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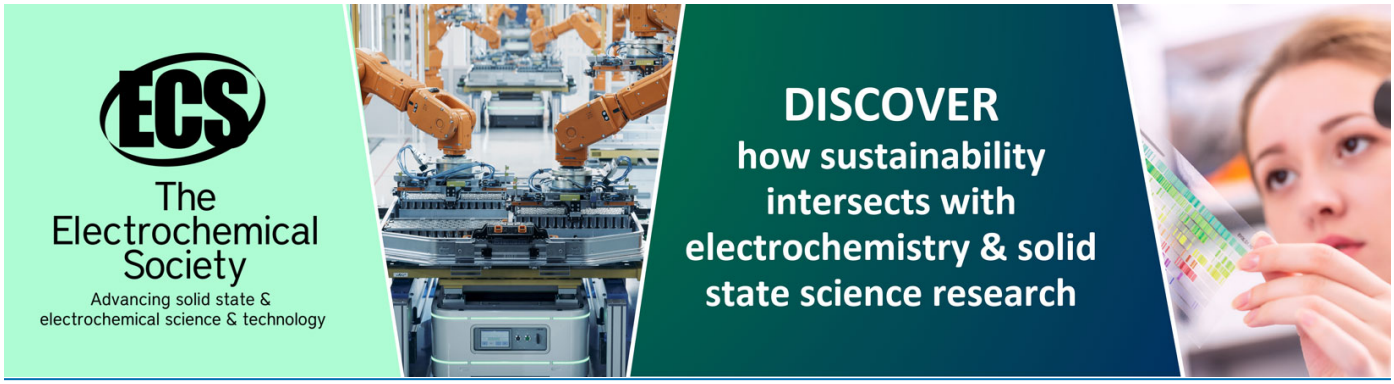

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Impact of Small Holder Dairy Farm on the Air Quality in Gunungpati District, Semarang Municipality

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Abstract

The study aimed to investigate the impact of small holder dairy farm on the air quality in the farm and surrounding area. The study was conducted in three farmer groups in the District of Gunungpati, including the farmer groups in the villages of Nangkasawit, Plalangan and Sumurejo. Samplings of air quality were conducted in four points (locations), i.e., inside the barn, 100 m, 200 m and 300 m from the area of farm. Parameters observed were emission of NH_3 CO_2, H_2S and CH_4. Results showed that the levels of NH_3 in the barn, 100 m, 200 m and 300 m from the farm area in Nangkasawit village were 0.211, 0.107, 0.104 and 0,035 ppm, respectively. The levels of NH_3 in Plalangan village were 0.289, 0.231, 0.13 and 0.108 ppm, respectively, and in Sumurejo village were 0.109, 0.110, 0.082 and 0.046 ppm, respectively. The levels of H_2S in Nangkasawit, Plalangan and Sumurejo villages at the entire points of observations were <0,002 ppm, with the acceptable standard level of H_2S was 0.02 ppm. In four locations of observations, the levels of CH_4 in Nangkasawit village were 809, 603, 599 and 521 ppb, in Plalangan village 999, 720, 645 and 582 ppb and in Sumurejo village 932, 824, 526 and 521 ppb. The levels of CO_2 in Nangkasawit village were 26.55, 28.35, 28.44 and 30.05 ppm, in Plalangan village 24.65, 25.10, 23.44, 21.05 ppm and in Sumurejo village 28.50, 27.35, 30.68, 31.50 ppm, with the standard level of CO_2 should be 30.000 ppm. In conclusion, the air quality was better (lower contamination) with the farther distance of locations from the barn.

1. Introduction

It has commonly been known that livestock sector produce waste that may pollute the environment. Waste derived from livestock activities can be solid waste, wastewater and gas. Ironically, most farmers in Indonesia do not care about the waste generated from their activities. Most of traditional farmers do not manage their waste properly, in that almost all the waste generated from the livestock husbandry is just directly disposed to the nearest river. This may consequently pollute the water especially around the farm area.

The concept of sustainable development requires realization of integration of economic interests, ecological interests and social interests. On the other hand, the principle and development pattern should be able to guarantee the implementation of justice and equity principles, increasing the quality of biodiversity, the application of integrative approach and must have a long-term perspective. The orientation of technological and institutional changes are conducted in such a way to ensure sustainable fulfillment and satisfaction of human needs for present and future generations. Hence, the public farming system with the environmental insights has a sense and purpose in the framework of food security and environmental sustainability (Budinuryanto, 2010).

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Waste as a negative factor in the livestock industry is a fact that cannot be eliminated easily. Apart from profits (in terms of business), livestock sector has a negative impact on the environment and public health. Waste directly disposed to the environment (without any proper treatment) will contaminate air, water and soil causing environmental pollution. Other than causing pollution to water, livestock husbandry also produces CH_4, NH_3 and H_2S that may cause unpleasant odor. Livestock houses, stacking and waste dumps are the source of these unpleasant odors. These above mentioned gases are actually the waste of metabolic process in the body of animals and the breakdown of organic materials by microorganisms in an anaerobic conditions (Widyastuti et al, 2013). Several factors have been identified to affect the rate of odor emission from the livestock activities, including livestock species, environmental conditions and waste management (Sarwanto and Tuswati, 2011). The present study aimed to investigate the impact of small holder dairy farm on the air quality in the farm and surrounding area.

2. Materials and methods

The study was conducted in three farmer groups in the District of Gunungpati, including the farmer groups in the villages of Nangkasawit, Plalangan and Sumurejo. Samplings of air quality were conducted in four points (locations), i.e., inside the barn (ST0), 100 m (ST1), 200 m (ST2) and 300 m (ST3) from the area of farm. Parameters observed were emission of NH_3 CO_2 H_2S and CH_4.

The collections of air for analysis of NH_3, CO_2, H_2S and CH_4 were carried out by air capture in the field with the aid of chemical reagents. The air capture methods for NH_3, SO_2 and CO_2 were based on impinger method (Ruslinda, 2005). The principle of this method is to absorb the contaminated air into the catcher in the impinger. Syringe was used for catching of air samples for CH_4 analysis. Analyses of CH_4, NH_3, H_2S and CO_2 were carried out in the Laboratory of Central Pollution Prevention Technology Industry Semarang.

3. Results and discussion

Based on the Minister of Environment Decree nr. 50 / MenLH / 11/1996 about odor, air quality parameters that need to be monitored in a farm are as follows:

3.1 Ammonia (NH_3)

The results of observation and measurement of NH_3 parameter in Nangkasawit village were 0.211, 0.107, 0.104 and 0.035 ppm, in the village of Plalangan 0.289, 0.231, 0.13 and 0.108 ppm and in Sumurejo village 0.109, 0.110, 0.082 and 0.046 ppm, with a permissible standard of 2 ppm. Based on these data, the ammonia content at the study sites was still below the permissible quality standard, which means uncontaminated condition. The results of air quality analysis around dairy farms in Nangkasawit village are presented in Table 1.

In the Plalangan village, NH_3 levels at each sampling points was the highest, followed by Nangkasawit and Sumurejo villages. The fact that fecal waste was only moved to the edge of the barn made the NH_3 level in Plalangan village higher than other village. In Sumurejo village the waste was sprayed using water flow at the time of washing the livestock before milking. This was in accordance with Sarwanto and Tuswati (2011) suggesting that the levels of NH_3 is lower in the farm with good husbandry and management practices. The description of air quality in three villages based on NH_3 content is presented in Figure 1.

Table 1. The Air Quality in Nangkasawit Village

Nr.	Parameters	unit	Gas levels				Permissible standard
			ST0	ST1	ST2	ST3	
1.	NH_3	ppm	0.211	0.107	0.104	0.035	2
2.	H_2S	ppm	<0.002	<0.002	<0.002	<0.002	0.02
3.	CH_4	ppb	809	603	599	521	
4.	CO_2	µg/m^3	26.55	28.35	28.44	30.05	30,000

ST0: sample collection was conducted inside the barn, ST1: sample collection 100 m from the area of farm, ST2: 200 m, ST3: 300 m

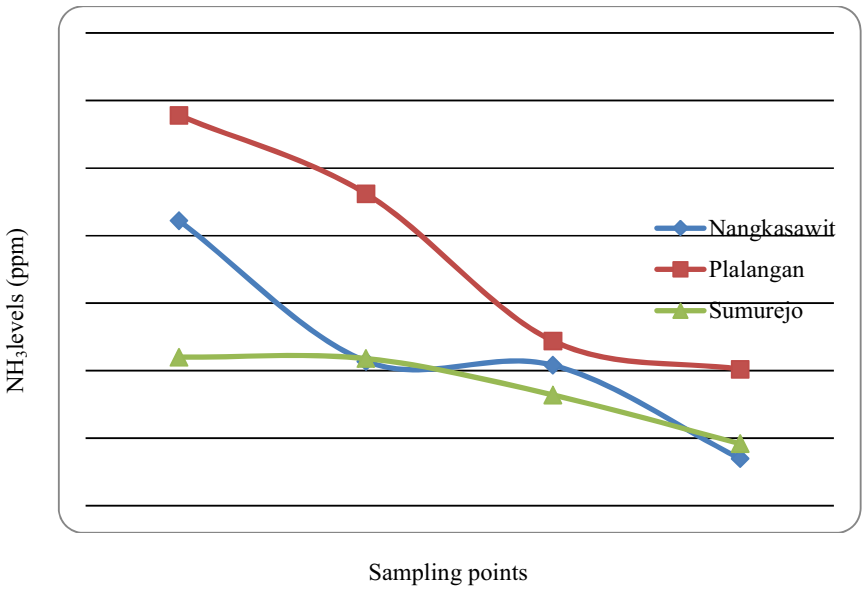

Figure 1. The levels of NH_3 in three villages at different sampling points

Based on our observations and measurements, it could be inferred that NH_3 levels tended to decrease with the farther of sampling point from the barn. This was in accordance with Latief et al. (2011) mentioning that NH_3 concentrations obtained from various places increase following the amount of feces present in the barn.

3.2 Hydrogen sulfide (H_2S)

Results from the observation and measurement of H_2S concentrations in Nangkasawit, Plalangan and Sumurejo villages at all observation points were below 0.002 ppm; with a permissible quality standard of 0.02 ppm. These results indicated that H_2S levels are still below the permissible standard, which means the environment is not polluted. The results of air quality analysis around dairy farms in Plalangan village are presented in Table 2.

Table 2. The air quality in Plalangan village

Nr.	Parameters	unit	Gas levels				Permissible standard
			ST0	**ST1**	ST2	ST3	
1.	NH_3	ppm	0.289	0.231	0.130	0.108	2
2.	H_2S	ppm	<0.002	<0.002	<0.002	<0.002	0.02
3.	CH_4	ppb	999	720	645	582	
4.	CO_2	$\mu g/m^3$	24.65	27.10	28.44	30.05	30,000

ST0: sample collection was conducted inside the barn, ST1: sample collection 100 m from the area of farm, ST2: 200 m, ST3: 300 m

Based on the above results, it can be inferred that the emission of H_2S in the study site has not caused unpleasant odor. Setyawan (1996) suggested that H_2S at the levels of 0.47 ppm in the air is the limit of concentrations that can produce unpleasant smell, while at the concentration of 1.0 ppm dimethyl sulfide begin to generate bad smell.

3.3 Carbon dioxide (CO_2)

The results of observation and measurement of CO_2 content in Nangkasawit village were 26.55, 28.35, 28.44 and 30.05 ppm, in Plalangan village 24.65, 25.10, 23.44, 21.05 ppm and in Sumurejo village 28.50, 29.35, 30.68 and 31.50 ppm for ST0, ST1, ST2 and ST3, respectively. Note that the permissible quality standard of CO_2 is 30,000 ppm. Based on the above data, the level of CO_2 in the research location was therefore still below the permissible quality standard (not polluted). The data of air quality around dairy farms in Sumurejo village are presented in Table 3.

Table 3. The Air Quality in Sumurejo Village

Nr.	Parameters	unit	Gas levels				Permissible standard
			ST0	**ST1**	**ST2**	**ST3**	
1.	NH_3	ppm	0.109	0.110	0.046	0.082	2
2.	H_2S	ppm	<0.002	<0.002	<0.002	<0.002	0.02
3.	CH_4	Ppb	932	824	526	521	
4.	CO_2	$\mu g/m^3$	28.50	29.35	30.68	31.50	30,000

ST0: sample collection was conducted inside the barn, ST1: sample collection 100 m from the area of farm, ST2: 200 m, ST3: 300 m

Our observations showed that Sumurejo village has a higher CO_2 levels compared to Plalangan and Nangkasawit villages. This was most likely because the sample collections in Sumurejo village followed the village road, so that there was a possibility of exposure of CO_2 emissions from the vehicle.

3.4 Methane (CH_4)

Our measurement of CH_4 content in Nangkasawit village in four observation points were 809, 603, 599 and 521 ppb, in Plalangan village 999, 720, 645 and 582 ppb and in Sumurejo village 932, 824, 526 and 521 ppb. Based on these data, the CH_4 content at the study sites was still below the permissible quality standard, which means not polluted.

In ruminant animals (beef, buffalo, sheep and goats), organic compounds in feed materials are fermented by rumen microbes to produce volatile fatty acids, CO_2, hydrogen (H_2) and microbial mass. Through methanogenic process (by methanogenic bacteria), CO_2 is reduced by H_2 to form CH_4, which emits through eructation (about 83%), respiration (about 16%) and anus (about 1%) (Haryanto and Talib, 2009).

Sumurejo village has the lowest methane (CH_4) emission throughout the sampling points, followed by Nangkasawit and Plalangan villages. The low methane emissions in Sumurejo village were closely related to feed management applied to dairy cows. In Sumurejo village, forage given to the cows was elephant grass, while field grass was provided to cows in Nangkasawit and Plalangan villages. Herawati et al. (2012) revealed that the type of feed given affects the methane production by the cows. The better quality of feed given, the lower CH_4 emitted by the cows. The description of air quality in three villages based on CH_4 exposure is presented in Figure 2.

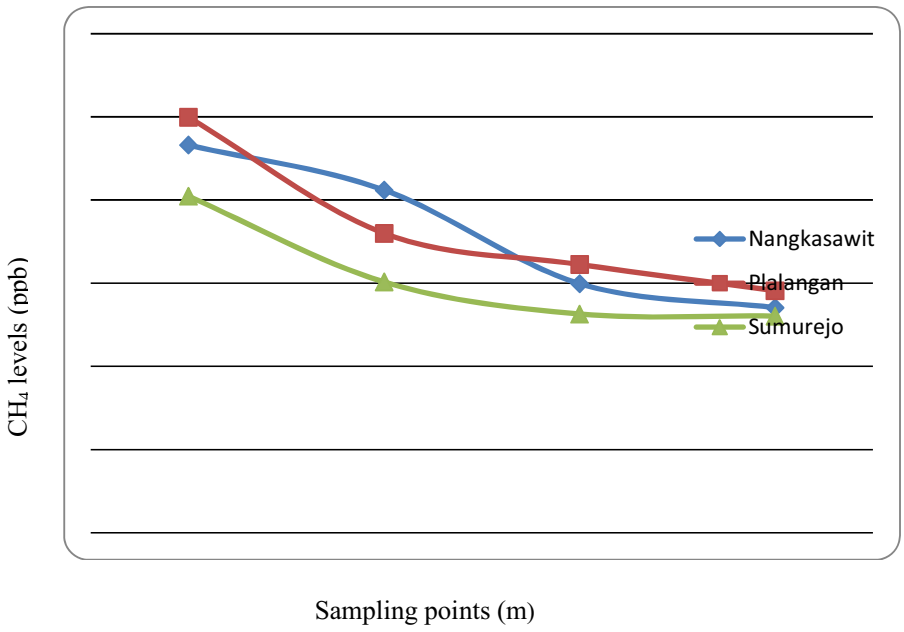

Figure 2. The Levels of CH_4 in Three Villages at Different Sampling Points

In addition to feeding, husbandry and management practice also affects the emitted CH_4. Indeed, husbandry and management practice (waste management) in Sumurejo village was better compared to that in Nangkasawit and Plalangan villages. This was in accordance with Sarwanto and Tuswati (2011) suggesting that the differences in environmental conditions and management practice of farmers in waste management will affect the level of CH4, NH_3 and H_2S.

Based on our observations, it appeared that the highest NH_3 level was found in Plalangan village, followed by Nangkasawit and Sumurejo villages. Similar results were seen for CO_2 and CH_4 emissions. With regard to the distance from the livestock activities, there was a tendency that further distance point of sampling from the location of farm, the levels of contaminants decreased, which

means the air quality was better. This was in accordance with the Decree of the Director General of Livestock Nr. 776 / kpts / DJP / Deptan / 1982, stating that the location of dairy farms must not be located in the city center and the settlement with a distance of at least 250 m from the settlement.

4. Conclusion

Air pollution in three observational villages was still within the permitted quality standard threshold. Of all parameters observed, the lowest pollution was found in Sumurejo village (due to good husbandry and management practice), followed by Nangkasawit and Plalangan villages. Another conclusion was that the air quality was better (lower contamination) with the farther distance of locations from the livestock activities.

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