

STATUS OF MANURE GENERATION AND MANAGEMENT PRACTICE IN HOUSEHOLD PIG FARMING IN HA HOA DISTRICT, PHU THO PROVINCE, VIET NAM

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Abstract. To assess the status of manure generation and management practice in household pig farming, the research was implemented in Ha Hoa district, Phu Tho Province. The used research methods were field survey, direct interview with households, experiment establishment to determine daily manure discharged from the different types of pigs (sow, porker, immature pig and piglet). Results showed that the average amount of manure generated per pig was 0.99 kg/day including piglets and 1.3 kg/day excluding piglets. The total amount of pig manure generated in the whole district was 80.7 tons/day. At the scale under 30 pigs, the ratio of pig farming households had waste treatment system to be 16 %, partial treatment system to be 46 % and not treatment system to be 38 %; At the scale larger than 30 pigs, the ratio of pig farming households had waste treatment system to be 76 %, partial waste treatment system to be 21 % and not waste treatment to be 3 %. In the whole survey area, the ratio of pig farming households had with, without and partial manure treatment system to be 46 %, 21 % and 33 %, respectively. The study also suggested suitable solutions for pig waste management especially suitable technical solutions for different scale of pig farms in Ha Hoa district, Phu Tho province.

Keywords: pig, manure, pollution, treatment technology, household.

Classification numbers: 3.3.1, 3.3.2, 3.8.2

1. INTRODUCTION

Viet Nam is a developing country with high ratio of agriculture sector, accounting for over 70 % of total gross domestic product (GDP). Currently, livestock brings new advancements in agriculture, contributes to the restructuring of agriculture from crop to livestock, and significantly improves the economic life of farmers. However, the unplanned development of livestock has increased environmental pollution and affected on public health. Especially, small-scale farming models has caused impacts seriously on soil and water by direct discharge waste and dead. The compositions of pig waste vary greatly which depend on the scale, hygienic methods and farming styles. They included water, in which water accounts for (75-95 %), the others were organic, inorganic substances and pathogens [1]. This directly affected on human

health, reduced immune system, increased diseases and treatment costs, lost productivity and economic efficiency. According to the World Health Organization (WHO), there were more than 50 % of infectious diseases originated from human and animal feces [2]. The livestock wastes were the source of many infectious diseases such as swine flu, blue ear pig disease, foot and mouth disease, diarrhea, etc.

Presently, in Viet Nam, a number of studies have been conducted to assess the environmental pollution status and to propose mitigation from pig farms. In 2009, Phung Duc Tien *et al.* had conducted the survey on the environmental pollution and waste treatment status at cattle, pig and poultry farms in Hung Yen, Nam Dinh, Binh Duong, Dong Nai, Long An and Can Tho [3]. The results showed barn and water use characteristics, solid and liquid waste treatment, air pollution levels, coliform and *E. coli* levels in wastewater. Trinh Quang Tuyen *et al.* [4] had assessed pollutants in wastewater from pig farms of 30 to less than 100 sows in Hanoi, Ha Tay, Thai Binh, Ninh Binh, the results showed that all the output water samples exceeded the allowed environmental standards. The study also assessed the level of air and noise pollution with the distance between pig farms and the household areas. The similar studies were conducted in two pig farms in Van Giang and Khoai Chau districts, Hung Yen province [5, 6]. In 2015, Nguyen Thi Thuy Dung *et al.* [7] had studied and proposed some solutions to protect the environment at 22 pig farms in Gia Lam district, Hanoi. The results indicated that pig farms have applied waste treatment methods such as composting or biogas. However, the waste was not fully treated, a large amount of waste was discharged directly into the environment. Surface and groundwater in around areas were contaminated pig farms [7]. In China, Yi Qian *et al.* [8] had conducted the research on estimation of the pollutants generated and discharged from livestock and poultry sector to facilitate the legislation of manure management. The results showed that household scales generate larger pollutants than large-scale. Regulation control, manure treatment and financial subsidies for the manure treatment and utilization are recommended to achieve the ecological agriculture. In Cambodia, Gunilla Ström *et al.* [9] investigated manure management practices to identify risk behaviours and socio-economic aspects associated with the handling of manure. The study indicated that manure management by urban and peri-urban livestock keepers may pose a public health threat and an environmental hazard. C. Pedizzi *et al.* [10] conducted environmental assessment of alternative treatment schemes for energy and nutrient recovery from livestock manure in Spain. It based on seven technologically feasible treatment scenario for energy (biogas) and nutrient recovery and/or removal. The preferred scenario was identified to be highly dependent on the particular conditions of each site, integrating environmental, social and economic criteria. Besides, there were many researches on estimation of green house gases emission from manure treatment and utilization methods. For example, Vanessa Burg *et al.* [11] assessed the energy and greenhouse gas (GHG) emissions benefits of using manure for biogas, considering its spatial distribution in Switzerland; S. Wei *et al.* [12] calculated the inventories of GHGs and NH₃ emissions for peri-urban livestock production in Beijing; Ngwa M. Ngwabie and Bren N. Chungong [13] measured manure parameters and to subsequently model CH₄ emissions in pig fattening barns with slated and concreted floors in Cameroon.

Although there were many studies on environmental pollution and manure management in pig farms, these studies had mainly focused on large farms without any assessment regarding the status quo, environmental management and waste disposal at household scales. The manure amount generated per day on different groups of pigs was also not conducted. Therefore, this study focuses on assessing the status of manure generation and management practice at pig

farming households and proposes some suitable solutions on environmental management and protection in rural areas.

2. STUDY AREA AND METHODS

2.1. Study area

Ha Hoa is a mountainous district located on the Northwest of Phu Tho province with 33 administrative units (32 communes and one town). The district is bordered by Yen Bai province at the North and Northwest, Yen Lap district at the southwest, Cam Khe district at the South and Doan Hung and Thanh Ba district at the east. Ha Hoa district is an agricultural district, in recent years this district focused on developing the livestock. Pig farms in Ha Hoa have high ratio in the livestock sector. In the period of 2010 - 2015, the total number of pigs in the district were relatively high, with an average growth rate of 3.52 %/year [14]. The total number of pigs in 2015 was 60,709 pigs, of which 11.8 % were sows; 86.15 % were porker; and meat production was 6.368,2 tons/year [15]. The total pigs were estimated to be 72,173 and 85,800 pigs by 2020 and 2025, respectively [16]. Pig farming households were mainly concentrated in Phuong Vien, Am Ha, Gia Dien, Bang Gia, Y Son, Chu Luu and Van Lang communes. The development of pig farms lead to increase waste generation such as feces, urine, litter, leftover food, dead animals, etc. The water, soil and air environment have been polluted and have affected seriously on health of surrounding residential households.

2.2. Methods

2.2.1. Primary data collection method

- Survey on pig raising and habits of pig waste discharge was conducted in 7 communes: Phuong Vien, Am Ha, Gia Dien, Bang Gia, Y Son, Chu Luu, Van Lang. These communes have the highest number of pig farming households at Ha Hoa district, Phu Tho province.

- Respondents were divided into 2 groups: group 1 includes those households with less than 30 pigs, and group 2 includes households with over 30 pigs. There are 25 households chosen to interview in each commune, in which, there are 20 pig farming households, 5 non-pig farming households. The total number of questionnaire forms is 175.

- The contents of the questionnaire mainly focused on pig manure generation, pig waste treatment by scale of farms and locality as well as constraints and awareness of local people in the management of this waste in Ha Hoa district, Phu Tho province. At the same time, the questionnaire also focused on the opinion of nearby households.

- The research also conducted the interview with staffs from the Natural Resources and Environment Division, Veterinary Department of Ha Hoa District to identify the management of local authorities on the discharge of pig waste from households in the study area.

2.2.2. Determination of manure generation in pig farming households

(1) Samples were divided into 4 groups of pigs: Sows (100 to 170 kg), porker (70-100 kg), immature pig (8 - 70 kg) and piglet (5-7 kg)

- Step 1: Clean pigsty and confine separately within 24 hours,

- Step 2: Collect manure three times per the day (12 pm, 6 pm and 6 am) and then

weight. The sampling procedure was repeated 10 times in 10 different pig farming households.

(2) Calculation of pig manure amount generated per day (kg/day)

The pig manure amount generated per day (kg/day) was calculated according to following formular:

$$k = (k_{sow} \times N_{sow}) + k_{porker} \times N_{porker} + (k_{immature\ pig} \times N_{immature\ pig}) + k_{piglet} \times N_{piglet} \quad (1)$$

where: k: manure amount generated per day; k_{sow} : manure amount of sows per day; k_{porker} : manure amount of porker per day; $k_{immature\ pig}$: manure amount of immature pigs per day; k_{piglet} : manure amount of piglets per day; N: number of pigs.

3. RESULTS AND DISCUSSION

3.1. Status of manure generation in pig farming households

3.1.1. The status of pig farming in Ha Hoa district

The survey results showed that total of pigs in 140 interviewed households were 3,814 pigs. On average, each commune had about 545 pigs. Figure 1 showed that the number of sows was relatively small (8 %) because households kept only qualificative sows. The percentage of porkers was the highest, accounting for 51 % of the total pigs surveyed. The rate of immature pigs was second, accounting for 30 % and piglet was 11 %.

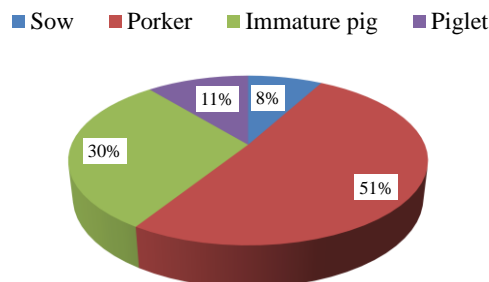


Figure 1. The rate of different pig groups in the study area.

3.1.2. The amount of manure generated from pig farms

The amount of manure generated from pig farms had been identified by the actual weight. The results in Table 1 showed that manure discharged from sows were the largest at 1.6 kg/day. It may depend on the high amount of feed of this group (about 4.6 kg per day). The average amount of waste of piglets was negligible and about 0.06 kg/day due to the amount of feed consumed only 0.3 kg/day. The amount of manure generated from immature and porker was 0.9 and 1.4 kg/day, respectively. It also depends on the amount of feed everyday. According to the survey results and the actual weight, the average amount of waste discharged into the environment of a pig was 0.99 kg (including manure generated by piglets) per average feed consumption of 2.4 kg. Compared with the research on waste generation in large scale pig farms in Hung Yen province, the manure generated factor of pig in Ha Hoa district was less than that in Hung Yen by 0.5 kg/day [5]. This difference was due to the type of feed, breeding, husbandry

practices and scale of pig farms.

Table 1. The coefficient of manure generated from pig farming households per day.

No.	Type of pigs	Manure generation (kg/day)	Feed amount (kg/day)
1	Sow (100 – 170 kg)	1.6	4.6
2	Porker (70 – 100 kg)	1.4	2.7
3	Immature (8 – 70 kg)	0.9	1.9
4	Piglet (5 – 7 kg)	0.06	0.3
Average		0.99	2.4

(Source: Field survey, 2017)

According to the the socio-economic development plan to 2025, the total of pigs in Ha Hoa district will be 85,800 pigs. At that time, the total amount of manure generated was 80.7 ton/day. If there are no any suitable management measures for this waste, it will be discharged directly to environment and causes pollution of soil, water, air and severely affects on the living environment. It also arises epidemic and affects on breeding efficiency. According to the operation manual of biogas reactor [17], from 10 kg of pig manure can produce 400-500 liters of gas daily, it was enough to supply fuel for the family of 04 members, or lighting of 60 W light bulb. If all 80.7 tons of waste of the district is treated by this method, biogas will be generated about $3.2 \times 10^6 - 4 \times 10^6$ liters/day, which is a great source of fuel for daily living of local people.

3.2. Status of manure management practice in pig farming households

3.2.1. Households with less than 30 pigs

The survey results showed, *households with less than 30 pigs* do not have waste treatment systems or only have partial manure treatment. The rate of pig farming households who had partial treatment systems was 46 %; without treatment systems was 38%; households had waste treatment system was 16 % (Figure 2).

■ Without treatment ■ A part treatment ■ With treatment

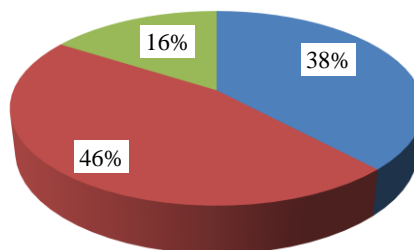


Figure 2. Status of manure management practice in households with less than 30 pigs.

Currently, at farming households without treatment system, the manure was discharged directly into environment by flushing into storage tanks (48 %), discharging into surrounding areas (7 %), into ditches and canals (15 %) and into the field (30 %). The concentration of pollutants from untreated wastewater contains COD is higher 13 times, BOD₅ higher 8 times, TSS higher 2 times, TN higher 1.5 times, and T-Coliform 22 times higher than QCVN 62-MT:2016 – BTNMT [18].

The interviewed households don't treat generated waste because their houses have wide area, pig farms close to storage tank, and they don't have enough budget for install a treatment system. Although all interviewed households said that the treatment of pig waste was very important, they did not pay much attention to the handling issue and didn't care about rural environmental landscapes.

For the pig farming households applied partial treatment system, they were aware of the need to treat manure before discharging. However, due to budget limitation, they use biogas bags to treat a part of manure (69 %) and utilize manure as feed for fish (31 %). These were the two most common forms of waste treatment in Ha Hoa district. Interviewed households said that biogas bags were inexpensive and odorless. Additionally, this technique was simple, easy to install and fix without skill requirement. Biogas bags can float on the water, very suitable to apply in rural areas in flooding season. However, treatment efficiency of this method is still lower than QCVN 62-MT:2016/BTNMT - *National Technical Regulation on the effluent of livestock*. For those households who have treated manure, the technology used was biogas tank. This method was applied mainly in medium pig farming scale (from 20-30 pigs). These households have known serious consequences of untreated pig farming waste for the environment. They also added that, beside treating manure, biogas tank also creates biogas which can be used for cooking and other domestic purposes. However, at a scale of less than 30 heads, the number of households investing in the construction of biogas tank for waste treatment was low (16 %). According to the research of Nguyen Thi Hong and Nguyen Khac Lieu [18], the average of BOD₅ and COD in outlet of bogas tank at pig farming households was 307±90 mg/l and 463 ± 127 mg/l, respectively. They are higher than that of QCVN 62-MT:2016/BTNMT (class B – BOD₅ = 100 mg/l and COD = 300 mg/l). It means that treated wastewater discharged from pig farming don't meet QCVN 62-MT:2016/BTNMT (class B), it contributes importantly to the local pollution.

3.2.2. Households with over 30 pigs

For households with over 30 pigs, 3 % of households don't have waste treatment. The main reason is lackage of budget. 21 % of households have partial treatment and 76 % of them have treatment system by biogas tank (Figure 3).

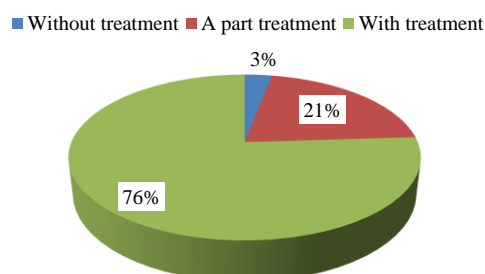


Figure 3. Status of manure management practice in households with over 30 pigs.

The ratio of waste treated in households with over 30 pigs was high due to high volume of manure generated everyday. The survey showed that these households have higher economic condition and they know serious impacts on the environment and human health from untreated pig manure. In addition, they will be complained by around people and fined by local government if they discharge directly manure to the environment. Compared to households with less than 30 pigs, the ratio of households without waste treatment decreased by 13 times, with partial waste treatment decreased by 2 times and with full treatment increased by 4.8 times. This showed that the pig farming households in bigger scale have increased in awareness in waste disposal.

In the whole survey area, the ratio of household pig farming without, with partial and with manure treatment system was 21 % (29/140), 33 % (47/140) and 46 % (46/140), respectively (Figure 4). It have contributed significantly on increase of the concentration of pollutants in surface water as well as soil and air environment in rural areas. In addition, the direct discharge of animal waste also facilitates the spread of pathogenic micro-organisms and impacts on human health.

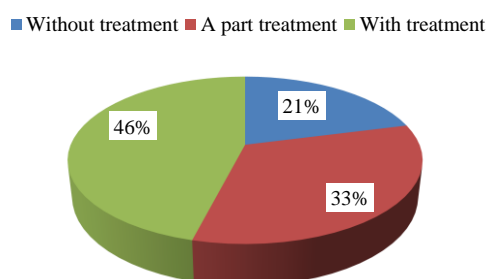


Figure 4. Status of manure management practice in Ha Hoa district.

3.3. The status of pig waste management of local authorities

3.3.1. Technical and financial support

In order to encourage good management of pig waste, Phu Tho province and Ha Hoa district had implemented many programs to support pig farming households in waste treatment. However, the interview results showed that there was only 7 % of respondents received financial support and 8 % received technical assistance when constructing waste treatment facilities such as biogas tanks and clean water works from the agricultural extension centers of the province. Households who did not receive the support from local authorities were very high proportion (85 %). This proved that the management and support for pig farms in the area were not effective.

3.3.2. Effectiveness of training

Trainings on pig waste treatment in Ha Hoa district were currently being organized by the Veterinary Office and the Department of Agriculture in coordination with other organizations in communes. According to survey results in 7 communes, 38/140 surveyed households (27 %) had been trained in environmental protection, they were mainly households with large scale pig farms (over 30 heads). Averagely, local people were trained about 1.33 times/year. The rate of non-trained households was 73 %, they were small scale farms (less than 30 heads) and did not

pay much attention to trainings on environmental protection and pig waste treatment.

For households attending the training, 66 % appreciated the effect of the trainings which not only help them raise awareness about environmental protection and environmental law, but also introduce to pig farming households new techniques in the management of pig waste. However, 8 % said that the contents of the training were not suitable, unrealistic.

3.3.3. Treatment methods for households without manure treatment systems

According to the interview results of staffs from the district animal quarantine stations, environmental officers, treatment methods for households without manure treatment systems were remedies, commitments (90.7 %), forced households to apply pollution mitigation measures (5.7 %); administrative offense (3.6 %). In general, these measures were not serious and strong enough for other similar cases.

3.4. Awareness of the community on the pig waste management

3.4.1. Households with pig farms

The survey results showed that only 28.6 % of the 140 households to be aware that environmental protection was very important in sustainable livestock development; 60.7 % thought that this is an important task; 10.7 % of households did not care. For the environmental impacts of pig waste, 100 % of households thought that if waste was not treated, it will affect on the environment and human health (97.8 %). It makes increase of disease risk for livestock and poultry (97.1 %) and emits harmful gases (30 %). This demonstrated that people concerned about the environmental impacts of the discharge of pig waste, but to put into practice, local authorities need to continue to expand the training and to propagate to households in the coming time.

3.4.2. Households without pig farms

When asked about opinion when pig waste from a pig farming household were spilled out and affected the environment, 18/35 (51.4 %) of respondents will remind households to take measures, 22.9 % inform to the local authorities, 20 % give reminder to the households during the community meeting. Of those, 2/35 (5.7 %) of the households did not respond because they were not affected on their benefits.

3.4.3. Comments from environmental staffs on the pig waste management and treatment

According to staffs of the Department of Natural Resources and Environment, Ha Hoa Veterinary Station, most households were aware of the importance of pig waste treatment. However, due to knowledge and budget limitation, the treatment of pig waste had not been effective. Only households with over 30 pigs have invested waste treatment systems, while households with less than 30 pigs were not interested in waste treatment. Ha Hoa is an agricultural district, the economy relies mainly on agriculture, people's lifespan is not high, so it is very difficult to invest much in waste treatment. In general, the management and treatment of pig waste in Ha Hoa district was facing many difficulties. In order to overcome this situation, there should be good coordination between local people and local government, as well as technical and financial support from different stakeholders.

3.5. Proposed solutions for pig waste management in Ha Hoa district

Proposed solutions for pig waste management in Ha Hoa district were compiled from the results of interviews with local people and officials from local environmental management agencies including:

3.5.1. Legal solutions

The proposed legal solutions were to issue clear sanctioning mechanisms, appropriate to each case of violation, especially on household farming; to support credit, encourage farmers to apply pig waste management models such as biogas, develop VACB (Garden - Pond - Pig farm – Biogas) model; and to issue regulations on environmental protection fees at pig farms, which can be calculated on pig head or location of household farms

3.5.2. Technical solutions

The technical solutions were proposed including to use fermentating or composting methods and earthworm breeding to create fish feed at small pig farming scale; to use biogas bags or tanks to utilize wastes and then treated waste is used for fish, biogas is used for domestic purposes at medium pig farming scale; and to develop a model of garden - pond - pig farm (V.A.C) or garden - pond - pig farm - biogas (V.A.C.B) for households with large scale and available land area.

3.5.3. Capacity building solutions

Local people and officials proposed to strengthen propagation and dissemination of state policies on livestock waste management, environmental protection ordinances, consequences and causes of environmental pollution for the entire community by radio, newspapers, loudspeakers, etc. 70, 83 % of the respondents want to integrate technical training with dissemination of government policies related to livestock development, waste management and policies related to environmental protection, while 74.17 % of interviewed households like to strengthen trainings to raise technical knowledge on process of husbandry, prevention of diseases, techniques of animal waste treatment such as techniques to use and operate biogas tanks, composting, solid waste treatment, and techniques to use bio-products to reduce stinky odors in livestock farms. 70 % of interviewed households proposed to disseminate causes of environmental pollution, effects of animal waste on the health, environment and economy of the households and to develop a husbandry technical manual and livestock waste management in order to disseminate information to relevant stakeholders.

4. CONCLUSION

In Ha Hoa district, the weight of manure generated depended on the amount of feed per day. The average manure discharge was 0.99 kg/day (including manure generated by piglets) and 1.3 kg/day (excluding manure generated by piglets). The total of pig manure generated in the whole district of Ha Hoa was 80.7 ton/day. For the households with less than 30 pigs, 46 % have had partial treatment systems, 38 % have not had waste treatment systems, and only 16 %. For the households with over than 30 pigs, 3 % of households have not installed waste treatment, 21 % have had partial treatment and 76 % have had waste treatment systems. In the whole survey area, the ratio of pig farming households have with, without and partial manure

treatment systems was 46 %, 21 %, and 33 % and, respectively. About the current state of pig waste management of local authorities, there was only 7 % of surveyed households said that they received financial support and 8 % received technical assistance in the construction of waste treatment facilities. Households who have not received any support from local authorities were still very high proportion (85 %). The training activities to improve knowledge in pig husbandry and waste treatment were also implemented, however, the frequency was still low and had not brought high efficiency. The local people were also less interested in environmental protection. In addition, the research had suggested some proper solutions for pig waste management, especially suitable technical solutions for different scale of pig farms in Ha Hoa district. Due to the limited time and conditions, the study was conducted only in 7 communes with the highest number of pig households in Ha Hoa district. Therefore, in the coming time, it should be carried out researches on the whole district to propose more effective solutions for pig waste management and treatment.

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