

## Factors Influencing Compliance with the Environmental Regulation : A Case Study of Swine Farms in Thailand

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**Abstract.** Policy makers have recently implemented an environmental regulation to reduce wastewater from swine farm. The purpose of this study was to clarify managerial factors that influence the farmer's compliance behaviour of environmental regulation in the swine farming sector. The data in the study were gathered from 82 farms which were located in Tha Chin River Basin, Nakhon Pathom province, Thailand. The survey was conducted from December 2008 to January 2009; the data were collected, through a questionnaire. Eleven farm's managerial factors; farm-size, farm land area, number of labourers employed in farm, distance from farm to nearest village, distance from farm to nearest river, age of farm owner, educational background of farm owner, farm owner experience in swine farming, membership of a farm's organization, environmental management practices, and the governmental subsidy were considered to examine the influencing factors on compliance behaviour. Simple regression has been used to explore the relationship between farm's managerial characteristics and compliance behaviour and Logistic regression model has been used to identify factors influencing compliance behaviour with the environmental regulation. The results from the study revealed that number of pig on farm, farm land, labour, age, education, membership of farm's organization and the governmental subsidy had a significant relationship on the compliance behaviour. The compliance behaviour is significantly influenced by a number of pigs on farm, farm land, age of farm owner, and membership of farm's organization.

**Keywords:** Environmental regulation, Effluent standard, Compliance behaviour, Swine farm, Farm characteristics

### 1. Introduction

Swine farming is the major cause of water pollution in middle region of Tha Chin River, distributed 53% of BOD loading in water pollution in middle region of Tha Chin River. In order to control water pollution from swine farming, the National Enhancement of Environmental Quality Act was passed as the act of effluent standard for swine wastewater, effective since February 2002. The standard on wastewater contains the maximum permissible limits for five parameters; pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Suspended solids (SS) and Total Kjeldahl Nitrogen (TKN).

Under the Act, the Pollution Control Department (PCD) is responsible for inspecting swine farm's wastewater effluent for compliance with the effluent standard. The act states that the effluent from small-medium and large-size swine farms must contain not exceed 100 mg/L of BOD, 400 mg/L of COD, 200 mg/L of SS and 200 mg/L of TKN. If a farm's wastewater effluent exceeds the standard, the PCD will send a compliance notice to recommend the farm improves their wastewater management practices. If, a farm continues to fail to comply with the standard, the farm will have to pay an environmental fee of 13.16 US\$ per day. Hence, to ensure the wastewater effluent meets the standard, swine farms can either construct

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wastewater treatment facilities or improve environmental management practices. The effluent standard is an environmental regulation that restriction on swine farming to discharge wastewater.

Implementation of the environmental regulation is essential to control wastewater discharge from swine farm, this regulation is compulsory, and not all farms have compliance with. Presently, there has been insufficient research paper on the compliance behaviour of swine farmers regarding environmental regulation in Thailand. Particularly in the area of farm’s managerial characteristics influencing compliance behaviour. Therefore, the purposes of this research are; to compare the managerial characteristics of the complaint and non-compliant farm, and to identify influencing factors on compliance behaviour with the environmental regulation. The results of this research will provide the significant information for policy-makers to adjust the current enforcement strategy in order to ensure the effective enforcement in the future.

## 2. Research methodology

### 2.1. Sampling technique

In this research, an in-depth survey has been conducted focusing on swine farming was located in Tha Chin River Basin, Nakhon Pathom province. Eighty-two farms were randomly selected for the survey from a list of 469 farms was located close to the river. The survey was conducted from December 2008 to January 2009. In the survey, the data were collected, through a questionnaire.

### 2.2. Model Specification

The literature on farmer’s compliance behaviour toward a compulsory environmental management program found that farmer’s compliance behaviour is determined by characteristics of farm, farmer and environmental management (E.W. Welch, and F.J. Marc-Aurele). In this study, eleven farm’s managerial characteristics were tested to examine the influencing factors on compliance behaviour. These variables are includes; farm-size measured by the number of pigs on the farm, farm land area, number of labourers employed in farm, distance from farm to nearest village, distance from farm to nearest river, age of farm owner, educational background of farm owner, farm owner experience in swine farming, membership of a farm’s organization, monitored waste effluent, and the governmental subsidy.

Analysis of influencing factors on compliance behaviour was conducted by two steps. The first step, simple regression has been used to explore the relationship between farm’s managerial characteristics and compliance behaviour, with a P-value of 0.05 being considered significant. The managerial characteristics that had a significant relationship with compliance behaviour will be included in the model in the second step. The second step, applied Logistic Regression Model to identify influencing factors on compliance behaviour with the environmental regulation.

To identify the influencing factors on compliance behavior with the environmental regulation, this study use Logistic regression model. Logistic regression model is a form of regression, which is used when the dependent variable is a binary response variable that has only two possible values. The logistic regression equation is as follows;

$$f(Z) = 1/(1 + e^{-Z}) \dots\dots\dots(1)$$

The empirical model of the effect of a set of explanatory variables on the compliance of environmental regulation is specified using the following linear relationship:

$$Z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots\dots + \beta_k X_k \dots\dots\dots(2)$$

Where:

Z represents the probability of farmer’s compliance behaviour with the environmental regulation. The value of Z signs is 1 if farmer is complying with the environmental regulation and 0 if otherwise. Compliant farms were defined as farmers who treated wastewater by treatment facilities or cleaning technology, otherwise they were non-compliant farms

$X_1, \dots, X_k$  are farm’s managerial characteristics.

$X_1$  = farm-size (number of pig in farm)

$X_2$  =farm land area (hectare: ha)

$X_3$  =number of labourers employed in farm (man-day/farm)

$X_4$  =distance from farm to nearest village (kilometre: km)

$X_5$  =distance from farm to nearest river (kilometre :km)

$X_6$  =age of farm owner (year)

$X_7$  =educational background of farm owner (schooling year)

$X_8$  =farm owner experience in swine farming (year)

$X_9$  =membership of a farm's organization (dummy: 1 if farmer were membership of farm's organization, and 0 if otherwise)

$X_{10}$  =monitored waste effluent (dummy: 1 if farms were monitored waste effluent, and 0 if otherwise)

$X_{11}$  =governmental subsidy (dummy: 1 if farmer were membership of farm's organization, and 0 if otherwise)

The coefficients of the regression model (Model 2) were estimated by applying the maximum likelihood estimation of factors influencing compliance on environmental regulation using the Statistical Package for the Social Sciences (SPSS).

### 3. Results and discussion

#### 3.1. Farm's compliance behavior toward the environmental regulation

As previously stated, in order to comply with the environmental regulation farms had to invest in wastewater treatment facilities or improve their environmental management practices. If farms treated wastewater by treatment facilities or cleaning technology, they were compliant farms, otherwise they were non-compliant farms<sup>1</sup>.

Accordingly, the sampled farms were questioned about how they treat wastewater under the regime of environmental regulation enforcement. Therefore, the survey result shows that there are 39 compliant farms and 43 non-compliant farms. In term of compliant farms, 25 farms constructed wastewater with treatment pond, four farms used biogas technology for manure management and treated wastewater, and 10 farms introduced cleaning technology to reduce waste contaminants before draining wastewater into the river. In term of non-compliant farms, 20 farms constructed wastewater collective pond between farm and the river, and other 23 farms discharged wastewater directly into the river.

#### 3.2. Managerial characteristics of compliant and non-complaint farms

Table 1 presents the managerial characteristics for compliant and non-compliant farm as related to the compliance behaviour. The last column (P-value) indicates the significant relationship between managerial characteristics and compliance behaviour. The results revealed that seven out of eleven variables had a significant relationship on the compliance behaviour. These variables are includes; number of pig on farm, farm land, labour, age, education, membership of farm's organization and the governmental subsidy.

Number of pig on farm which represents farm size had a strongest significant (p-value=0.0000) relationship with the compliance behaviour. The average number of pigs is found greater in compliant farm than in non-complaint farm. This meant that the larger farms are more likely to comply with the environmental regulation than the smaller farms. The educational background of farm owner, age of farm owner and the labour were higher significant (p-value=0.0001, 0.0002 and 0.0007) relationship with the compliance behaviour. The farms which were managed by younger and educated owners are more likely to comply with the environmental regulation. The larger farm land also tended to be complied with the environmental regulation.

Moreover, membership of farm organization had a significant relationship with compliance behaviour since the memberships of farm's organization are pressured to comply with the environmental regulation. And farm receiving subsidy were significant (p-value=0.01, 0.03) relationship with the compliance behaviour. The result also revealed that, farm receives the subsidy they will be more likely to comply with

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<sup>1</sup> The definition was followed by the Notification of the Pollution Control Department, as of September 12, 2008

the environmental regulation. However, the results show that the location of farm to nearest village and river, farming experience of farm owner and farm were monitored wastewater effluent were not significant ( $p$ -value $<0.05$ ) relationship with the compliance behaviour.

Table 1: Managerial characteristics of complaint and non-complaint farm

Managerial characteristics	Unit	Mean Value			p-value
		All sampled farm (82 farms)	Compliance farm (39 farms)	Non-compliance farm (43 farms)	
Number of pig on farm	pig	988	1,573	457	0.0000 <sup>***</sup>
Farm land	ha	1.61	2.23	1.06	0.0317 <sup>**</sup>
Labor	man-day/farm	5.38	7.26	3.67	0.0007 <sup>***</sup>
Distance to nearest village	km	6.6	6	7.10	0.4154 <sup>ns</sup>
Distance to nearest river	km	1.13	0.84	1.39	0.1150 <sup>ns</sup>
Age	year	50	45	54	0.0002 <sup>***</sup>
Education years	year	8	9.6	6.5	0.0001 <sup>***</sup>
Farming experience	year	18	18	19	0.3613 <sup>ns</sup>
Member of farm organization	farm	18	13	5	0.0175 <sup>**</sup>
Monitoring wastewater effluent	farm	66	33	33	0.3753 <sup>ns</sup>
Governmental subsidy	farm	7	7	0	0.0348 <sup>**</sup>

Source: Computed from 82 farms survey

Note: <sup>\*\*\*</sup>, <sup>\*\*</sup> indicated the significant at the 1% ( $p \leq 0.001$ ) and 5% ( $p \leq 0.05$ ) level, respectively, and ns indicated not significant

### 3.3. Factors influencing compliance behavior with the environmental regulation

This study is also attempted to analyze influencing factors on compliance behaviour by using Logistic Regression Model. Seven managerial characteristics that had a relationship with the compliance behaviour are included in the Logistic Regression Model. The estimation result was shown in Table 2.

The result revealed that number of pig on farm, farm land, age of farm owner, and membership of farm's organization had a significantly influenced compliance of environmental management ( $p$ -value $\leq 0.05$ ). Number of pig on farm, and farm owner were memberships of farm's organization were highly significant at 1% ( $p$ -value=0.007,  $p$ -value=0.009) and having positive impact on the probability of compliance with the environmental regulation. This interpreted that the larger farm as measured by number of pig on farm had an increasing rate to comply with the environmental regulation. The farm owners who were memberships of farm's organization also have an increasing rate to comply with the environmental regulation. This is because participating in farm's organization will be placed pressure on farm to comply with the regulation.

In term of age of farm owner, it has a significant ( $p$ -value=0.017) and having a negative impact on the probability to comply with the environmental regulation. This probably indicates that the older owner had a lower probability to comply with the environmental regulation, while the younger owner tended to be complied by increasing rate with the environmental regulation. In term of farm land, it is poor significant ( $p$ -value=0.170), but had a negative impact on the compliance behaviour with the environmental regulation. The results showed that labour, education, and the subsidy are not significant, meaning that these variables were not influenced compliance of environmental regulation. It is very important to mention that all of farm receiving subsidy complied with the environmental regulation, but the statistically result showed that the government subsidy was not influenced compliance behaviour. It is because in the survey, only 7 out of 39 compliant farms (17.95%) were received subsidy, while 32 out of 39 complaint farms (82.05%) were not received.

Table 2: Logistic regression for factors influencing compliance with the environmental regulation

Independent variables	coefficient (n=82)	p-value
Number of pig on farm	0.0028	0.007 <sup>***</sup>
Farm land	-0.4300	0.170 <sup>*</sup>
Labor	0.0441	0.829 <sup>ns</sup>
Age	-0.1059	0.017 <sup>**</sup>
Education years	0.1268	0.236 <sup>ns</sup>
Member of farm organization	2.2856	0.009 <sup>***</sup>
Governmental subsidy	0.8203	0.586 <sup>ns</sup>
Constant	1.4135	0.546 <sup>ns</sup>
Number of observation	82	
Pseudo R <sup>2</sup>	0.5148	

Source: Computed by the Author

Note: (1) <sup>\*\*\*</sup>, <sup>\*\*</sup>, <sup>\*</sup> denote significant level at 1%, 5% and 10% respectively, and ns denote not significance

(2) Dependent variable indicate 'Compliant farm=1' and 'Non-compliant farm=0'.

#### 4. Conclusion

This research paper analyzed the managerial characteristics of swine farmer to comply with the environmental regulation. Data were gathered from farm survey and there were analyzed by Logistic Regression Model. The empirical results showed that number of pig on farm, farm land, age, education, labour, membership of farm's organization and the subsidy had a significant relationship with the compliance behaviour. Number of pig on farm and membership of farm's organization were strongly influenced compliance of environmental regulation. Age of farm owner and farm land has a poor significant influenced on the compliance behaviour with the environmental regulation. The finding of this research could provide key influencing factors of compliance behaviour for the government to ensure the effective enforcement of environmental regulation in the future.

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