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FACTORS AFFECTING SWINE FARMER'S DECISION ON SELECTING WASTE TREATMENT SYSTEMS

ปัจจัยที่มีผลต่อการตัดสินใจเลือกใช้ระบบบำบัดของเสียของผู้ประกอบการฟาร์มสุกร

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Abstract

The objective of the study were to obtain 1) socioeconomic background of the swine farmers and their current waste treatment system used on farm; 2) the suitable and technically possible waste treatment system for the study site; and 3) factors affecting farmers' decision on selecting waste treatment system. The sample were drawn from 78 swine farmers in Sam Khwai Phueak sub-district, Mueang district, Nakhon Pathom province. The analytical tools of the study comprised descriptive statistics and a multinomial logit model for analyzing the factors affecting farmers' decision on selecting waste treatment system.

The suitable and technically possible waste treatment systems, that the farmers were willing to try on, were stabilization pond, cover lagoon, and anaerobic filter, respectively. As such, the key factors affecting farmers' decision in selecting the waste treatment systems were technical and financial supports from the related agencies, information dissemination frequency, and non-farm income, respectively.

To promote the farmers in installing the technically appropriate waste treatment system on their farm, the related agencies such as Department of Livestock Development, Department of Agricultural Extension, Pollution Control Department, and local administrative

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organizations should focus on the following issues: 1) continuously and constantly clarify and provide apparent information on efficiency of different waste treatment systems to the farmers; 2) financial support should be provided partially associated with the farmers' own investment on waste treatment installation; and 3) promote opportunities in searching ways of increasing farmers' non-farm income.

Keywords: anaerobic filter, fixed dome, cover lagoon, stabilization pond

บทคัดย่อ

วัตถุประสงค์ในการวิจัย คือ เพื่อศึกษาถึง 1) สภาพเศรษฐกิจและสังคมของผู้ประกอบการฟาร์มสุกรและระบบบำบัดของเสียจากฟาร์มสุกรที่ใช้อยู่ในปัจจุบัน 2) ระบบบำบัดของเสียจากฟาร์มสุกรที่มีความเหมาะสมในพื้นที่และเป็นไปได้ทางเทคนิค 3) ปัจจัยที่มีอิทธิพลต่อการตัดสินใจเลือกใช้ระบบบำบัดของเสียจากฟาร์มสุกร กลุ่มตัวอย่างที่ใช้ในการศึกษา คือ ผู้ประกอบการฟาร์มสุกร ในตำบลสามควายเผือก อำเภอเมือง จังหวัดนครปฐม จำนวน 78 ฟาร์ม เครื่องมือที่ใช้ในการวิเคราะห์ข้อมูล ได้แก่ สถิติเชิงพรรณนาและแบบจำลองมัลติโนเมียลโลจิท เพื่อวิเคราะห์ปัจจัยที่มีอิทธิพลต่อการตัดสินใจเลือกใช้ระบบบำบัดของเสีย

ผลการศึกษาพบว่า ระบบบำบัดของเสียจากฟาร์มสุกรที่มีความเหมาะสมและเป็นไปได้ทางเทคนิคที่ผู้ประกอบการฟาร์มสุกรคิดว่าเหมาะสมในพื้นที่มากที่สุด คือ ระบบบำบัดของเสียแบบบ่อปรับเสถียร ระบบบำบัดก๊าซชีวภาพแบบโดมคงที่ และระบบบำบัดแบบถังกรองไร้อากาศ ตามลำดับโดยปัจจัยสำคัญที่มีอิทธิพลต่อการตัดสินเลือกใช้ระบบบำบัดเหล่านี้ ได้แก่ การได้รับการสนับสนุนจากหน่วยงานที่เกี่ยวข้องในด้านข้อมูลทางเทคนิคและด้านเงินทุน ความถี่ในการได้รับข่าวสาร และรายได้นอกภาคเกษตร ตามลำดับ

ในการส่งเสริมให้ผู้ประกอบการฟาร์มสุกรใช้ระบบบำบัดที่มีความเหมาะสมทางเทคนิคหน่วยงานที่เกี่ยวข้อง อาทิ กรมปศุสัตว์ กรมส่งเสริมการเกษตร กรมควบคุมมลพิษ และองค์การบริหารส่วนท้องถิ่น เป็นต้น ควรเน้นประเด็นการส่งเสริมดังต่อไปนี้ 1) ทำความเข้าใจและให้ข้อมูลที่ชัดเจนกับผู้ประกอบการฟาร์มสุกรในด้านประสิทธิภาพของระบบบำบัดแบบต่างๆ อย่างต่อเนื่องและบ่อยครั้ง 2) ควรสนับสนุนเงินทุนบางส่วนในการก่อสร้างและปรับปรุงระบบบำบัดที่มีประสิทธิภาพร่วมกับการลงทุนของผู้ประกอบการฟาร์มสุกร และ 3) ส่งเสริมให้ผู้ประกอบการมีโอกาสในการเสริมสร้างรายได้นอกภาคเกษตรมากขึ้น

คำสำคัญ: ระบบบำบัดแบบถังกรองไร้อากาศ, ระบบบำบัดก๊าซชีวภาพแบบโดมคงที่, ระบบบำบัดก๊าซชีวภาพแบบพลาสติกคลุมบ่อ, ระบบบำบัดแบบบ่อปรับเสถียร

Introduction

Recently, the number of swine commercially raised have increased constantly. Normally, each swine farm produces wastewater around 10-20 L/ swine/ d. It contains BOD approximately 1,500 – 9,000 mg/L depending on farm size and waste management system[1] Unfortunately, this farm wastewater also carries ammonium nitrate about 320 – 2,300 mg/L. The runoff of farm wastewater can eventually contaminate public water sources leading to eutrophication process[2]. The water contamination leads to severely cause environmental and socioeconomic problems such as odor, disease, and community's welfare loss. According to Department of Livestock

Development and Department of Pollution Control, the appropriate waste treatment system for small and medium swine farms in terms of treatment efficiency comprises 4 types: 1) anaerobic filter which is the most popular waste treatment system due to its low construction costs, low maintenance, and low space required; 2) fixed dome biogas system which is costly to install but occupies less space with long life time; 3) cover lagoon biogas system which is more simple to install than the fixed dome and is associated with lower construction costs and low maintenance. However, it requires larger installation space that is not compatible with high price land; and 4) stabilization pond system which is also a simple treatment system. It is low maintenance while requires massive space since it contains several waste treatment ponds connected together.

Upon the survey in the study area, it is found that almost all of the waste treatment systems in the area are low efficient causing unpleasant odor and large amount of farm wastewater dumped into Sam Khwai Phueak and Chedi Bucha canals, especially in rainy season[4]. These air pollution and wastewater problems, mostly derived from small swine farms, severely cause damages to the community in terms of welfare losses in tangible and intangible economic values.

Hence, this study mainly aims to explore factors affecting swine farmer's decision on selecting waste treatment system in order to come up with baseline data and guideline for setting an appropriate policy implication on swine waste management, especially for small and medium swine farms. The objectives of the study are to retrieve:

1) socioeconomic background of the swine farmers and their current waste treatment system used on farm;

2) the suitable and technically possible waste treatment system for the study site; and

3) factors affecting farmers' decision on selecting waste treatment system.

Materials and methods

This study was conducted in Sam Khwai Phueak sub-district, Muang district, Nakhon Pathom province. Basic statistic analyses such as mean, maximum, minimum, and standard deviation were applied to portrait the socioeconomic information of the swine farmers. In addition, a multinomial logit regression model was used to explore the factors affecting farmer's decision on selecting waste treatment systems. A pre-survey was performed in order to determine the existing waste treatment systems and

alternative waste treatment systems were selected based on academic and technical advices of the experts. Each farmer was asked to reveal his expected selection on waste treatment system according to his farm and socioeconomic background. As such, three waste treatment systems based on the farmers' selection in the study area: anaerobic filter; fixed dome; and stabilization pond. Each type of waste treatment system has both advantages and disadvantages depending upon physical and financial factors. However, these three waste treatment systems are the most possible and available in the study area. This selection was entered into the multinomial logit model as the dependent variable while the all related factors affecting the decision were treated as the independent variables of the model. The multinomial logit model in this study can be structurally exhibited as follows:

$$\Pr_j(i) = \frac{e^{u_{ij}}}{e^{u_{j\,\text{Anaerobic filter}}} + e^{u_{j\,\text{fixed dome}}} + e^{u_{j\,\text{stabilization pond}}}} \quad (1)$$

where $Pr_j(i)$ is the probability of selecting waste treatment i for swine farmer *j*

U_{ij} is the utility of selecting waste treatment i for swine farmer *j*

i is type of waste treatment system

j is swine farmer, *j = 1,…,78*

e is the natural logarithm value = 2.7183

To complete the process of equation (1), the utility function was calibrated according to the factors affecting the swine farmers' decision as shown in the following equation (2):

$$\begin{aligned} U_{ijk} = {} & \beta_{0ijk} + \beta_1 Yr_{ij} + \beta_2 aware_{ij} + \beta_3 vol_{ij} + \beta_4 area_{ij} + \beta_5 treure_{ij} + \beta_6 outin_{ij} + \\ & \beta_7 swinein_{ij} + \beta_8 lia_{ij} + \beta_9 \cos t_{ij} + \beta_{10} sub_{ij} + \beta_{11} adj_{ij} + \beta_{12} bypro_{ij} + \\ & \beta_{13} parti_{ij} + \beta_{14} new_{ij} + \varepsilon_{ij} \end{aligned} \quad (2)$$

where *Yr* is swine age (in year)
aware is Awareness on waste treatment.
vol is The amount of waste from swine
area is Area in the construction of treatment systems.
treure is The benefits expected from treatment.
outin is Non-agricultural income.
swinein is Net income from swine farm.
lia is liability.
cost is Cost of Construction treatment systems.
sub is Received support from various agencies.
adj is Adjust
bypro is expected benefits from treatment.
parti is Frequency of participation in activities.
new is the frequency of the perception of waste from swine.
ε is error
k is the coefficient of each type of waste treatment systems: anaerobic filter; fixed dome; and stabilization pond, respectively
$\beta_0,..,\beta_{14}$ are the coefficients of the independent variables.

Results and Discussion

The results of the study can be divided into 2 parts. Part I shows the general socioeconomic background of the swine farmers in the study area, while Part II is dealing with factors affecting the farmer's decision on selecting waste treatment systems. Both results are described in details as follows:

Part I: General Socioeconomic Background of the Swine Farmers

1. Farmer's Background

The majority of the farm owners are male (60.3%) under the average age of 51 years old with a fundamental level of education. The second occupations available in the area are fish culture and cropping farmers, respectively. On the average, the annual income from operating a swine farm is approximately 2.00 million baht per household. The income derived from the second occupation as the farm and non-farm incomes are around 0.22 and 0.28 million baht per household, respectively. In terms of loans, the major sources of farm loan are drawn from the Bank for Agriculture and Cooperatives (BAAC) and other commercial banks. These loans are mainly used for swine farm operation. Accordingly, most farmers are the members of the BAAC in order to

access to the loan more easily than the other sources of funds. Generally, the frequency of receiving information about the farm standard and technical knowledge of the farmers is rather low. However, among various media, the information from government officers, TV media and training provided by the government agencies are the effective media types that are popular among the farmers in the study area.

2. Swine Farm Operation

More than a half of the swine farms are small farms and the rest are medium farms. There is no large farm in the area. Most farmers have operated their farms for 11-20 yr of experience. The average farm size is approximately 3.62 rai per farm on which the area for sun-drying swine manure and for waste treatment process take up only 0.35 and 1.34 rai per farm, respectively. The farm owner decides solely on the matter of farm management. Almost all the swine farms in the area are operated under the contract farming system with the average production cost of 1.41 million baht/ farm/ yr. As a whole, the fattening swine are the major source of the farm income. In terms of the farm labor, each farm contains three family labors and four hired labors on the average.

3. Swine Waste Management

Approximately 80.80% of the swine farms have fundamental waste management by means of collecting solid manure before spraying water to clean the barn after all. However, 10.20% of the swine farms only spray water both solid and liquid forms of swine waste at the same time. This directly causes severe environmental problems. Only few farms manage the swine manure by sun drying process. As a result, 86.20% of the swine farms have been facing the problems with flies and diseases, 37.20% with odor, and 10.30% with wastewater problems, respectively. More than 95% of the swine farms have experienced in being fined due to the farm waste mismanagement. It is evidently that 83.30% of the swine farms have engaged in accumulating pond waste treatment system, while only 7.70% and 2.60% of the swine farms are associated with anaerobic filter and stabilization pond systems, respectively. The rest go to cover lagoon and other types of stabilization ponds. Moreover, fixed dome biogas system, which provides high waste treatment efficiency, is not found in the area. Remarkably, there are 3.80% of the swine farms have not installed any single farm waste treatment system. According to the interviews, the most effective media that the farmers appreciate most can be seen in forms of radio and television. In addition, environmental awareness of the farmers can mainly be found in terms of wastewater issues.

Part II: Factors Affecting Farmer's Decision on Selecting Waste Treatment System

According to the multinomial logit model, Table 1 shows the results revealing factors affecting farmer's decision on selecting waste treatment system described in terms of marginal effect values. Each value indicates the magnitude of the probability in selecting each type of waste treatment system under various socioeconomic and related factors. Comparing three types of waste treatment systems, according to the constant values, the farmers in the study area tend to choose the stabilization pond over the fixed dome and the anaerobic filter systems, respectively. In terms of decisional factors to select each waste treatment system, the expected benefits from installing waste treatment system (marginal effect = 1.016) and receiving supports and subsidies from related agencies (marginal effect = 0.289) are the most important factors for selecting the anaerobic filter system. For the fixed dome system, receiving supports and subsidies from related agencies (marginal effect = 0.587) and non-farm income (marginal effect = 0.370) are the effective decisional factors, while the cost of installing waste treatment system (marginal effect = 0.787) and frequency in receiving technical information (marginal effect = 0.732) are the most two important decisional factors for choosing the stabilization pond system. As a whole, the significant and important decisional factors affecting the farmer's decision are supports and subsidies from related agencies, expected benefits from installing waste treatment systems, frequency in receiving technical information, and cost of installing waste treatment systems.

In shorts, the analytical results show that most farm owners chose to have stabilization pond system installed on their farms. Therefore, the stabilization pond system was considered as the base case in this study. The decision factors were drawn from construction costs, frequency in receiving information about waste management, non-farm income, fines for farm waste violation, expected benefits from waste treatment system, and government subsidy, respectively.

Table 1 Marginal effect values indicating probability of selecting swine waste treatment systems under related decisional factors

Decisional Factors	Type of Swine Waste Treatment Systems		
	Anaerobic Fixed	Filter Dome	Stabilization Pond
Constant Value	-4.190[a]	1.891[a]	2.302[a]
Non-farm Income	-0.651	0.370[a]	0.2842[a]
Water Quality Adjustment Value	-0.163[a]	-0.127[a]	0.2832[a]
Cost of Installing Waste Treatment System	-0.294[a]	-0.493[a]	0.787
Supports and Subsidies from Related Agencies	0.289[a]	0.587[a]	-0.8752
Expected Benefits from Installing Waste Treatment System	1.016	-0.248[a]	-0.7672[a]
Frequency in Receiving Technical Information	-0.102[a]	-0.630[a]	0.7322[a]

Note: [a] significant level at 5%

The second place that the farm owners selected to install was anaerobic filter system. The factors affecting the decisions respectively came from expected benefits from the treatment system, government subsidy, frequency in receiving technical information, wastewater fines, construction costs, and non-farm income.

Additionally, it is shown that the last place of the treatment system chosen by the farm owners was fixed dome biogas system. The decision factors were government subsidy, non-farm income, wastewater fines, expected benefits, construction costs, and frequency in receiving technical information, respectively.

Conclusion and Recommendation

The objective of the study were to obtain 1) socioeconomic background of the swine farmers and their current waste treatment system used on farm; 2) the suitable and technically possible waste treatment system for the study site; and 3) factors affecting farmers' decision on selecting waste treatment system. The sample were drawn from 78 swine farmers in Sam Khwai Phueak sub-district, Mueang district, Nakhon Pathom province. The analytical tools of the study comprised descriptive statistics and a multinomial logit model for analyzing the factors affecting farmers' decision on selecting waste treatment system.

A multinomial logit model was applied in this study to analyze factors affecting farmer's decision on selecting waste treatment systems. The analysis was based on considering the stabilization pond system as a base case due to its most popular selected system. The results reveal that the leading factors commonly and significantly affect farmer's decision on selecting all the treatment systems are derived from construction costs, expected benefits from treatment systems, and government subsidies, respectively.

To promote the farmers in installing the technically appropriate waste treatment system on their farm, the related agencies such as Department of Livestock Development, Department of Agricultural Extension, Department of Pollution Control, and local administrative organizations, should focus on the following issues: 1) continuously and constantly clarify and provide apparent information on efficiency of different waste treatment systems to the farmers; 2) financial support should be provided partially associated with the farmers' own investment on waste treatment installation; and 3) promote opportunities in searching ways of increasing in farmers' non-farm income.

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