Bangladesh was established in 1972 at Bangladesh Agricultural University, Mymensingh campus. Lately, Bangladesh has 55,000 biogas plants all over the country (Huda *et al*., 2014). Traditionally, Governmental and Non-Governmental organization provides technical and financial support to install biogas plant in Bangladesh (Islam *et al*., 2008). The service staff (extension worker) installs plant with their own personnel, and plant owner has very little participation in installment process. Therefore, plant owner may not received adequate information about operation and maintenance of biogas plant. Proper functioning and maintenance of biogas plant requires some technical knowledge about mixture of feeding material with water at an appropriate ratio, cleaning of slurry, pipe line, gas stove. An early study by Ghimire (2005) reported that most of the plants in Bangladesh were not functioning properly due to under-feeding, higher water-dung ratio, ignorance of users on feeding-requirements, improper use of main gas valve, zero maintenance of defective parts. This indicates that biogas plant owner in Bangladesh needs proper training on various aspects of operation and maintenance of biogas plant.

It is well understood that training increases the knowledge and skills of a participant in doing a particular job. Indeed, training develops skills, knowledge and attitude of an individual required not only for overcoming problems but also for avoiding creating problem situations. Biogas plant owners in Bangladesh usually do not received any formal training from any Government or Non-government organization. An early study mentioned that only 11 percent of the biogas plant owners received training on operation and maintenance of their plants (IDCOL, 2011). This could result in inefficiency in handling the problems of biogas plants. Furthermore, there may exist wide gap between modern or improved biogas performance and the local ones. To our best knowledge, no study was conducted to gather information of biogas plant owners' knowledge and skill for proper maintenance of biogas plants

in Bangladesh. Accordingly, the present study was conducted to know the knowledge and skill of biogas plant owner to operate and maintain their plants for analyzing their training needs and to prioritize the subject for training.

2. Materials and Methods

2.1 Selection of study area and participant

Twenty villages of three districts namely Pabna, Tangail and Mymensingh were purposively selected to attain the objective of the present paper. Dairy farm activities were considered during this study. Farmers with functioning biogas plant and not functioning biogas plants were selected from these villages. One hundred and seventeen farmers were interviewed from October 2021 to March 2022. Eight biogas plant activities were selected to judge the farmers about their training needs; whereas every selected activity has three to four sub-activities.

2.2 Development of the questionnaires

The questionnaires for this study were developed with both open and closed forms of questions. However, the first part of the questionnaire has some short answer type of questions about the respondent personal and livestock farming information like name and address, age, education, training experience, farming experience and biogas plant size (Table 1); those were measured through ordinary methods. Secondly, farmers' knowledge, skill and training needs of biogas plant activities were judged by designing eight main questions; and every main question has three to four sub questions (Table 2). The knowledge about the biogas plant activities was measured by asking three to four sub questions. The set of question were used four scaling frame where 1 corresponds to poor knowledge, 2 corresponds to fair knowledge, 3 corresponds to good knowledge and 4 corresponds to excellent knowledge. Similarly, skill also measured by telling them to perform eight operations about biogas plant. The question were used three scaling frame where 0 corresponds to failed, 1 corresponds to done with difficulty and 2 corresponds to done correctly. In addition, training need of respondents was measured by a 3-points scale with responses namely essential, moderately essential, and not at all and weights assigned for each of these responses were 2, 1 and 0 respectively.

2.3 Calculation of knowledge of the respondents

Farmer's knowledge was judged by asking eight questions about biogas plant activities, each question has three to four sub questions. The knowledge was computed as a knowledge score based on eight biogas plant activities knowledge test with respect of their level. Level of knowledge represented six level of cognitive behavior as postulated by Bloom (1956) and revised by his Associates Anderson and Krathwohi (2001). These six levels are remember, understanding, applying, analyzing, evaluating and creating. The knowledge score were evaluated along a four point scale: where 1 corresponds to poor knowledge, 2 corresponds to fair knowledge, 3 corresponds to good knowledge and 4 corresponds to excellent knowledge. The total score of a respondent was calculated by adding the scores of all activities. The knowledge score of the respondents could range from 8 to 32, that's were categorized as a Low (score below12), Medium (Score=12 to 24) and High (score above 24). The responses were analyzed using Knowledge index in selected activities. This was used to identify and categorize the training needs of biogas plant owners in selected activities. The formula adopted by khan (2009) and Islam (2007) was used for the calculation of knowledge index (KI) of a category for a respondent.

Knowledge index (KI) = 3.Khp + 2.Kmp + 1.Klp

Where,

KI = Knowledge Index
Khp = Percentage of respondents with high knowledge
Kmp = Percentage of respondents with medium knowledge
Klp = Percentage of respondents with low knowledge

Knowledge index of a category could range from 100 to 300, where 100 indicated the lowest knowledge and 300 indicated the highest possible knowledge of a farmer. According to Grish (2006) the knowledge level was interpreted in terms of low, medium and high (Table-2).

2.4 Calculation of Skill of the respondents

The skill of the respondents on biogas plant related practices was judged by telling them to perform eight selected operations. The quality of performance of a respondent for each selected task was evaluated along a 3 point scale: "done correctly", "done with difficulty" and "failed". The scale points were assigned weights as 2, 1 and 0 respectively. The total skill score of a respondent was computed by adding all scores of eight selected performance. Thus the score range of the respondents could range from 0 to 16, where o indicating no skill at all in any of the items and 16 indicating the highest possible skill in all the items. The score range were categorized as a Low (score below 6), Medium (Score=6 to 12) and High (score above12)
The formula adopted by khan (2009) and Islam (2007) was used for the calculation of Skill index (SI) of a category for a farmer.

Skill index (SI) = 3.Shp + 2.Smp + 1.Slp

where,

SI = Skill Index

Shp = Percentage of respondents with high Skill
Smp = Percentage of respondents with medium Skill
Slp = Percentage of respondents with low Skill

Skill index of a category could range from 100 to 300, where 100 indicated the lowest Skill and 300 indicated the highest possible Skill of a farmer. The Skill level was interpreted in terms of low, medium and high (Table-3).

2.5 Calculation of Training needs of the respondents in different biogas plant activities

Training need of respondents was measured by 8 selected items related with biogas plant activities including sub-activities. Training need was evaluated along with three point scale based on respondent's knowledge and skill where 0 is corresponding to No training need, 1 is corresponding to Moderately essential training need and 2 is corresponding to Essential training need. To assess the training need of the respondents for each biogas plant activities three point scale were analyzed as a frequency distribution. Total training needs score of the respondents for individual biogas plant activities were calculated by multiplying the frequencies with their score values and adding them as like 2 x frequency of essential training need + 1 x frequency of Moderately essential training need + 0 x frequency of No training need. Total scores for different biogas plant activities were ranked to identify the important topics to include them in training (Table-4). To categorize the respondents through their training need total training need score of a respondent for eight biogas plant activities were calculated. The training needs score for each main biogas plant activities will be 0 to 2, thus the total positive score could range from 0 to 16 where, 0 indicating no need and 16 indicating highly need. This score were categorized as a Low needs (score below 6), Medium need (score range 6-12) and High need (score above 12) (Table-5).

2.6 Data collection and analysis:

All the survey was conducted by the researchers themselves during October 2021 to March 2022. The researchers visited the farm and collected data directly talking with the farmer. SPSS 21 was used to analyze the data. General descriptive statistics, frequency distribution, percentage and proportion test were used to present the data.

3. Result

3.1 Selected characteristics of the biogas plant owner:

The basic information of the respondents regarding their age, education, training and farming experience, and biogas plant size are presented in Table-1. Most of the biogas plant owners were in middle (43.59%) to old (41.03%) age group while only 15.38% were in young age group. Above 92% biogas plant owners were literate and 30.77% of them have upper secondary level of education (10 years of formal education). Most of the respondent (65.81%) had no training experience, only 25 (21.37%) and 15 (12.82%) respondents had short and medium training experience, respectively. More biogas plants were installed by farmers with medium farming experience (71.79%) compared with farmers with small (14.53%) and large (13.68%) farming experience. The most popular size for biogas plant was 2.4 cubic meters followed by 4.8 cubic meters, 3.2 cubic meters, and 2.0 cubic meters, respectively.

Table 1: Characteristic profile of the respondent

Selected Characteristics		Respondents (N=117)	
		Number	Percent
Age	Young (below 31)	18	15.38
	Middle (31-50)	51	43.59
	Old (above 50)	48	41.03
Education	Illiterate but Can sign only (0.5)	9	7.69
	Primary level (1-5)	28	23.93
	Secondary level (6-10)	44	37.61
	Upper secondary level (above 10)	36	30.77
Training Experience	No training	77	65.81
	Short (1 days)	25	21.37
	Medium (7 days or less)	15	12.82
Farming experience	Small (bellow 1 years)	17	14.53
	Medium (1 to 5 years)	84	71.79
	Large (above 5 years)	16	13.68
Biogas plant size	4.8 Cubic meter	37	31.62
	3.2 Cubic meter	21	17.95
	2.4 Cubic meter	51	43.59
	2.0 Cubic meter	8	6.84

3.2 Knowledge and skill of biogas plant owners on biogas related activities:

Biogas plant owner's knowledge and skill index for plant related activities were shown in Tables 2&3. Data shows that owners with functioning biogas plant has higher knowledge and skill index in all eight areas of biogas related activities compared to owners with non-functioning biogas plant. Both the owners with functioning and non-functioning biogas plant had the highest knowledge and skill index on the use of biogas properly and lowest knowledge and skill index on utilization of slurry pit.

Table 2: Respondent's Knowledge index for biogas Plant activities

Practice/operation in BP performance	Farmer's Knowledge Index (n=117)							
	Functioning BP (n = 90)				Not functioning BP (n = 27)			
	High	Medium	Low	KI	High	Medium	Low	KI
Use of biomass properly	46	34	10	240.00	12	11	4	229.63
Utilization of slurry pit	41	37	12	232.22	11	9	7	214.81
Maintenance of biogas plant	48	33	9	243.33	12	12	3	233.33
Use of biogas properly	60	25	5	261.11	16	8	3	248.15
Proper utilization of slurry	42	36	12	233.33	11	10	6	218.52
Communication with service staff	45	35	10	238.89	12	10	5	225.93
Marketing of biogas & slurry	44	35	11	236.67	12	9	6	222.22
Environmental safety of biogas plant	50	30	10	244.44	14	9	4	237.04

Table 3: Respondent's Skill index for biogas Plant activities

Practice/operation in BP performance	Farmer's Skill Index (n=117)							
	Functioning BP (n = 90)				Not functioning BP (n = 27)			
	High	Medium	Low	KI	High	Medium	Low	KI
Use of biomass properly	43	35	12	234.44	10	9	8	207.41
Utilization of slurry pit	35	37	18	218.89	8	8	11	188.89
Maintenance of biogas plant	44	34	12	235.56	10	10	7	211.11
Use of biogas properly	57	26	7	255.56	14	8	5	233.33
Proper utilization of slurry	37	35	18	221.11	8	9	10	192.59
Communication with service staff	45	30	15	233.33	9	10	8	203.70
Marketing of biogas & slurry	41	36	13	231.11	9	9	9	200.00
Environmental safety of biogas plant	46	33	11	238.89	10	11	6	214.81

3.3 Ranking the training priorities of biogas plant owner

Biogas plant owners ranking of their training priorities about 8 areas of plant related activities were computed and presented in Table 4. Owners with functioning and non-functioning biogas plants ranked utilization of slurry pit as their top priority training need (Score: 104 and 34 respectively) while use of biogas properly was least priority (Score: 88 and 27). The respondents with functioning and non-functioning biogas plant have approximately above 80% moderately essential to essential training need in 8 areas of plant related activities (Table 4).

Table 4: Training needs assessment of respondents in biogas plant activities

Practice/operation in BP performance	Farmers (n=117)									
	Functioning BP (n = 90)					Not functioning BP (n = 27)				
	Essential need (%)	Moderately essential need (%)	No need (%)	Total need score	Rank order	Essential need (%)	Moderately essential need (%)	No need (%)	Total need score	Rank order
1. Use of biomass properly	20	68.89	11.1	98	5	18.51	74.07	7.40	30	5
Utilization of slurry pit	21.11	73.33	5.56	104	1	25.93	74.07	0	34	1
Maintenance of biogas plant	17.78	67.77	14.4	93	6	22.22	62.96	14.81	29	6
Use of biogas properly	17.78	62.22	20	88	8	18.52	62.96	18.51	27	8
Proper utilization of slurry	21.11	72.22	6.67	103	2	25.93	70.37	3.70	33	2
Communication with service staff	18.89	74.44	6.67	101	4	22.22	70.37	7.40	31	4
Marketing of biogas and slurry	21.11	71.11	7.78	102	3	22.22	74.07	3.70	32	3

Environmental safety of biogas plant	18.89	64.44	16.6	92	7	22.22	59.25	18.51	28	7

3.4 Training need of the Biogas Plant Owner:

On the basis of the scores obtained, the plant owners were classified into three categories, Low (score below 6), Medium (score range 6-12) and high (score above 12) training need and the result is presented in Table 5. The majority of owner with functioning biogas plant has medium (52.22%) to high (40.00%) training need while all farmers with non-functioning biogas plant thought that they need medium (55.56%) to high (44.44%) training need. There was no significant difference among the farmer's categories for their training needs in 5 % level of probability.

Table 5: Training needs frequency distribution of respondents

Categories	Farmer (n=117)		Proportion test (Z- value) (Asymp. Sig. (2-sided)
	Functioning BP (n=90)	Not functioning BP (n=27)	Farmer
Low (score below 6)	7 (7.78%)	0 (0%)	1.494 (NS)
Medium (score range 6-12)	47 (52.22%)	15 (55.56%)	-0.3049 (NS)
High (score above 12)	36 (40.00%)	12 (44.44%)	-0.4113 (NS)

4. Discussion

Training need analysis could gather substantial information regarding target groups knowledge and skill in performing a specific function. The present study aims to assess the biogas plant owner's thinking about their training needs and categorizes the area of training priorities for biogas plant's proper operation and maintenance. The results indicate that most of the biogas plant owners (both functioning and non-functioning) need training for better management of their plants.

There are number of ways to conduct training needs analysis like survey, interview, focus group discussion, observation, participatory appraisal, and so on. We interviewed each biogas plant owner separately with a semi-structured questionnaires and visited their plants to observe their biogas related activities and gather information for the present study. Brown (2002) stated that interviewing is a good way to collect data among others, as it generates spontaneous feedback, and the respondent could answer without being self-conscious or suspicious. Interviews yield the highest response rates in survey type research but it could be time consuming (Leedy & Ormrod, 2001).

Age of the farm owner played an important role in decision-making about installation of biogas plant. Our results revealed that 85% of the respondents were middle to old aged who installed plants. Taylor (1975) stated that age is a more important determinant in information processing and decision-making performance. Worthy et al. (2011) stated that neurobiological and behavioral studies also revealed that wisdom comes with age and older people feel more confident in decision making. Most of the respondents (73%) have at least 5 years formal education, which is much higher than the national average. In an earlier study, Shamsuddin *et al* (2007) also reported a higher literacy rate (75 to 100% in different parts of Bangladesh) in dairy farmer. Usually, dairy and poultry farmers are economically solvent group of people in Bangladesh; as a result they have more access to education ((Shamsuddin *et al*., 2007). This could be helpful to form favorable attitude towards biogas plant performance. Training is essential for proper operation and maintenance of biogas plant. Unfortunately, only 34.19% plant owner had 1 to 7 days of training while the rest of 65.81% had no training experience at all. A good number of respondents (85.47%) had medium to high farming experience which indicates that some farming experience is helpful to make decisions about biogas installation. Among the respondent, 2.4 m^3 and 4.8 m^3 sized biogas plant was most popular. Selection of biogas plant size could be influenced by the size of dairy or poultry farm they have, as farm waste is the main raw material and their own family size.

Knowledge and skill are the important factors to perform biogas plant activities effectively. Knowledge refers to learning concepts, principles and information regarding a particular subject by a person, while skill refers to the ability of using that information and applying it in a context ((Honebein *et al*., 1993). Our results revealed that owners with functioning biogas plant have higher knowledge and skill index compared with farmers without functioning biogas plants. Among the eight biogas related activities owner of both functioning and non-functioning biogas plant has the highest knowledge and skill about the usage of biogas. In Bangladesh, all biogas plants are installed under direct supervision of extension worker. The extension worker usually motivates people by explaining the usage and benefit of biogas rather than other biogas related activities like slurry management or marketing issue. This is reflected in our result as both the owner of functioning and non-functioning plant has the lowest knowledge and skill on utilization of slurry pit. This should be mentioned here that in the present study we only consider cooking for biogas usage rather than its many other usages.

The result of the present study revealed that all the biogas plant owner has varying degree of training need. Only 7.78% owner of functioning biogas plant feels they have low training needs. Remaining 92.22% owner of functioning biogas plant and 100% owner of non-functioning plant deemed they have medium to high training need. Bahauddin & Salahuddin (2012) reported that biogas could improve the living standard of rural people. Similarly, the plant owners are aware that it is possible to improve their living

standard through cash generation, saving time for cooking, increase crop production and decrease production cost by using slurry, reduce chemical fertilizer in fish culture and purify the environment by biogas plant operations. Therefore, they are interested to receive training on different aspects of biogas. The notable training provider on biogas in Bangladesh is IDCOL and Grameen Shakti. Unfortunately, their training has very limited exposure to bio-slurry management.

Biogas has diversified social, economical and environmental benefits (Kabir *et al*., 2013). It is noted that bio-fertilizers that could be generated from biogas production are directly used in the agricultural field to increase the soil fertility (Islam, 2006). However, the present study revealed that slurry management is greatly overlooked by the plant owner. Functioning and non-functioning biogas plant owners ranked utilization of slurry pit as top important training topic. Biogas plant owners are satisfied with their slurry management and they are interested to use it as a composted fertilizer. Owners of both functioning and non-functioning biogas plant were aware that biogas is beneficial for cooking, lighting and preparing electricity as the least important topic for training.

5. Conclusion

The study aims to assess biogas plant owners' training needs and categorize areas of training priorities for proper operation and maintenance of their plants. The results indicate that most biogas plant owners need training for better management of their plants. Age plays a significant role in decision-making about biogas plant installation, with 85% of respondents being middle to old aged. Most respondents have at least 5 years of formal education, which is higher than the national average. Training is essential for proper operation and maintenance of biogas plants, but only 34.19% of plant owners have 1 to 7 days of training, while 65.81% have no training experience. A good number of respondents have medium to high farming experience, which is helpful in making decisions about biogas installation.

Knowledge and skill are important factors for performing biogas plant activities effectively. Owners with functioning biogas plants have higher knowledge and skill index compared to farmers without functioning biogas plants. In Bangladesh, all biogas plants are installed under direct supervision of extension workers, who usually motivate people by explaining the usage and benefits of biogas rather than other biogas-related activities like slurry management or marketing issues. The study found that biogas plant owners have varying degrees of training need, with only 7.78% feeling they have low training need. Proper training could develop knowledge and skill of the plant owner for better management of biogas plant and better utilization of produced biogas and slurry. Biogas has diversified social, economical, and environmental benefits, but slurry management is often overlooked by plant owners.

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Conflict of Interest

No conflicts of interest are disclosed by the author regarding this manuscript.

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