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Decision Process for Adoption of Biogas Technology for the Sustainable Development in Uttaradit Province, Thailand

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Abstract: The purposes of this research article aims to 1) present an appropriate form of biogas technology production from livestock manure for small scale farmers and 2) investigate farmers' perception of biogas technology characteristics for an appropriate technology adoption decision. Findings showed that, the balloon biogas technology from livestock manure was an appropriate technology for this community. That employs a large bag made from PVC plastics to collect and siphon gas material. It was suitable for small scale farmer, relatively low labor-intensive and cheap to construct and operate. Besides, the farmers perceived that balloon biogas technology for livestock waste was superior to traditional practice in all of the aspects included in the study, i.e., relative advantage, compatibility, complexity, trailability and observability.

Key words: Adoption process · Balloon Biogas Technology · Appropriate technology · Trialability

INTRODUCTION

Huay-bong Community in Muang District, Uttaradit Province has raised more than 802 beef cows that produce 19.2 tons of dung per month. This large amount of dung has caused a continuous unfavorable impact on the environment and the resultant happiness of the community. However, dung can be employed to produce biogas for household use. Biogas originates from micro-organisms in the process of bio-degradation of organic material under anaerobic (without air) conditions. Methane is naturally produced as a result of this process. It is colorless, odorless and inflammable. Raw materials for producing biogas are, for example, all kinds of animal manure and waste water from agriculture industrial plants. There are several kinds of biogas technology production from manure, for example, fixed dome digester, floating drum digester, plug flow digester and etc, each of which have different advantages and disadvantages. However, each has a high cost of production making it inappropriate for small scale farmers who have only 5-10 cows. Therefore, this research article aims to 1) present an appropriate form of biogas technology production from livestock manure for small scale farmers and 2) investigate farmers' perception of biogas technology characteristics for an appropriate technology adoption decision process [1], with the hope of helping them apply that technology to resolve their problems and to make them become self- reliant (Figure 1).

MATERIALS AND METHODS

Data collection was done through related document, focus group discussion and case study from target farmers in Huay-bong community during July 2010 to February 2011. Content analysis was conducted in order to synthesize the context and decision on adoption process of biogas technology for the sustainable development.

RESULTS AND DISCUSSION

An Appropriate Biogas Digester for Small Scale Farmers: The balloon biogas technology from livestock waste was an appropriate technology for this community that employs a large bag made from PVC plastic to collect and siphon gas material (Figure 2). It was suitable for small scale farmers, low labor-intensive and cheap to construct and operate (about 80-100∈). This balloon biogas digester was 6 meters in length, 5.25 meters in circumference and 7.8 m^3 in capacity (liquid = 5.9 m^3 gas = 1.7 m^3). This system produces 2 m^3 gases per day

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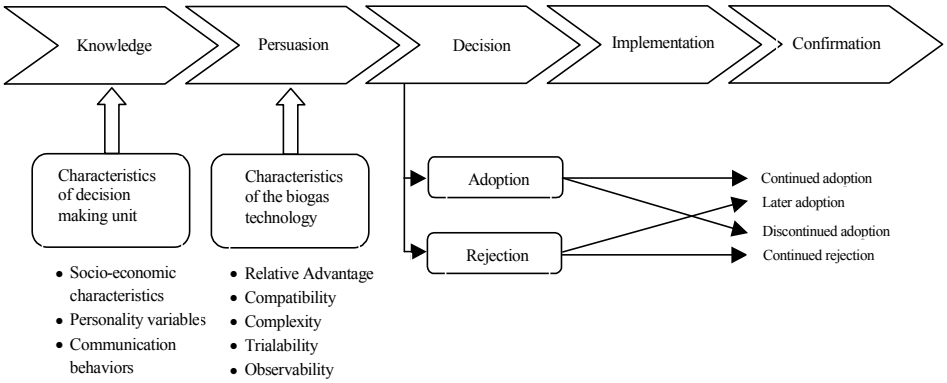

Fig. 1: Conceptual framework of decision process for adoption biogas technology

Fig. 2: Balloon biogas technology from PVC plastic

Fig. 3: The steps of balloon biogas technology constructions

and sufficient for 2 stoves for a 2-3 hour period for each stove [2]. The steps of balloon biogas technology construction were 1) dig a hole: 1 meter deep, 4 meters long and 2 meters wide 2) dig two ditches, one for an entrance tube and the other for an exit tube 3) make a balloon cover: place an amount of PVC plastic flat on the ground, cut to the dimensions of 6 meters x 2 meters and cut to 3 pieces 4) connect the PVC plastic balloon together with PVC glue 5) at both open ends, insert a PVC pipe and fold the bag into the pipe, wrap rubber threading around the folded parts 6) cut a hole in the center of the balloon bag 10 mm. in diameter and attach a small plastic tube 7) test the balloon bag by filling it with car exhaust 8) lay the balloon in the hole, fill it with water and arrange the form so that it fits correctly 9) create a loading tank, an entrance tank, an entrance tube valve and an exit tank 10) the methane can then be siphoned through plastic piping directly into a stove for use (Figure 3).

Farmers' Perception of Balloon Biogas Technology

Informants' Personal Characteristics: The results of the study revealed that most of the respondents (75.76%) were male with an average age of 48.58 years, with primary level of education (81.82%) and were farmers (66.57%). Most respondents received information about biogas technology from community leaders (69.69%) and the respondents raised cows that produced dung for biogas. Regarding their interest in biogas technology, most of the informants (81.81%) wanted to reduce their costs and household expenditure on LPG gas,

Table1: Quantity and percentage of levels of the respondents' perception of the characteristics of balloon biogas technology

Levels of perception of characteristics of the technology	Quantity (N = 33)	Percentage
1. Relative Advantage		
Perceived as better (2.34-3.00)	30	90.91
Perceived as the same (1.67-2.33)	3	9.09
Perceived as no good (1.00-1.66)	0	0
WMS. = 2.83 SD. = 0.32 Min. = 2.00 Max. = 3.00		
2. Compatibility		
Compatible (1.51-2.00)	33	100.00
Incompatible (1.00-1.50)	0	0
WMS. = 1.97 SD. = 0.83 Min. = 1.60 Max. = 2.00		
3. Complexity		
Perceived as better (2.34-3.00)	30	90.91
Perceived as the same (1.67-2.33)	2	6.07
Perceived as no good (1.00-1.66)	1	3.03
WMS. = 2.83 SD. = 0.34 Min. = 1.60 Max. = 3.00		
4. Trialability		
Perceived as better (2.34-3.00)	29	87.88
Perceived as the same (1.67-2.33)	3	9.09
Perceived as no good (1.00-1.66)	1	3.03
WMS. = 2.84 SD. = 0.44 Min. = 1.00 Max. = 3.00		
5. Observability		
Perceived as better (2.34-3.00)	31	93.94
Perceived as the same (1.67-2.33)	1	3.03
Perceived as no good (1.00-1.66)	1	3.03
WMS. = 2.86 SD. = 0.39 Min. = 1.00 Max. = 3.00		

followed by 27.27 percent of them wanted to fully exploit manure in the community and 9.09 percent of them wanted to develop biogas technology as an example of sufficiency economy practice. Regarding knowledge and understanding of balloon biogas technology from PVC plastic bag, it was found that the respondents answered an average of 5.42 questions correctly, with the fewest being 2 correct answers and the most 9 correct ones. The questions that most respondents (96.97%) answered correctly were about types of manure appropriate for biogas production and how to test the leakage of gas from the biogas bag. The question that the fewest (21.21%) could answer correctly was about types of biogas production from manure. The data analysis showed that most respondents (63.64%) had the knowledge and understanding of biogas technology at a medium level.

Perception of Characteristics of Balloon Biogas Technology: This research aimed to investigate people's perception of the characteristics of biogas technology production from manure based on Everett M. Roger's theory in five aspects, namely; relative advantage, compatibility, complexity, trialability and observability [1, 3, 4]. Data collected from informants were as follows (Table 1):

Relative Advantage: The results of the analysis revealed that most respondents (90.91%) perceived balloon biogas technology from PVC plastic bags as better than LPG gas and other types of biogas production from manure with an overall total mean of relative advantage at 2.83. It can be concluded that the respondents perceived this biogas technology as being better for environmental benefits, community benefits, household expenditures, cost effectiveness, technology expenditures and potentiality in technological production and maintenance respectively, than other biogas technology.

Compatibility: The findings revealed that all respondents (100%) perceived balloon biogas technology from PVC plastic bags as compatible with the user with an overall total mean of compatibility at 1.97. This can be explained by the respondents perceiving the biogas technology as being consistent with their needs, for example, with their everyday life, employing livestock manure as raw material for biogas production, filling balloon biogas technology production system with manure, a sufficient amount of gas for cooking and the ability to solve technological problems respectively.

Complexity: The findings revealed that most respondents (90.91%) perceived balloon biogas technology from PVC plastic bags as easily useable with an overall total mean of complexity at 2.83. That is to say the respondents perceived the biogas technology as being easy to operate, for example, the installation of the biogas technology for use in the compound of their house, the calculation of the amount of manure for filling the digester and the calculation of the amount of gas needed, understanding and spending time on learning, maintaining and repairing the technology by themselves respectively.

Trialability: The findings revealed that most respondents (90.91%) perceived balloon biogas technology from PVC plastic bags as being better experimented on a limited basis than other types of biogas technology production from manure with an overall total mean of trialability at 2.84. That is the respondents perceived the biogas technology as being experimented, for example, on biogas bag production, on biogas production system installation, on using biogas for cooking, on solving biogas systemic problems and on being an expert in technology transfer inside and outside the community respectively.

Observability: The findings showed that most respondents (93.94%) perceived balloon biogas technology from PVC plastic bags as being more noticeable than LPG gas and other types of biogas production from manure with an overall total mean of observability at 2.86. That is to say the respondents could notice the results of the following more clearly, for example, environmental compensation, LPG import reduction, global warming reduction, exploitation of community manure, technology adoption by the community, confidence and ability in technology transfer, production and installation of the system, recognition from study groups both in the province and from other provinces, economic return – income and expenditure on the use of biogas technology respectively.

The Relatedness of the Characteristics of Balloon Biogas Technology: The results of the data analysis showed that the five characteristics of biogas technology production from manure, namely relative advantage, compatibility, complexity, trialability and observability, were related to each other with the statistical significance at the level of 0.01 ($p < 0.01$). The relation was positive and in the same direction (Table 2). The research results revealed that trialability was the most important characteristic, particularly in the biogas technology which required several learning steps both theoretically and practically. Trialability was beneficial to the technology users in that it reduced technological complications ($r = 0.845^{**}$), enabled the users to notice the results clearly ($r = 0.843^{**}$) and as a result, the respondents could share their knowledge of the technology with people within and out with the community resulting in technology adoption.

The Implementation of Balloon Biogas Technology Production: With regard to the implementation of biogas technology from PVC plastic bags both physically and in the aspect of utilization, 85.29 percent of the respondents had implemented the technology and it was interesting to find that the gas amount calculation did not correspond with its uses. That is to say that there was more Methane gas than necessary which resulted in the damage of the system and the leakage of gas from the bag (Figure 4). Moreover, the emission of gas through the safety valve directly harmed the environment. To deal with these problems, it is necessary to educate and train people on how to calculate the amount of manure and that of Methane gas arising from the system in relation to their everyday use. Another alternative is to fully exploit biogas usage besides cooking, for example, using Methane energy to dry agricultural products, to boil and to extract herbal insecticide.

It can be concluded from the results of the research that the most important factor supporting the adoption of the biogas technology in relation to the information

Table 2: Correlation coefficient of the characteristics of biogas technology

	Characteristics				
Characteristics	Re_advantage	Compatibility	Complexity	Trialability	Observability
Re_advantage	1.000	0.446**	0.577**	0.646**	0.480**
Compatibility		1.000	0.680**	0.575**	0.431**
Complexity			1.000	0.845**	0.789**
Trialability				1.000	0.843**
Observability					1.000
WMS.	2.83	1.97	2.83	2.84	2.86
S.D.	0.32	0.83	0.34	0.44	0.39

** = significant at the 0.01 level

Fig. 4: The problem of the leakage of biogas and safety valve system

channel is through people, whether it be community leaders, academics, or neighbors, because it is easier and because of proximity explaining the technology to other people is a more effective means of communication. This conclusion conforms to the idea stated by Les Robinson[1] talking about interpersonal communication or face-to-face communication that affects an innovation adoption decision. With regard to the perception of the five characteristics of biogas technology from PVC plastic bags, the respondents who were small scale farmers perceived the biogas technology as better than LPG gas and other types of gas in the aspects of relative advantage, compatibility, complexity, trial ability and observability. Regarding the relatedness of the characteristics, it was found that trialability was the most important factor that brought about the technology adoption. This finding agreed with Roger [1] saying, "Innovations that are perceived by individuals as having greater relative advantage, compatibility, trial ability, observability and less complexity will be adopted more rapidly than other innovations." This study shows that biogas technology production from manure in PVC plastic bags maintains a good balance in academic technology, the economy and the environment [5, 6]. Consequently, leading to genuinely sustainable development for small scale farmers.

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