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Spatial Model of Good Dairy Farming Practices and Sub-Clinical Mastitis Prevalence in West Java

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Abstract

This research was conducted to evaluate the Good Dairy Farming Practices (GDFP), Good Dairy Milking Practices (GMiP) and sub-clinical mastitis Prevalence in West Java.Questionnaires were distributed into 133 of small holder dairy farmers from seven districts (Bogor, Sukabumi, Bandung, Garut, Kuningan, Sumedang and West Bandung). One thousand three hundred twenty six quarter milk samples were collected and tested for mastitis using IPB-1 mastitis test. A spatial distribution of GDFP and sub-clinical mastitis prevalence in West Java were then displayed using Geographical Information System (GIS).Results showed that the average GDFP score in West Java was 3.06 (scale of 0-4) while average score of GMiP was 2.30.

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The IPB-1 mastitis test showed that the average sub-clinical mastitis prevalence in West Java was 67.50%, which ranged from 57.10 to 80.80%. Spatial distribution of sub-clinical mastitis in dairy farms located in West Java showed some areas need more attention regarding sub-clinical mastitis prevention. This research found that the incidence of sub-clinical mastitis prevalence was higher during the 6th of parity. There was a positive relationship between GDFP aplication and milk production, otherwise the stages of lactation did not influenced the sub-clinical mastitis prevalence. It can be concluded that the GDFP closely correlated to milk production, but not to sub-clinical mastitis prevalence.It was also suggested that the dairy farming management system still need to be improved particularly in health and milking process in order to control prevalence of sub-clinical mastitis.

Keywords: dairy cow; sub-clinical mastitis; good dairy farming practices; milking management; spatial distribution.

1. Introduction

Milk yield is a main purpose of dairy industry. Directorate General of Livestock Service (Ditjenak) mentioned that average of milk production in Indonesia was 11.9 liter/day, lower than that of average milk production in other countries (20-30 litre/day). Almost 90% of total milk production in Indonesia was produced by small holder dairy farmer (1 – 9 heads animal/farmer). Many factors influence dairy cow productivity. Management practice, health and disease are factors that affect dairy cow productivity. Sub-clinical mastitis is an intramammary infection that can reduce milk production[1, 2]. The prevalence of sub-clinical mastitis in dairy cows in Indonesia was approximately 75-83% [3], but the reports on the correlation between management practice and prevalence of sub-clinical mastitis in dairy cows in Indonesia were not yet done well. According to[4] and [5]who reported that the cow characteristics (type, parity), rearing management (udder cleanliness, housing systems, calving conditions), seasonal factors (climate), and the interactions of different factors correlated with with the number of somatic cell count as indicator of subclinical mastitis occurrences. In order to get information of good dairy farming practices and sub-clinical mastitis prevalence, the present study was done.This study can be analyzed with the approach of geographic information system (GIS) that will perform the pattern of spatial map. The results of this model can be used to identify environmental factors and management practices that affect milk production and prevalence of sub-clinical mastitis . The basic information obtained is useful for application of dairy farming practices and reduce mastitis sub-clinical prevalence. This is beneficial for making decision process in order to increase dairy cow productivity in Indonesia. The objectives of the present study were to evaluate the implementation of good dairy farming practices (GDFP), good dairy milking practices (GMiP) and sub-clinical mastitis prevalence in West Java and to analyze correlation of application GDFP and GMiP on sub-clinical mastitis prevalence.This results of the present study will be use as baseline information for more appropriate sub-clinical mastitis control and prevention programs based on location, level of incidents and problems of each dairy farm center in West Java.

2. Materials and Methods

2.1. Study site

This study was conducted in seven districts dairy farm in West Java, Bandung, West Bandung, Bogor, Garut, Kuningan, Sumedang and Sukabumi from November 2015 to August 2016.

2.2. Research design

This research was a field study. Data were obtained by observations and interviews. IPB-1 reagents were used to detect sub-clinical mastitis [6].

2.3. Data collection

The interviews were conducted to 133 farmers.Questionnaires were used to get information of good dairy farming practices and good dairy milking practices. A total of 1326 quarters milk samples were collected from 336 cows started from first to sixth parity, at stage of lactation from the third to seventh month kept at small holder dairy farms. Milk production each cattle was measured.

2.4. Observation parameters

A modified questionnaire of [7] and [8]was used to evaluate the implementation of modified good dairy farming practice (GDFP). The data in the questionnaires was divided into two parts, firstly Good Dairy Farming Practices consist of breed and reproduction, feeding, management, housing and equipment, and health and the second one evaluate a good dairy milking practices parameters. Each part was calculated by given scoring(4,3,2,1, and 0). IPB-1 mastitis test was used to detect sub-clinical mastitis according[9]. Milk samples were taken from each quarter. A cow was diagnosed sub-clinical mastitis if at least one quarter was detected positive.

2.5. Data analysis

Data application of GDFP and GMiP obtained from interviews. Dairy farmer performance classification divided into four groups; bad (score 0.00 to 1.00), unfavorable (Score 1.01 to 2.00), sufficient (Score 2.01 to 3.00) and good (score 3.01 to 4.00).

Sub-clinical mastitis prevalence was calculated by the following formula [10].

$$Prevalence = \frac{no.\ animal\ with\ disease\ at\ a\ point\ in\ time}{no.\ animal\ at\ risk\ at\ the\ point\ in\ time} \qquad (1)$$

GDFP application data associated with location and sub-clinical mastitis prevalence were analyzed using *analysis of variance* (ANOVA). The acquired data on input into the spatial distribution maps using ArcGIS 10.1 diploma IPB licensed.

3. Results and discussion

3.1. Application of Good Dairy Farming Practices

GDFP evaluation was conducted in breeding and reproduction, feeding, management, housing and equipment, and animal health aspects. The results of GDFP application at seven districts in West Java were shown in Table 1. Five districts had GDFP rates above 3.01. It means that the GDFP was in good category. Meanwhile, the other two districts had average GDFP of 2.74 and 2.91, respectively. These were classified as sufficient.

Table 1: Good Dairy Farming Practices (GDFP) implementation in West Java

No.	District	GDFP aspects					Average	Performance
		Breed & Reproduction	Feed & Water	Mana-gement	Housing & Equipment	Health		
1	Bogor	3.27	3.81	3.04	2.59	2.60	3.06	Good
2	Sukabumi	3.01	3.27	2.75	2.16	2.51	2.74	Sufficient
3	Bandung	3.42	3.64	3.01	3.28	3.12	3.29	Good
4	Garut	3.25	3.52	2.83	2.65	2.98	3.05	Good
5	Kuningan	3.21	3.56	2.77	2.82	2.18	2.91	Sufficient
6	Sumedang	3.25	3.80	3.17	3.05	2.91	3.23	Good
7	West Bandung	3.32	3.56	3.27	2.88	2.74	3.15	Good
		3.25	3.59	2.98	2.78	2.72	3.06	
	GDFP applied in West Java						**3:06**	**Good**

Districts with good performance were Bogor, Bandung, Garut, Sumedang and West Bandung. The most dominant aspects affecting the performance of GDFP were feeding, breeding and reproduction. Although other aspects were not dominant, but they were also considered sufficient to meet the requirements of technical aspects of dairy cows management. Districts with sufficient performance were Sukabumi and Kuningan. Aspect housing and equipment in Sukabumi did not meet the requirements. In addition, animal health was a criterion that scored low in Kuningan district. But other aspects especially breed and reproduction as well as aspects of feeding were considered match with the standard criteria. Among five aspects, feeding and breed and reproduction had means of 3.59 and 3.25, included in good categories and it was the dominant factor affecting the performance of the application GDFP in West Java. In general, applications of GDFP and GMiP in dairy farms located in West Java were well-managed. From the economic, social and enviromental point of view, GDFP should confirm the safety of the milk and milk products and appropriateness to their determined use, and also the feasibility of the dairy farm enterprise to conduct the practices in the future. Our study showed that in

general the animal health had the lowest score (2.72). This condition was caused by that the farmers rely on paramedic person to detect the animal health, so the farmer had minor roles. Majority of farmers could not recognize the symptoms of dairy cattle's diseases. In addition, it was revealed that vaccination to the cattle was not conducted unless there was free vaccine provided by government. Thus, government vaccination program was an important factor to protect the animal from emerging tropical diseases. In fact, there was sufficient vermin control activity to the females and heifers. Reference [11] mentioned that control of diseases through vaccination program was efficient to minimize the prevalence of diseases in dairy cattle such as sub-clinical mastitis. Smallholder dairy farms with three to four cattle per farmer made the dairy cattle farms in West Java could not categorized as economical scale of dairy farms. Most of the farmers did not only work as dairy farmers but also work in other agricultural sector to obtain secondary income. Therefore, the farmers pay less attention on their dairy cattle. The farmers applied traditional dairy farming practices. These may be the reason for low scores in housing, equipment and animal health.

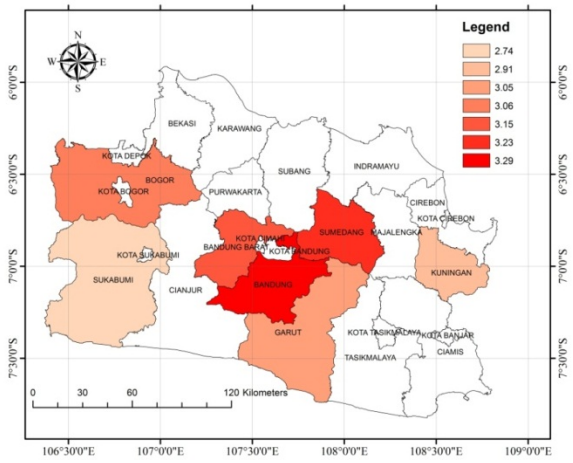

Figure 1: Spatial model of good dairy farming practices in West Java

Applications of GDFP Spatial map that showed the region with the implementation of GDFP sufficient(score 2.01 to 3.00) depicted in light red (2.74), while the region with the implementation of good GDFP(score 3.01 to 4.00)depicted in dark red (Figure 1). The sub-clinical mastitis spatial map overviews the difference of GDFP implementations in each district the application of the technical aspects was good and sufficient. Sukabumi dan Kuningan districts had the lowest GDFP among all sampling areas. The farmers in these two areas did not make any efforts to improve milk quality produced because there was very minor control from the milk cillecting unit, The cooperatives also did not fully visit the farmer, so it contributed to low application of GDFP in the farm. Instead it is a technology sharing institution that facilitates networks and initiates innovations[12].

3.2. Application of Good Milking Dairy Practices (GMiP)

Evaluation of good dairy milking practices (GMiP) in West Java showed that GMiP had a much lower score than the GDFP; thus, West Java classified in sufficient category (Table 2). The results showed that six of seven districts in the observation performing sufficientGMiP application, while the districts, Sukabumi had unfavorable GMiP application performance.

Table 2: Evaluation of *Good Dairy Milking Practices* (GMiP) implementation in West Java

No.	District	GMiP aspects			Average	Performance
		Before milking	Milking	After milking		
1	Bogor	1.25	1.94	3.10	2.10	Sufficient
2	Sukabumi	1.17	2.11	2.56	1.95	Unfavorable
3	Bandung	2.36	2.09	2.94	2.46	Sufficient
4	Garut	1.86	2.15	2.75	2.26	Sufficient
5	Kuningans	2.00	2.18	2.50	2.23	Sufficient
6	Sumedang	1.98	2.51	3.02	2.50	Sufficient
7	West Bandung	2.47	2.27	3.05	2.60	Sufficient
	Average	1.87	2.18	2.85		
	GMiPaplied in West Java				**2.30**	**Sufficient**

GMiP observations were covering the aspects before milking, milking time and after milking. The results of this study indicated that these three aspects of the assessment, almost all areas have a lower score on the aspect of before milking and milking time. Milking management aims to minimize microbial, chemical and physico contamination, to produce good quality milk. The farmer should have more attention at before and after milking. Before milking the farmer bathing the cattle and wipe the mammary gland with warm towel, but they did not use different towel in each cattle. Reference [13] recomended that using individual paper towels for udder preparation and feding cows directly after milking minimize incidence of sub-clinical mastitis. In addition almost all the farmer did not use dry and clean clothe before milking. Reference [8] suggested wear suitable and clean working clothes. As a traditional farmer and milking by whole hand method and striping. Reference [8] Guiding that handle the teats gently, ideally using the 'fist-grip' method, avoiding any discomfort pain or injury to the animal. More than 90% of farmers did not do teat dipping after milking this make the application of milking aspect in West Java low and clasified as sufficient group. Figure 2 shows the spatial map application GMiP in West Java. Light red area represented the lowest application of GMiP in West Java which is Sukabumi.Sukabumi was one of districts that markets milk directly sent to the milk collector. Sukabumi district in contrast to other districts, where there was no milk collection co-operatives as well as six other districts. The dominant factor that contributes in good GMiP was the aspect after milking, and most of farmers carry out the procedure in accordance to good dairy farming practices initiated by [7]. However, farmers in Sukabumi showed a poor GMiP performance indicated with low implementation of the technical aspects before milking, showing that the farmers did not apply GMiP well, such as cleaning the barn before milking, udder hygiene and cleanliness of the milked itself.

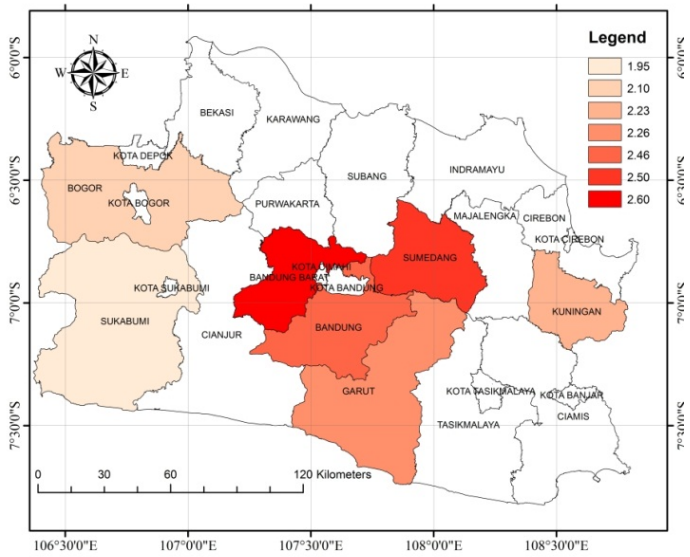

Figure 2: Spatial model of good dairy milking practices in West Java

3.3. Sub-clinical Mastitis Prevalence

Milk samples test from each quarter were tested using reagent IPB-1. The result showed that the prevalence of sub-clinical mastitis in West Java was 67.50%, which means that more than half population of dairy cattle in West Java at least one quarter exposured to sub-clinical mastitis (Table 3). The highest sub-clinical mastitis prevalence was 80.80% found in Kuningan, otherwise the lowest was 57.40% observed in Sumedang.

Table 3: GDFP and GMiP performance, sub-clinical mastitis prevalence and milk yield in West Java

No.	District	Performance		Sub-clinical Mastitis Prevalence (%)	Milk yield (l/head/day)
		GDFP	GMiP		
1	Bogor	3.06	2.10	76.50	14.7 ± 4.4
2	Sukabumi	2.74	1.95	66.70	14.1 ± 6.0
3	Bandung	3.29	2.46	69.20	15.6 ± 4.2
4	Garut	3.05	2.26	58.70	14.3 ± 4.3
5	Kuningan	2.91	2.23	80.80	13.3± 1.6
6	Sumedang	3.23	2.50	57.10	14.9 ± 3.5
7	West Bandung	3.15	2.60	63.40	16.0 ± 4.1
	Average	**3.06**	**2.30**	**67.50**	**14.7± 4.2**

This study showed that the average milk production in West Java was 14.7 7 liters/head/day, the lowest one was

in Kuningan (13.3 liters/head/day) and the highest was in West Bandung (16 liters/head/day). This amount of production can be said ideal for dairy cattle in the tropics, although the region of origin (subtropical region) can reach 30-40 liters/head/day.There was a positive relationship between the application GDFP and milk production (y = 5,106 + 3.26x; r = 0.76).The analysis showed that milk production in West Java was 76% affected by the GDFP dessimination, so it can concluded that every increase of 1 scores GDFP will be followed by the increase of the milk production by 3.26 litres / cow / day. The management aspect such as rearing aspects to the milking process was the most dominant aspect that affected GDFP dessimination (r = 0.85). The spatial map illustrates the prevalence of sub-clinical mastitis in West Java showed in light red area was a region with the lowest incidence of sub-clinical mastitis and dark red area shows the highest prevalence of sub-clinical mastitis (Figure 3). As a geographyc-based data, this spatial map was a basic database to evaluate the implementation of GDFP and GMiP factors relative to prevalence of sub-clinical mastitis in West Java based on cluster of incidence.

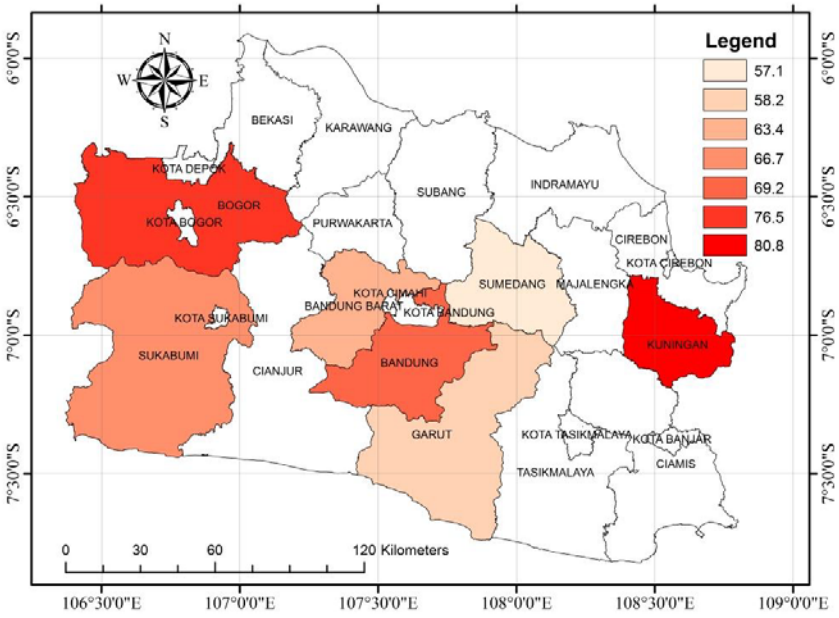

Figure 3: Spatial model of sub-clinical mastitis prevalence in West Java

Differences in the susceptibility levels of dairy cows breed against mastitis was associated with genetic differences and the level of immunity [11]. Friesian Holstein (FH) was the most dominant of dairy cattle breed in West Java (76%), 23% cross breed (FH and other breeds) and the rest were Jersey, and others. Selection of dairy cows has contributed to the prevalence of sub-clinical mastitis. FriesiansHolstein (FH) has a higher risk of developing mastitis than other breeds dairy cows [14, 15]. Sub-clinical mastitis as an inflammation of mammary gland was characterised by reduced milk yield and altered milk composition. The results showed that the highest sub-clinical mastitis prevalence was in Kuningan district, consequently this district had lowest milk yield. Environmental factors play significant role in the incidence and prevalence of sub-clinical mastitis. Probability of sub-clinical mastitis prevalence was almost twofold higher (1.68) in dirty cow housing [16]. Results of GDFP dan GMiP evaluation in Kuningan district showed that less farmers of this district conducted good practices of

GDFP and GMiP. Therefore, milk production was low and it is categorized as sufficient. Control and prevention of sub-clinical mastitis was influenced by various factors. Reference [11] reported that a mastitis control program includes improving udder health management, environmental hygiene control, and separation of primipara cattle to multipara cattle.

3.4. Effect of month of lactation and parity to sub-clinical mastitis prevalence

Sub-clinical mastitis tests was conducted at the third to seventh month of lactation (lactation stage) because somatic cell count was higher at early lactation and at late lactation months. The results of this study indicate that there was no influence of the months of lactation on the prevalence of sub-clinical mastitis (P> 0.05). The tendency of the prevalence of sub-clinical mastitis increased from the first month of lactation to second month of lactation (Table 4). The same results was reported by [17]. The prevalence of high mastitis observed in early lactation (1- 3 months) and declined in mid lactation (4-7 months). In addition, the incidence of sub-clinical mastitis was also influenced by variations in the characteristics of livestock, such as milk production.

Table 4: Relationship between lactation stage and sub-clinical mastitis (SCM) prevalence

Lactation Stage (month)	n (cow)		SCM Prevalence (%)	Milk Yield (l/head/day)
	Total	SCM Detected		
3	74	48	64.7	15.78 ± 4.7
4	65	48	73.9	15.28 ± 3.9
5	63	49	77.8	15.19 ± 4.2
6	70	43	61.4	14.68 ± 4.0
7	59	35	59.3	15.01 ± 3.8

Sub-clinical mastitis prevalence and milk yield in different stage of lactation have been presented in table 4. Overall sub-clinical mastitis was increase from 3rd to 5th stage of lactataion, 64.7%, 73.9 % and 77.8 % respectively, decrease during 6th and 7th 61.4% and 59.3 %. Milk yield varied significantly (P<0.05) during different stage of lactation and have positive correlated with sub-clinical mastitis prevalence. The decline in milk production was due to the peak of lactation achieved in the 3rd month and then milk production will decline gradualy until the end of lactation. Reference [18] reported that there was not efect of stage of lactation on somatic cell count as a sign level of sub-clinical mastitis.

The results of this study showed that in the first lactation the incidence of subclinical mastitis reached 52.9%, which means more than half of cows those in first calving suffered to subclinical mastitis. The highest average milk production was achieved at 3rd lactation (16.27 l/head/day), (table 5). The incidence of sub-clinical mastitis based on lactation period provided information that the incidence of sub-clinical mastitis increases with an increase in lactation period. There was a significant different in susceptibility of sub-clinical mastitis

between primipara and multipara cattle. This is reasonable because the primipara cattle has lower milk production than the multipara does. Reference [2] mentioned that milk production reaches its peak at the 4th lactation. The highest prevalence of sub-clinical mastitis was observed at the 6th lactation. The results was consistent with reports of [17], who reported that animals those calving less than three times, had a chance of sub-clinical mastitis infection of 1.0 times and the cattle that calving more than three times was more susceptible to sub-clinical mastitis by 3.6 times.The manual milking method done by farmers was one of factors triggering the occurrence of injury in udders that lead to sub-clinical mastitis.

Table 5: Relationship between parity and sub-clinical mastitis (SCM) prevalence

Parity	n (cow)		SCM Prevalence (%)	Milk Yield (l/head/day)
	Total	SCM Detected		
1	51	27	52.9	14.04 ± 3.1
2	78	60	76.9	14.95 ± 3.6
3	103	68	66.0	16.27 ± 4.6
4	55	40	72.7	15.67 ± 4.6
5	30	17	56.7	13.96 ± 3.4
6	14	11	78.6	14.20 ± 4.2

Infected cattle mastitis risk level associated with physiological phase of cattle. Heifers at the first calving was more susceptible to mastitis in early lactation than older cattle. A research report on isolation of mastitis-causing pathogens by [11] found that mastitis causing pathogens called *Coagulase-negative staphylococci* (CNS) and *staphylococcus sp.*decrease over the age of cattle. Sub-clinical mastitis was a complex disease that was influenced by many factors, especially the management, the environment and the factors related to livestock such as lactation period and month of lactation [4, 17]. Proliferation of udder gland was affected by thepresence of pathogenic bacteria that leads to a lower milk production.

4. Conclusions and suggestions

4.1. Conclusions

Implementation of the technical aspects of dairy cattle rearing in West Java was associated to the level of milk production, but not on the prevalence of sub-clinical mastitis. Implementation GDFP in West Java included in both categories, while the application of GMiP can be categorized sufficient. Lactation period affects the prevalence of sub-clinical mastitis.

4.2. Suggestion

This research results were fundamental geographic-based data that will be beneficial to support policy making in

improving milk production and its quality, as well as to supress prevalence of sub-clinical mastitis; particularly West Java.

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