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Review Article

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Willingness to Pay for Biogas Digestor Construction of Farmers who have Swine Livestock in the Households' Level: Champasak Province, Lao PDR

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Abstract

The purpose of this paper is to identify the environmental issue and policy solution for encouraging biogas construction. An environmental evaluation related to environmentally friendly communities' beneficial biogas production persuasion policy applies to household-level farms with the idea of building biogas production under Scenario 1. As the first policy recommendation for the Laos government to focus on environmental issues solutions, farmers were appreciated for contributing to biogas construction activities and agreed to participate in the schemes to produce biogas production practices equal to 216.86 USD/household. The data analysis estimated that farmers with swine livestock would be willing to pay 43.18 USD per household in satiation 2. The willingness to pay valuation under scenario 3 for policy optimization in the case of a promotion scheme from the government or international organizations to participate in providing building and installation materials or technical encouragement 11.69 USD/household represented feasibility biogas production construction implementation if the project is a long-term project with a project duration of more than 5 years or more, but if the project is a short-term project with a project duration of fewer than 5 years.

Keywords: Willingness to Pay, Contingent Valuation Method and Need for Help.

Introduction

Research Background

Livestock activities plays important role for agriculture sector in developing countries [1]. Besides providing food, livestock production is a significant source of income for family farms and contributes towards to the economic growth of countries [2]. They are the basis for the growth of industry, trade, and services and also contribute to income generation for farmers in rural areas as well [3]. But on the other hand, the accumulation of manure is also a natural microbial degradation process, with the release of methane (CH4) and carbon dioxide (CO2) into the atmosphere, which is one of the causes of global warming [4]. Therefore, finding ways to manage waste effectively is the only way to reduce the pollution caused by agricultural activities in order to meet the goals of sustainable development [5].

Biomethane's benefits, such as reduced emissions and long-term sustainability, are actually mentioned. The only other naturally occurring, energy-containing carbon resource known that is large enough to be used as a substitute for fossil fuels is biomass [6]. Biogas reduces greenhouse gas emissions while also encouraging protection because it can disperse electricity [7]. The approach is better for the environment because it uses agricultural and industrial byproducts rather than conventional method and uses biomass-generated power at a lower cost [8]. Even though the waste digestate provided by anaerobic decomposition is excellent, digestate is uncommon in agriculture due to the lack of air delivery [9]. One of the main greenhouse gases affecting the redistribution of solar energy in the Earth's atmosphere is methane [10]. About 20% of its anthropogenic emissions are made by agriculture and, in regularly by livestock activity [11]. The most significant volumes of greenhouse gases are emitted during intestinal fermentation of farm animals (about 40%) and synthetic fertilizers in crop production (more than 13%), and these figures are increasing every year [12].

Pigs as pets as a farmer in category one pork consumption in Laos has increased along with the country's population growth, according to the data center for national statistics, which shows that in 2000, the country had all of 1,101,000 pigs; by 2005, all of 1,824,000 pigs; and in 2020, all of 3,122,000 pigs, which increased by about threefold from 2000 (Center National Statistics, Department of Planning). Pig farming is mainly done in the southern and central parts of the country. Pig farming has been on the rise in Laos, especially in Champasak, Saravan, and Savannakhet provinces, since 2007. Especially in Champasak province, according to the figures of the Department of Agriculture of Champassak province, it shows that in 2006, there were 6,730 farmers in the province who were able to produce a total of 128,171 pigs. By 2022, there were 259,832 pigs, that 10,228 households responded this activity, the number of farms raising pigs' larger farmers raising a covenant with foreign companies (Contract Farming) 28 farms which can produce pigs more than 58,328 pigs/year increase from 2006 about 201.15% (Department of Agriculture and Forestry Champasak, 2022) based on technical found that with 1 to expel waste from an average of 5 kg/day [13]. When calculating the amount of waste from pigs in the province of Champasak that each year the amount of waste from pigs all around 948,386 tons/year.

Pigs in large farms are under-managed and closely monitored by the authorities concerned, particularly the Department of resources, natural environment, and agriculture, and raising in small farms and raising at the household level is not yet as effective as it should be due to the nature of livestock scattered, limited budget, innovative equipment or tools are insufficient to include methods and strict management practices to solve problems that do not fit with reality, as noted. Due to the health problems of the people in the community, the livestock of the farmers themselves, and the environment, due to these wastes, they send a stench to the nearby communities, as a collection point and a breeding ground for many kinds of germs such as flies, mosquitoes, snails, cockroaches, and other diseases that can be spread to people, worms, and other pathogens [14]. Not only that, the problem of waste from the farm also has a negative impact on the mental state of people, such as causing frustration, awkwardness, and the community not stagnant, which also creates a sense of uneasiness for visitors.

Based on the technical data studied in many countries in the past, it is found that biogas is a process of organic decomposition by microorganisms in an anaerobic state [15]. When decomposed, it will form a gaseous mass (N2) (30% CO2). Methane has more components than other gases, has colorless, odorless, and flammable properties, is lighter than air, but has a volatile odor caused by hydrogen peroxide [16]. An adult pig produces around 5kg of manure every day [17]. This waste is 90% water and 7% volatile solids. Thus, pig wastewater treatment by applying biogas technology gives three benefits:

1. Significantly solved environmental impacts such as odors emissions and insects, water pollution
2. High-quality energy in the form of biogas (1 m3 biogas is equivalent to thermal energy content 21.5 MJ, or equivalent to 0.46 kg LPG, or 1.2 kWh electrical energy, or 1.2 kg charcoal)
3. Slurry will serve as an excellent bio-fertilizer, which is especially good for soil improvement.

Using waste from pig manure to produce gas biological application of waste with high performance environment as processing power, clean and sustainable, so that, if brought to such established contact with farmers raising pigs, it will be very useful for farmers, especially if there is a problem with the smell of animals in the community, while farmers will be given the bio for packaging household cooking, which would reduce the volume of firewood and charcoal used in the house, the other causes of farmers in the forest. In addition, the residue and wastewater from the biogas production process are high quality fertilizers that are safer and more effective on crops than the use of animal manure. Not only that, the hatching process kills the eggs of infected animals, which reduces flies, mosquitoes, cockroaches, etc., reducing the risk of health problems in the community. Of course, the creation of biogas construction installation is associated with the use of labor, materials, equipment and a some of costs which are directly related to the farmers who are the polluters and who will implement the project and who are also the direct beneficiaries of the project. Therefore, when there is a project, farmers who own pigs should be involved in sacrificing their resources to contribute to the project. Still, a project is only a hypothetical event that is used as a tool to evaluate the willingness to pay and economic value to solve the environmental impact caused by raising pigs with the method of not producing biogas from pig waste, which value will reflect the feasibility of implementation and be a basis for policy-making to promote pig raising in Champasack province to be efficient and sustainable in the future.

Research Objectives

This research has the idea to change the management method of waste management in the old pig farm system to one that includes biogas digestor installation in order to reduce the environmental impact, but the method is related to the installation cost of the biogas system. Therefore, the purpose of this research is to evaluate the willingness to pay of pig farms and the feasibility of their participation.

Research Scope

In Laos, farm households commonly raise pigs, and small-holders continue to account for 80% of total pig production [18]. If animal manure is appropriately managed, waste volume is reduced and residues are enriched with plant nutrients. However, if not managed properly, animal manure has significant negative effects on the environment. Air and water pollution are possible risks. Additionally, contamination of food crops with various pathogens is also possible. The willingness to pay for balloon biogas plants will be used pig manures on a household level farm in Champasak focuses on three key issues: the valuation of willingness to pay (WTP) to produce gas biologically; investigation of the factors influencing WTP to produce gas biologically; study the information on the need for incentives in various fields to lead to the decision to produce gas biologically. Under the terms of the assumed situation (Contingent Valuation Method: CMV) to create a similar situation, factors affecting willingness to pay to create gas biological will consider three factors: household characteristics, economic and social factors, Logit model will be used in order to test the relationships between dependence and independence variables [19]. The information on the need for incentives in various fields which leading decision to produce balloon biogas plants will consider three needs: funding, equipment, and technical. In order to

have clarification information to be used in the evaluation, the researcher used a questionnaire as a tool to collect data by interviewing all 350 households that raise pigs.

- Assuming that there is assistance in building biogas digestor construction and installations for households that raise pigs by facilitating all construction facilities, such as the provision of materials, equipment, core & assistant labor, and technicians supporting in biogas construction process, the pig owner must pay all incurred costs
- Assuming that there is construction assistance that building biogas digester construction and installation for households that raise pigs by facilitating all the construction facilities, the pig farm must be responsible only for core and assistant labor
- Assuming that if the building biogas digestor construction and installation are supported, the construction costs will be paid first, and the pig farm is going to pay back later on.

Research Methodology

Population and Sample

Based on the secondary data information of the department of agriculture and forestry, Champasak 2022 indicated that households that have a swine livestock total of 10,228 include 28 farms that have contract farming with private sector companies, farm levels that have swine numbers of more than 100 include 42 households, a household that has swine numbers of between 50-100 has 164 farms, a household has swine between 10-50 has 1,208 households, and a household has swine between 1-9 has 8,814 households. Therefore, in order to be consistent with the possibility of producing biogas suitable for swine livestock in the number of swine between 6-20, the population of swine livestock in the number between 10-50 was identified as the target population in this research, which was 1,208 households that have swine livestock in the number of swine livestock between 10-50 pigs as the total population of this research.

$$n = \frac{N}{1 + N(e)^2};\ n = \frac{1{,}208}{1 + 1{,}208(0.05)^2} = 300.50 \approx 350$$

To further enhance the credibility of CVM assessment tools under hypothetical market conditions, the study identified a total of 350 samples from the study population.

Table 1: Shows the Sample Size of the Population and Sample Group

No	District	Population Size	Sample Size
1	Pakse	52	15
2	Sanasomboun	166	48
3	Batiengchaleunsouk	112	32
4	Paksong	106	31
5	Pathouphone	135	39
6	Phonthong	154	45
7	Champassack	78	23
8	Soukhoumma	129	37
9	Mounlapamok	117	34
10	Khong	159	46
Total		1,208	350

Source: Department of agriculture and forestry of Champasak province

Design of Research Tools

CVM is a tool used to assess the economic value of non-marketable natural resources and the environment [20]. It is a highly flexible tool and can be used for all kinds of assessments, depending on the nature of the questionnaire used to question the affected people or the benefits of the environmental changes that are taking place. The principle of CVM is to inquire about the willingness of consumers or the public to contribute to the improvement or restoration of the quality of natural resources and the environment by creating a hypothetical situation. (CV Scenario) on changing the quality of natural resources and the environment as well as examples and measures that will help to address or improve those natural resources and the environment by asking questions in a willing manner. If environmental quality is to be improved, will consumers or stakeholders be willing to pay to improve the environment? The nature of the question is to ask a closed-ended question (closed-end) single question by assigning a bit price to the target group, choosing whether to pay or not to pay from the selected price level, whether the sample group is willing to pay or not, and the value of the value to be paid to the group.

The design of a research tool to study farmers' willingness to pay for the construction of a biogas plant was based on the objectives of the study, using a questionnaire as a survey tool. The questionnaire was divided into five sections:

- **Section 1:** Information on household characteristics such as the gender of the household head, age, education, main occupation, household members, household labor force, and agricultural area are provided.
- **Section 2:** Information related to household income and household sources of income.
- **Section 3:** Information on household breeding, such as: number of breeds, duration of rearing, costs and benefits of rearing, how to manage waste from rearing, and receiving incentives from government agencies in various forms.

- **Section 4:** Information on the use of fossil fuels in household cooking, such as consumption of charcoal, firewood, electricity consumption, and fuel costs.
- **Section 5:** In the characteristics of the question in this section, it is informative about the creation of an event to assess the willingness to pay or the willingness to contribute to the sample group by creating a hypothetical situation to explore the attitudes of the farmers who are the ones who do the polluting activities or stakeholders after the project occur (Contingent Valuation) is assumed.

Status 1: Assume events that result in balloon biogas plants owners must bear all costs, and scenario 2 is the case with the program from the part of the aid in the form of building materials, installation materials, and providing the technical know-how, but the farmers will bear the cost of labor of balloon biogas plants constructions, which creates situations where situations present in pig raising and management of waste from the pig, including impacts arising from the pig, now explain the nature of the activity or construction of balloon biogas plants that will happen to solve the problem better, including raw materials to be used in the construction of biogas, the agency responsible when projects occur, and the contributions of farmers. In addition to explaining the benefits, farmers will have to sacrifice resources in order to contribute to solving environmental problems. The way the question is to assess the willingness to pay or willingness to contribute is to use a technical question closed with a bid once (Single Bounded) to which farmers say, willing or unwilling (yes-or-no). If the answer is willing to record Y = 1, or when the answer is not willing to record Y = 0. Which makes the assumption that the problem can be solved in three ways. Each situation has a "bid price" of five prices based on the price that can actually be implemented as a reference price, increasing or decreasing the price by two times to see the response of the willingness to pay to the price. For data collection with each sample group, a random questionnaire selection method or a random sampling method is used to answer the questionnaire in order to avoid bias in data collection.

- **Scenario 1:** It is a hypothetical event when there is a project to provide biogas construction assistance to households that raise pigs by facilitating all construction conveniences such as the provision of materials, equipment, labor implementing, and technicians to be used in biogas construction installation, but the owner of the pig must be responsible for all costs. In this case, 5 prices have been determined: A. LAK 0.75 million; B. LAK 1.5 million; C. LAK 3 million Kip; D. LAK 6 million; E. LAK 12 million.
- **Scenario 2:** It is a case where an entity comes to help, such as a government entity or an independent organization that comes to help with material, equipment and technical advice, but the owner of the pig must contribute in terms of labor implementing. In the event that there is no labor in the household, labor will be hired from outside to work instead, but the owner of the pig must be responsible for the cost, which has an estimated price of: A. LAK 0.25 million; B. LAK 0.50 million; C. LAK 1 million; D. LAK 2 million; E. LAK 4 million.
- **Scenario 3:** It is assumed that when there is a project involved in the construction of biogas production by spending all the construction costs first, then the owner of the pig will pay in installments within the specified time. B. LAK 0.10 million /month; C. LAK 0.25 million /month; D. LAK 0.50 million/month; E. LAK 1 million /month where we refer the price to evaluate the willingness to pay is using the single bounded price presentation method so that the respondents express their opinion whether they are happy or not happy to pay the price presented, for the price set in each bid is based on the actual cost that is possible in each hypothetical situation.
- **Section 4:** Information on the need for incentives in various fields to lead to the decision to produce balloon biogas plants, which includes the need for funding, equipment, and technical requirements.

Data Analysis Methods

Given that the change in demand arises from the expectation of people from the change in the nature of non-marketable goods from the current nature of the goods, or q^0 to an improved level of q^1, which people will express in the form of the highest willingness of the individual to pay as a result of such a change.

From the objective theory, the demand variable or the utility variable of the people or v (•) is determined depending on the budget or the income of the people. Determined depending on the budget or income of the people (W) The price of the goods (P) Characteristics of goods that do not pass the market (q^1) and economic and social status (S) with an economic approach that assumes the most desirable objective factors under budget constraints can be analyzed for the following indirect demand or utility variables:

$$v=v(p,w,s,q^1) \qquad (1)$$

Changing the nature of goods that do not pass through the market from q^0 to q^1 as a result, consumer demand improved by stabilizing other factors as follows

$$v(p,w,s,q^0)<v(p,w,s,q^1) \qquad (2)$$

The needs of consumers in this case will be assessed using Compensating Variations. By changing the nature or quality of goods to improve the needs of the people in the beginning, but in the end, the needs of the people will be at the same level due to the declining income makes people want or the same utility to the nature or quality of the product will increase with the same willingness to pay the highest (WTP) in order to consume better quality products by having to pay the same amount C as equation (3) below:

$$v(p,w,s,q^0)<v(p,w,s,q^1)$$
$$\text{or } v(p,w,s,q^0)=v(p,w-c,s,q^1) \quad (3)$$

which C is Compensating Variation the estimated change in the demand or willingness of the people to pay the most from the change in the nature of goods that do not go through the market from the assumption (3) can be defined as Bid function or c (•) Which is determined by various factors in the model can be written in the following general format:

$$c=c(p,w,s,q^0,q^1)$$

People's willingness to pay the maximum for goods that people must be able to afford or must be worth no more than the budget of the people's income.

$$c(p,w,s,q^0,q^1)=WTP\leq w$$

The above identifies changes in the nature or quality of products that do not pass the market from q^0 to q^1. It's a good thing that people want, but in general the change in the nature of the product can have three different perspectives: change makes people feel better, makes people feel the same, and makes people feel bad.

All three cases are possible 3 but said that for public goods or private goods that have a social dimension that is beneficial to society as a whole, it is not right for the willingness to pay to have a negative value because people can reduce or reject products that do not meet their needs, so in this case it can be set as a negative [21].

$$0\leq c(p,w,s,q^0,q^1)=WTP\leq w$$

Estimation of Economic Value

The economic value of a project, policy, or natural resource and the environment consists of the value in various aspects of the actual valuation, which can be done by evaluating the value of the parts. Because these values are assessed by the impacts on the people, the benefits, and the disadvantages, Therefore, appraisals are often used in terms of the amount of money per person and the total value of the project, the policy, or the natural resources and environment that can be studied by combining the various utility values of all the people in the society in the area of the assessment.

Assessments that can be made are not difficult to estimate because the value of the part that is directly utilized can be estimated from the value that is traded in the market. But there are many types of values that are not directly marketed, so the overall valuation can be done in a variety of ways, either in combination or in some way to obtain a complete value, depending on the constraints of each economic valuation technique.

Economists have developed two ways to evaluate the value of goods or services:

Revealed Preference Method is an indirect observation of actual market behavior that gives the value of each product or service. This method relies on information already in place to compare products in the market, but does not find the value of goods or services directly. This method consists of two steps: 1. Observe the demand (demand function) of the buyer in the market. The second step is to compare the demand for the product that is not in the market but is related to the product observed in the first step.

Stated Preference Method is a popular method for economists because it can predict events, products, or services that can be held in the real market, making it easier for consumers to respond to events and techniques to assess the value of events that may occur. A study to assess the value of non-marketable goods and services in barter. In this way, surveys will be conducted from questionnaires or interviews to inquire about consumers' willingness to pay or willingness to receive compensation due to changes in the quantity or quality of goods or services.

Hypothetical market approaches values can be evaluated by assuming the situation to find the desired value. Popular valuation techniques are the direct valuation method under the hypothetical market. (Contingent valuation) Survey Based Method, in order to inquire about the willingness to pay or to inquire about the willingness to compensate directly from individuals in the society, this technique requires the creation of a situation or condition for the society to be in a state of exchange in order to get something better. (Use Value) and (Non-use value) This is the most widely used method of valuing non-performing value and is also the most controversial method.

There is also a method of Benefit transfer This is a method that can be used for all kinds of valuation because this method does not have to do a survey or collect actual data, but a survey of documents from old research and the value of what has been learned from others to be used to represent the value being studied, which is a method of valuation in case of time and budget.

Assessing the willingness to pay to build balloon biogas plants

Specifically, this research will define "farmers' WTP value" as the bid, and the bid could be presented by bid*. Bid * could be presented as:

$$Bid_i^*=X_i\beta+\mu_i$$

Where X is the covariate group that might influence farmers' WTP value. X and ω are disjoined. Independent error μ followed Gaussian distribution and its mean value is zero but variance is ð_(u^*)^2 If Z is equal to one, the conditional expectation of bid decided by vector X is given by:

$$E(bid\backslash Z=1,X_i)=X_i^{I}\ \beta+\rho\eth_e\ \eth_u\ \lambda_i$$

Where ƛ_i represents to inverse Mills ratio obtained in the first stage with logit model to estimate the samples if Z is equal to one. X_i = facto of characteristics of the i^th individual and are independent variables.

The models used to investigate the value of willingness to pay are:

$$\text{"Prob" ("WTP" =1)}=\alpha+\beta\text{"Bid"}$$

Consequently, we are going to find the median WTP of those who are willing to pay

$$Bid_{medain}=-\frac{\alpha}{\beta}\ \text{or}\ WTP_{Medain}=-\frac{\alpha}{\beta}$$

Result and Discussion

Evaluating the Value of Willingness to Pay

Evaluating of the Value of Willingness to Pay under Scenario 1

The study under scenario 1 is a study under a hypothetical situation when there is a project to provide construction assistance that will be supported biogas construction installation to households that raise pigs by facilitating all the construction conveniences, but the pig owner must be responsible for all the costs. The research results found that the number of people who are

willing to pay according to the value presented is slightly lower than the number of those who are not willing, with the proportion of those who are willing to pay equal to 46.57%. And those who are not willing to pay is equal to 53.43%

Table 2: Information on Willingness to Pay Discriminated against Price Offered

Bid Price (Million Kip)	Decision making		Total
	Agree to pay (Yes)	Not agree to pay (No)	
0.75	58	12	70
	(82.86)	(17.14)	
1.50	46	24	70
	(65.71)	(34.29)	
3.00	31	39	70
	(44.29)	(55.71)	
6.00	21	49	70
	(30.00)	(70.00)	
12.00	7	63	70
	(10.00)	(90.00)	
Total	163	187	350
	(46.57)	53.43)	

Source: Obtained from interview respondents 350 sample, 1 April to 20 May,2022

The trend of willingness to pay is decreasing as the price increases. It is in accordance with the basic rule of will to the price (Demand). This aspect shows the challenge of implementation if the project actually happens, especially in the case of construction costs if the value is high, there are many chances of not getting cooperation from the farmers who are raising pig as the respondents.

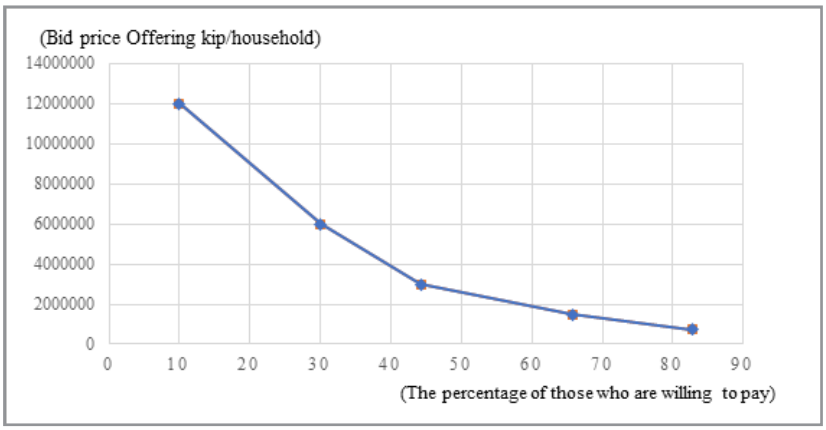

Figure 1: Shows the Proportion of Respondents who are willing to Pay Discrimination based on the Bid Price under the 1st Scenario

The results of the assessment of the willingness to pay of farmers to contribute to the solution of the environmental problems caused by pig farms with biogas production methods under scenario 1 are shown in Table 3 below.

Table 3: Shows the Results of the Analysis of the Value of WTP under the Scenario 1

WTP (1)	Coef.	Z	P>|z|
Bid	-0.000000318***	-7.68	0.000
_cons	1.172336	6.23	0.000
Log likelihood =	-195.40695		
Number of obs =	350		
LR chi2(1) =	92.74		
Prob > chi2 =	0.0000		
Pseudo R2 =	0.1918		

Note: *** 99% statistical confidence level

From the information in the table 5 above, we can calculate the value of the willingness to pay to contribute to the construction of biogas production as follows

$$WTP_{median} = -\frac{1.17236}{0.000000318} = 3{,}686{,}591.19 \text{ Kip/HH or } \$216.86 \text{ USD/ HH}$$

The results of the calculation of the value of willingness to pay show that when the project in the 1st scenario occurs, the farmers who own pigs are happy to contribute to the biogas construction installation activities equal to LAK 3.687 million/household. or about 216.86 USD/household. This number shows the cost sacrifice of pig owners in contributing to the solution of the environmental impact caused by raising pigs in the household. From this value, it can be calculated as capital for the management of waste caused by pig farming by economic methods by multiplying it with the number of families that raise pigs in Champasack province, the number of 1,208 households, so the estimated economic value is equal to LAK 4.45 billion or USD 0.26 million (17,000 LAK = 1 USD)

Evaluating of the Value of Willingness to Pay Under Scenario 2
An analysis of the value of willingness to pay under scenario 2 is an analysis of WTP in the case of a promotion scheme from government or international organizations to participate in providing building and installation materials and technical encouragement. Households that own pigs must contribute to labor (main construction works and balloon biogas plants installation assistant) in order to support various activities in construction of biogas production installations, but in the case that the households that own swine livestock do not have time or if there is no labor assistant in the family related to these installation activities, it is necessary to hire or pay for labor from outside instead.

This case can be interpreted to mean that if there is a project of such a nature, most of the farmers who raise pigs are happy to participate in the project, equating to 71.43%, of which only 28.57 percent do not agree to participate in the project. But when the cost that the farmer must contribute in case of a shortage of labor in the household is presented, it appears that the number of those who are willing to pay the value presented is only 37.14%, which means that the farmers who raise pigs are still worried about contributing to the various activities of the project's implementation. That makes them not dare to make a decision, especially in the case that the price offered is over LAK 0.50 million and they will be willing to pay less.

Table 4: Information on Willingness to Pay According to Price Presented

Bid Price (Million Kip)	Decision making		Total
	Agree to pay (Yes)	Not agree to pay (No)	
0.25	48	22	70
	(68.57)	(31.43)	
0.50	36	34	70
	(51.43)	(348.57)	
1.00	30	40	70
	(42.86)	(57.14)	
2.00	13	57	70
	(18.57)	(81.43)	
4.00	3	67	70
	(4.29)	(95.71)	
Total	130	220	350
	(37.14)	(62.86)	

Source: Obtained from interview respondents 350, 1 April to 20 May,2022

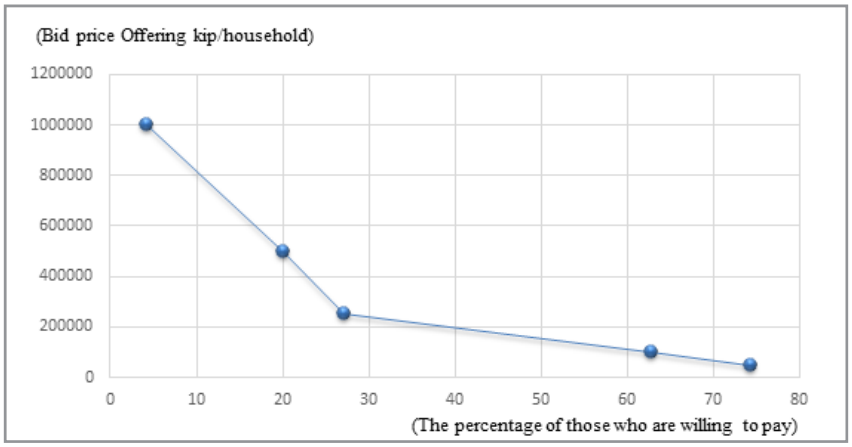

Figure 2: Illustrates the Proportion of Respondents who are willing to Pay Discrimination Based on the Bid Price under the Scenario 2

In the beginning, the bid price offering was LAK 0.25 million / household. The respondent's willingness to agree to pay equals 68.57 percent of all respondents. When the bid price offering shifted to LAK 0.50 million/household, the respondents' willingness to agree to pay equal to 51.43%. When the bid price offering increased to 4 million kip/household, the respondent's willingness to agree to pay equal to 4.29 percent of all respondents.

Table 5: Illustrates Results of the Analysis of the Value of WTP Under the Scenario 2

WTP (2)	Coef.	Z	P>|z|
Bid	-0.00000107***	-7.00	0.000
_cons	0.7890	4.13	0.000
Log likelihood =	-186.98545		
Number of obs =	350		
LR chi2(1) =	87.83		
Prob > chi2 =	0.0000		
Pseudo R2 =	0.1902		

Note: *** 99% statistical confidence level

Table 5 above indicates the calculation of the value of farmers' willingness to pay to contribute to the production of biogas production construction in the case of the project implementation in the 2nd situation by finding the median value as follows:

$$WTP_{median} = -\frac{0.7890}{0.00000107} = 737{,}383.18 \text{ kip/HH or } \$43.18 \text{ USD /HH}$$

The estimation results from data analysis represented the willingness to pay in the scenario 2. It indicates the value of the willingness to pay that farmers who have swine livestock will be appreciated to contribute will be equal to LAK 0.74 million/household or about 43.18 USD/household, which can find out the total value all the farmers who raise pigs in Champasak province will contribute to solving the problem by multiplying by the number of families who raise pigs in the amount of 1,208 households. The expected economic value is equal to LAK 890.76 million or about USD 52,397.58 (17,000 LAK = 1 USD)

Evaluating of the Value of Willingness to Pay Under Scenario 3

An analysis of the valuation of willingness to pay under scenario 3 is an analysis of WTP in the case of a promotion scheme from the government or international organizations to participate in providing building and installation materials and technical encouragement. The whole budget will be supported by the international organization, but households that have swine livestock are required to pay the money back monthly in order to contribute to the project implementation.

When the loan amount was offered at LAK0.05million/month, 74.29 percent agreed to participate; when the amount was changed to a LAK 0.25 million/month loan, 27.14 percent agreed to pay; when the lump sum was increased to a LAK 0.50 million/month loan, only 20.00 percent agreed to pay; and when the amount was increased to a LAK 1 million /month loan, only 4.29 percent agreed to pay for participating in project implementation. The figures above show that if we ask for a higher proportion of value-participating swine livestock households, they will decrease their contribution

Table 6: Information on Willingness to Pay According to Price Presented

Bid Price (Million Kip)	Decision making		Total
	Agree to pay (Yes)	Not agree to pay (No)	
0.05	52	18	70
	(74.29)	(25.71)	
0.10	44	26	70
	(62.86)	(37.14)	
0.25	19	51	70
	(27.14)	(72.86)	
0.50	14	56	70
	(20.00)	(80.00)	
1.00	3	67	70
	(4.29)	(95.71)	
Total	132	218	350
	(37.71)	(62.29)	

Source: Obtained from interview respondents 350 sample, 1 April to 20 May,2022

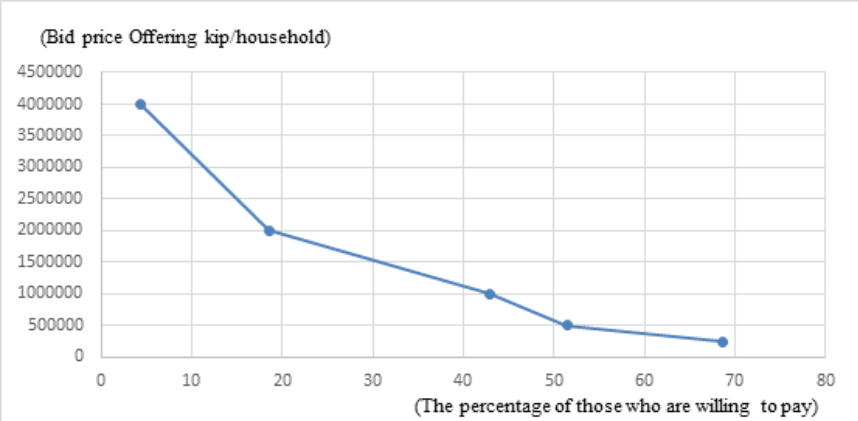

Figure 3: Illustrates the Proportion of Respondents who are willing to Pay Discrimination Based on the Bid Price under the Scenario 3th

The estimation result under the scenario 3rd is the concept of biogas production construction for households who have swine livestock through the international organization's budget support but the household is required to pay an amount of money back to the scheme in order to avoid households who are not ready to contribute immediately. The data analysis results found that if the project was implemented, the respondents almost agreed to participate, 68.57 percent. When the amount of money increased, the respondents' willingness to pay only 37.71%. But in the case that the amount of money to be paid back is as low as LAK 0.05 million/month, there are those who are willing to pay an amount equal to 74.29%.

Table 7: Illustrates Results of the Analysis of the Value of WTP Under the Scenario 3

WTP (3)	Coef.	Z	P>|z|
Bid	-0.00000477***	-7.35	0.000
_cons	0.88796	4.67	0.000
Log likelihood =	-180.02173		
Number of obs =	350		
LR chi2(1) =	103.81		
Prob > chi2 =	0.0000		
Pseudo R2 =	0.2238		

Note: *** 99% statistical confidence level

When the price increases to LAK 0.10 million/month, there are those who are willing to pay an amount of 62.81%. The number of those who are willing to pay tends to decrease when the amount presented increases. At the highest cost level, which is LAK 1 million/household/month, the number of those who are willing to pay will decrease to only 4.29%.

Table 8 above indicates the data analysis result calculation of the value of farmers' willingness to pay to contribute to the production of biogas production construction in the case of the project implementation in the 3rd situation by finding the Median value as follows:

$$WTP_{median} = -\frac{0.88796}{0.00000447} = 198{,}648.77 \text{ kip/HH or } \$11.69 \text{ USD/HH}$$

This figure of willingness to pays under scenario 3 in case of a promotion scheme from the government or international organizations to participate in providing building and installation materials and technical encouragement for 11.69 USD/household represents the feasibility of the biogas production construction implementation if the project is a long-term project with a project duration of more than 5 years or more, but if it is a short-term project with a project duration of less than 5 years, it is less likely because the amount of money that the household that has swine livestock will pay back is very low compared to the cost of actual operation

Conclusions and Recommendation

Conclusion

However, pig farming is very important to the household economy, food security and the stability of the price of pork in the market. The implementation of the construction project that aims to produce biogas is another option that should be considered to help farmers who raise pigs to capture the CO2 with the environmental impact that has occurred, but this operation must be carried out together with other measures so as not to affect the farmers too much because the construction of biogas construction installation has significant high cost evident based on implement the biogas project. According to the actual data about the biogas construction cost is between 6-15 million kip/digestor. This depends on the size of the biogas digestor and the number of pigs in the farm. Furthermore, the results of the study on the willingness to pay of pig owners who are willing to contribute to the creation of biogas digestor installation in the event that they have to bear all the costs are worth it with LAK 3.687million/household or about USD 216.86/household. Household which it reflects that if a project of this nature takes place it is very

unlikely that the farmers will cooperate, but the identify under the 2nd scenario reflects that if the farmers receive assistance in materials, equipment, tools and technicians, but the farmers will have to contribute labor, it is more likely because the value of willingness to pay in this case is equal to LAK 0.737 million/household or about USD 43.18 /household, which is considered to be a figure close to the reality of implementation. Situation 3th the case where a project is involved in the construction of biogas production by spending all the construction installation costs in advance, the owner will pay the installments later within the specified time, the willingness to pay is equal to LAK 0.199 million/household or USD 11.69/household. It is another option that has the possibility of implementation because the life of biogas is between 3-5 years. Therefore, if it is collected during this period, the donor will be able to collect the funds back, but it is a very challenging option because this option will make the farmers bear the burden for many years

Recommendation

In order to make the concept of biogas digestor generation on pig farms possible, there must be many incentives, such as:

1. There will be a certain amount of funds to support various costs in the creation of biogas digestor construction and installation system, which may include all support or provide material, equipment, and technical assistance, or pig owners may be responsible for core and assistant participatory
2. Give an opportunity for investors to invest in the creation of a biogas digestor construction and installation system and then collect service fees, moreover there must be monitored
3. Provide sources of low-interest or no-interest loans to pig farmers so that they can use them to create biogas digestor model and improve environmental management systems on farms
4. Disseminate information about the environmental impact, the urgent need to build a biogas plant, as well as provide technical training in the construction of a biogas plant

A survey of the pig farmers needs found that what the pig owners want most from external parties to come and help is to come up and help with funding by providing grants and no interest loans, followed by vaccines to prevent, maintain, and treat diseases that occur in pigs feeding process, equipment necessary for raising pigs, and training in various technical techniques for raising pigs in sustainability.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper

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