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Reproductive Performances of Friesian Holstein Dairy Cows in Different Agricultural Ecosystems

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ABSTRACT

The objective of this study was to study reproductive performance of Friesian Holstein (FH) dairy cows in the three different agro-ecosystems at the operational area of Bayongbong's cooperative, Garut regency, Indonesia. The method used in this study was the survey method. The study was carried out in Lebakjaya village, which has drylands and rainfed agricultural ecosystem (AES DL-Rainfed); Cintanagara village which has drylands and irrigated rice field agricultural ecosystem (AES DL-IRF); and Pamalayan village which has drylands tropical forest (AES DL-Forest). The total samples were 208 dairy farmers and 315 head of FH dairy cows from the three places, 18 dairy farmers and 44 head in Lebakjaya village, 95 dairy farmers and 120 head in Cintanegara village, and 95 dairy farmers with 151 head in Pamalayan village. The study used a simple random sampling and the reproductive performances data were obtained from the field and artificial insemination practices. The data were descriptively analyzed using SPSS 22.0. After that, it was tested using T-Student statistical analyses. The results showed that the reproductive performances in AES DL-Rainfed were S/C 2.23 ± 0.45 times, days open (DO) 148.89 ± 65.52 days, and calving interval (CI) 431.00 ± 65.18 days. The reproductive performances in AES DL-IRF were S/C 2.31 ± 0.54 times, DO 161.95 ± 61.99 days, and CI 444.47 ± 61.21 days, and the reproductive performances in AES DL-Forest were S/C 2.11 ± 0.62 times, DO 138.38 ± 47.18 days, and CI 419.86 ± 46.95 days. The reproductive performances of AES DL-Forest were more efficient ($P<0.05$) than the AES DL-IRF. It was concluded that the reproductive performances in the three study locations, for the characters of reproductive value S/C and DO deviated from the ideal estimation, whereas the CI was around the ideal estimation.

Keyword: Agro-ecosystem, Dairy cows, Reproductive performances

Introduction

Dairy cows are mainly managed for milk producing purposes. Currently, dairy cows are the most dominant farming animals compared to beef cattle in high land areas of West Java, Indonesia. Domestic milk consumption is dominantly supplied by imported milk (about 79.93%), meanwhile local cow's milk only contributes 20.07% (Pusat Data dan Sistem Informasi Pertanian, 2016). The government has tried to increase the population of dairy cow to increase domestic milk production and reduce imported milk. The gestation of female FH dairy cow are regularly imported each year to increase the fresh milk production (Anggraeni, 2012). However, it seems that milk production is still dependent on cow's population but the improvement of dairy cows production should also be enhanced. Cow productivity potency is influenced by genetic factor, environment, and the interaction of them (Karnaen and Arifin, 2009). The environmental factor presumably contributes around 70% to milk production and it basically can be classified into external and internal environments. The external environment is the outer side conditions of the cows like climates, feeding, and rearing management; whereas the internal environment is the biological aspects of the cows such as length of lactation, dry period, days open, and calving intervals (Anggraeni, 2000).

The most influencing environment factor towards dairy cow' productivity is feed. Feed cost is the highest operational expenditure in a dairy farm (Devendra and Sevilla, 2002). The feed cost contribution towards total production cost can even increase significantly when using feed commodities that are not based on local resources. Thus, all aspects about feed supplies and prices in operating dairy farm become really critical (Ginting, 2011).

Agricultural ecosystem typology and production intensity of the plants really determine the amount of biomass, nutrition quality, and feed varieties provided in an area. The horticulture areas in Indonesia are mixed farming systems that are intensive toward dryland plateau agricultural ecosystem (Ginting, 2011). In this mixed system the role of cow especially ruminant (dairy cow) is highly important and is an essential part of production system (Thorne and Tanner, 2002).

Local potential feeds like agricultural by-products (rice straw, corn straw, soy straw), agricultural estate and business have been optimally utilized yet as feed for cow. The study by Umiyasih *et al.* (2006) reported that feeds from those kinds of by-products contain low nutrients; however they have good potential in feed provision fulfilling the needs of feed for ruminant.

Another environmental factor that influences dairy cow productivity is reproductive aspects. A good and normal reproductive handling will be followed by the improved dairy cow productivity. The cow with 12 months calving interval, generally the lactating dairy cow lactates normally for about 305 days and about 60 days for dry period (Warwick and Legates, 1979). The days open was varied whether between individuals or between lactations. In order to raise the conception value and suppress reproductive disturbances, it is recommended that the cows should give time lag at least 60 days after giving birth (Stevenson, 2001). Though, to reach birth interval of 365 days it is urged the cows should be gestation again in the next 80-90 days after giving birth (Anggraeni, 2008). If all environmental factors that influence milk production can be well conditioned, hopefully the milk production will upturn.

The altitude of the dairy cow farm can affect the dairy cow performance. Nowadays, in Garut regency the general dairy cows are breed in dryland plateau agricultural eco-system that are adjoined to tropical forest, drylands around horticultural farm, and lowland rice field agricultural eco-system.

The kinds of hays (animal feeds from green plants) and the supply in dryland plateau agricultural ecosystem are different from the lowland agricultural ecosystem depends on the planting patterns, and grass and leguminous availability in each location (Prawira and Atien, 2010). At the same grass type the quality of the hays in plateau are better than in the lowland because the higher the air temperature the higher the ratio between the trunk and the leaves. The reproductive efficiency can only be reached through a good management and a precise policy taking in the daily activity. An accurate reproductive management system holds essential role in determining a good production level of a dairy cow farm. The reproductive management goal parameter can also be measured from its reproductive characteristic performance achievement levels.

The aim of this study was to describe the reproductive performances of FH dairy cows in three dairy cow farms of different agricultural ecosystems in Garut regency.

Materials and Methods

This study was carried out in three different agricultural ecosystems i.e.Lebakjaya village, with the drylands and rainfed (AES DL-Rainfed); Cintanagara village with the drylands and irrigated rice field (AES DL-IRF) in equal extent as the agricultural ecosystem; Pamalayan village with drylands tropical forest (AES DL-Forest). It was carried out from July, 2014 until December, 2014.

The material used in this study was lactation FH dairy cows that have complete reproductive traits, from the second lactation period to four lactation period. The dairy belong to the farmer of Bayongbong Cooperative Garut regency in the three agro-ecosystem areas, namely: 1. AES DL-Rainfed as many as 44 heads, 2. AES DL-IRFas many as 120 heads and 3. AES DL-Forests as many as 151 heads.

The method used in this study is the survey method. Determination of samples of farmers and livestock is carried out purposively, meaning that only farmers whose livestock have complete reproductive record data. The number of samples taken was randomly simple, while the data of all dairy cow used in the sample were analyzed descriptively. It is carried out in two phases i.e. pre-survey and survey phase. The pre-survey phase coordinates the location and determines the sum of the sample. The survey phase is to get primary data from the study location using direct interview with milk cow farmer. The data collection techniques used in this study is observation, measurement, weighing, recording, and interview. While secondary data is data on environmental conditions of farms in each location. The number of samples taken in this study is presented in Table 1.

The parameters are:1) fodder quantity and quality and 2) reproductive characteristic performance. Fodder quantity measured by weighing concentrates and hays consumed in each lactating dairy cows (kg). Fodder quality tested through proximate analysis. Reproductive characteristic performance studied: calving Interval: calculating the gap between two sequential calving of an adult lactating dairy cow (days), days open: period or interval from calving period the cow to the service (re-mating) and the conception period (days), and service per conception: the sum of services done to reach conception of each individual. After the reproductive data was obtained from the field and Artificial Insemination practices at Milk cooperative, then the results of the data were inputted and processed using SPSS version 22.0 for descriptive analysis and then performed T-test student statistics.

Table 1. Number of dairy cow farmers and livestock in the three study locations

No.	Location	Farmer (household)	Dairy Cow (heads)
1.	AES DL-Rainfed	18	44
2.	AES DL-IRF	95	120
3.	AES DL-Forest	95	151
	Jumlah	208	315

Results and Discussion

General conditions of the study locations

The study was located in Lebakjaya village, Karangpawitan district (AES DL-Rainfed) an altitude of 500-700 mdl and the intensity of rain that is equal to 1.477 mm/year. The range of ambient temperature between 20.95-28.85^{0}C and humidity between 59.76-94.26% (measurement results). Another location was Cintanagara village, Cigedug district (AES DL-IRF) that located at an altitude of 1,000-1,300 mdl with rainfall intensity that is equal to 2,706 mm/year. The range of ambient temperature of the area is between 18.65-26.90^{0}C and humidity is between 71.26-88.26% (measurement results). The third location was Pamalayan village, Bayongbong district (AES DL-Forest **).** The environmental conditions are at an altitude of 1,500-1,700 mdl with rainfall intensity that is equal to 2,776 mm/year. The range of ambient temperature is between 18.75-23.55^{0}C and humidity between 78.26-88.26%.

Conditions of dairy cow population, milk production, and cowmen population

Dairy cow population, milk production, and cowmen population data of the three study location was presented in Table 2, obtain from population data belongs to Mandiri cooperative and cow cowman group Lebak Jaya.

Based on Table 2, the dairy cow population in three locations had no good management. In order to the ratio of productive dairy cow compared to non-productive in each study locations. Whereas the comparison of lactating dairy cows to dry period AES DL-IRF and AES DL-Forest showed that it was not an ideal ratio. The ideal one in AES DL-Rainfed. The optimum balance of productive cattle to non-productive according to Makin *et al*. (1991) was 70% productive dairy cow and 30% non-productive. Whereas, the ideal ratio of lactating dairy cows to dried period are at least 85% lactating dairy cows and 15% dried period (Dasuki, 1983).

The average daily milk production capacities of each cows or lactating cows are 10.6; 10.1; 11.4 liter in each of the three locations. Low milk production of Holstein Friesian can be achieved by paying attention to management factors, especially improving the level of nutrition (Worku, *et al*., 2016). Continually, from the cow ownership in AES DL-Rainfed, AES DL-IRF, and AES DL-Forest, was 5; 2.6; and 2.3 productive cows.

The feeding management operated in the three agricultural ecosystems by the cowmen has been properly carried out congruous to the recommended criteria. Generally, the cowmen were aware of the feed needs based on the weight of the cow and the milk production levels. The given hays generally consist of king grass, native grass, corn leaves, sweet potato leaves, rice hay and legume. The average sum of the hays and concentrates given and consumed by each lactating dairy cow per head per-day of each agro-ecosystem at each study locations is presented in Table 3.

Table 2. Dairy cow population, milk production, and cowmen population in Lebakjaya village, Cintanagara village and Pamalayan village

No.	Description	Study Location		
		AES DL-Rainfed	AES DL-IRF	AES DL-Forest
1.	Dairy Cow Population			
	- Total of Population	144	755	754
	- Productive Cow	90 (62.5%)	500 (66.2%)	462 (61.3%)
	- Non-productive Cow	54 (37.5%)	255 (33.8%)	292 (38.7%)
	- Lactating Cow	80 (88.9%)	369 (73.8%)	335 (72.5%)
	- Dry Periode	10 (11.1%)	131 (26.2%)	127 (27.5%)
2.	Milk Production (liters)			
	- Total of Milk Production/Day	850	3,715	3,810.4
	- Milk Production/ cow/Day	6	4.9	5.1
	- Milk Production/Lact. Cow/Day	10.6	10.1	11.4
	- Milk Production/ ProductiveCow/Day	9.4	7.4	8.2
3.	Population of farmer (people)			
	- Total of the farmer	18	191	201
	- Ownership Sum of Cow/ Farmer	8	3.9	3.7
	- Ownership Sum of Prod. Cow/Farmer	5	2.6	2.3
	- Ownership Sum of Lact. Cow/Farmer	4.4	1.9	1.7

Source: - Mandiri cooperative Cow cowman group Lebakjaya

Table 3. The average of feeding amounts and feed consumption of dairy cow in Lebakjaya, Cintanagara and Pamalayan

No.	Study Location	Weight (kg)	Feed Used	Average Value of Feeding and Consumption (Kg/Cow/Day)	
				Feeding	Consumption
1.	AES DL-Rainfed	428.16±43.50	*Forage* (Hays)	45.11±8.36	42.14±4.28
			Concentrates	7.16±0.81	7.16±0.81
2.	AES DL-IRF	433.41±34.11	*Forage* (Hays)	51.21±3.04	43.27±3.60
			Concentrates	5.32±1.01	5.32±1.01
3.	AES DL-Forest	447.09±34.04	Forage (Hays)	54.24±4.50	45.49±3.49
			Concentrates	5.76±1.59	5.76±1.59

Based on the Table 3 it was displayed that the farmers had given hays and concentrates pretty well to their cow. The average hay feeding in the three locations was higher, and the concentrate feeding was lower than the study result of Siregar (2001) stating that the best hay feeding was around 17.8 kg/cow/day and the concentrate feeding was 9.5 kg/cow/day.

The nutrition in the feed determines the quality of the feed, beside the state that the nutrition amounts consumed by the cow must be proper to the needs. The quantity of nutrients substances consumed by the lactating dairy cows of the three locations was presented in Table 4.

The qualities of feed given in the three locations (Table 4) was relatively the same that give also the same influence. It is displayed by the milk production capacities of the three locations that relatively the same.

Service per conception

The sum of service per conception (S/C) was calculated based on the stock of frozen straw cements used until the last insemination indicating that the lactating cow was positively pregnant as the result of palpation rectal conception test at day 40-60 after insemination. The S/C sums of the three study location were presented in Table 5.

Based on the data that S/C performance in three location was found that the S/C of each locations are 2.23±0.45; 2.31±0.54; 2.11±0.62. In the Table 5 it can be seen that the service per conception in AES DL-Rainfed was not really different from that of AES DL-IRF and AES DL-Forest, whereas the S/C in AES DL-IRFwas different from that of AES DL-Forest. This state indicates that the cow in AES DL-Rainfed and AES DL-Forest, based on the management, the breeding are better than that of AES DL-IRF. It means that the fertility level of the lactating cow of AES DL-Rainfed and AES DL-Forestwas higher than that of AES DL-IRF as the result of the better feeding and farming management.

The S/C value in those three agro-ecosystems of study locations was inferior in comparison to in the central highlands of Ethiopia (Wondossen *et al*., 2018), Ujung Berung district (Darodjah, 2009), Pangalengan district (Sukraeni, 1985) and Dasuki (1983), i.e. on the average of 1.9±0.05, 2.20±0.92, revolve around 2.12-2.18 and 2.2. However, the S/C value of the study location better than that of the study result of Makin (1990) i.e. 2.91±1.63 in Cirebon; 2.77±1.01 in Subang; 2.83±1.04 in Sumedang; whereas 2.8 in West Java; and 2.6 of National S/C (Toharmat, 2013).

The S/C value in every study location showed inferior results, because according to Ball and Peters (2004) that the average value of service per conception that was considered as

Table 4.The average of feed consumption and the needs of nutrition based on body weight, production, milk fat value of the three different agricultural ecosystem in the study location

No.	Study Location	Body Weight (kg)	Milk Prod. Kg 4% FCM (kg)	Average of Consumption and Needs (kg)		
				DM	*CP*	TDN
1.	AES DL-Rainfed	428.16±43.50	11.12			
	- Cons.			21.19	1.81	12.46
	- Needs			10.00	1.37	6.92
	- Difference			11.19 (+)	0.44 (+)	5.54 (+)
2.	AES DL-IRF	433.41±34.11	10.78			
	- Cons.			15.39	1.59	9.44
	- Needs			10.18	1.35	6.85
	- Difference			5.21 (+)	0.24 (+)	2.59 (+)
3.	AES DL-Forest	447.09±34.04	11.24			
	- Cons.			15.45	1.73	10.01
	- Needs			11.01	1.40	7.11
	- Difference			4.44 (+)	0.33 (+)	2.9 (+)

Notes:
- The sum of nutrition consumed was calculated based on proximate analysis in Laboratorium Nutrisi Ternak Ruminansia dan Kimia Makanan Ternak Laboratory of Fakultas Peternakan Universitas Padjadjaran (2014).
- The needs of nutrition was calculated based on Table of Needs in Sudono (1999)
- *DM* : Dry Matter
- *CP* : Crude Protein
- TDN : Total Digestible Nutrient
- FCM : Fat Corrected Milk

Table 5. Dairy cow reproductive in Lebakjaya, Cintanagara and Pamalayan village

No.	Study Location	*Service per Conception* (S/C)	Days Open (DO)	Calving Interval (CI)
1.	AES DL-Rainfed	2.23±0.45[ab]	148.89±65.52[ab]	431.00±65.18[ab]
2.	AES DL-IRF	2.31±0.54[b]	161.95±61.99[b]	444.47±61.21[b]
3.	AES DL-Forest	2.11±0.62[a]	138.38±47.18[a]	419.86±46.95[a]
	Total	2.21±0.58	150.06±56.88	432.06±56,49

Note: The same lowercase towards columns means no significant difference.

normal is 1.6 – 2.0 times, in other words ideally a dairy cow should be pregnant after 1 – 2 mating times. In Indonesia, a good service per conception value is less than 2 (Sudono, 1999). Afterwards, good service per conception values, (1) very good: less than 1.5; (2) good: 1.51-1.81; (3) General : 1.81-2.0;and (4) worse: more than 2.01 (Wells and Burton, 2002).The normal S/C value occurs around 1.6-2.0 timesor the optimum value was 1.6 (Bath *et al*., 1978).

Sudono (1999) and Makin (2011) stated that the goal of an artificial insemination in an insemination period until pregnancy has for considerable factor, i.e. 1) healthy dairy cow, 2) punctual time for mating, 3) semen quality, and 4) the inseminator's experience.

Days open

Days open in cow was the interval between the giving birth time and the last mating time resulting pregnancy of a dairy cow. Based on the Table 4, it was stated that the days open of dairy cow in AES DL-Rainfed, AES DL-IRF, and AES DL-Forest severally148.89±65.52 days; 161.95±61.99 days and 138.38±47.18 days.

The analysis result shows that the average days open of cows in AES DL-Rainfed was not different from that of AES DL-IRF, and AES DL-Forest. However, the DO average value in AES DL-IRF showed significant difference ($P<0.05$) from AES DL-Forest. This difference was presumably caused by the cowmen's failure in detecting the cow's lust, or its reporting delinquency to the inseminator so that the re-mating in AES DL-IRF occurs in the month following. This prediction was based on the S/C value in AES DL-IRF that showed significant difference from that of AES DL-Forest (Table 5). The longer period of the days open (DO) in AES DL-IRF presumably caused by errors in the mating management so that to get pregnancy it requires 2.31±0.54 times of mating. Studies reported that the shorter values of DO are mostly caused by environmental factor, especially the mating management and the given dietary quality.

The cycle of the days open values resulted in this study (138.38-161.95 days) is less than good as it occurs 120 days. According to Murray (2009), a good days open occurs in 100 days, and betterments are required when the DO occurs more than 120 days. The condition in this study location was better than that in the central highlands of Ethiopia as 179.89±6.82 days (Wondossen *et al*., 2018) and in Kemiri village, Jabung district, Kawasan Koperasi Agro Niaga Jabung, Malang, East Java that showed average DO as 202.45±165.84 days, depending on the calving (Wahyudi *et al.,* 2013). The ideal days open period was 60 – 90 days (Bath *et al*., 1978) in order that the reproductive becomes efficient after calving. Accordingly, the days open values in the three agro-ecosystems are longer than that of the recommended value. If the days open value occurs more than 90 days, it gives economic consequences of non-efficient reproductive and showed some bad mating management in those three different study locations.

Calving interval

Calving interval was the interval between two consecutive calving times. It can be seen in the Table 4 that the calving interval average values of the three agro-ecosystems in each village are as follows: AES DL-Rainfed 431.00±65.18 days; AES DL-IRF 444.47±61.21 days; and AES DL-Forest was 419.86±46.95 days. Based on the average calculation of calving interval, the value of AES DL-Rainfed showed was not significant difference from that of AES DL-IRF and AES DL-Forest. Whereas the calving interval of AES DL-IRFwas clearly different ($P<0.05$) from AES DL-Forest. The interval differences between AES DL-IRF and AES DL-Forest was caused by the difference of the DO values since the pregnant period value was relatively the same. Pregnancy period value of several FH dairy cow samples obtained in the three study locations are 281.47-282.53 days with 282.01 days average value. The result showed that the shortest days open (138.38±47.18 days) occurs in AES DL-Forest also the shortest period of calving interval (419.86±46.95 days).

The calving interval value (419.86 - 444.47 days) and the average (432.06±56.49 days) result in this study showed calving interval variance that was shorter than that of several researchers' reports. Wondossen *et al*. (2018) reported that the calving interval of FH dairy cow in the central highlands of Ethiopia moved around 469.19±7.88 days, Zainudin *et al.* (2014) reported that the calving interval of FH dairy cow in CV. Milkindo Berkah Abadi Tegalsari village, Kepanjen, Malang moved around 460.9-674.0 days, and the calving interval of FH dairy cow in Kemiri village, Jabung, Malang moved around 472.19±156.45 days (Wahyudi *et al.,* 2013). Dudi *et al*. (2006) stated that Tandangsari coorporation, Sumedang district possessed average CI value as 15–16 months. Siregar (2003) stated that in reality, the CI value of the dairy cow of the most cowmen is relatively still longer, i.e. 417–453 days.

According to Mc.Intyre (1971), the CI variance occurred, was caused by the DO difference and the frequent S/C. This was affirmed by Moran (2005), stating that the high S/C value will cause a too long CI. The CI value resulted in this study, in the three different agro-ecosystem, was in the cycle of ideal state. The maximum CI value move around 12–14 months (Bath *et al*., 1978; Sudono, 1999). However, the calving interval of each agro-ecosystem shows reproductive efficiency declining compared to the previous study result in Garut district, i.e. 376.03 days (Sopiyana and Makin, 2005). Mekir (1982) reported that the calving intervals in Indonesia was valued around 12.7-15.6 months, whereas the calving interval in Ireland, i.e. 379±58 days (Coffey, *et al*., 2016).

The higher the CI value showed a lower reproductive efficiency of the cow. To detect errors in reproductive can also be examined from the calving interval states. Hardjopranjoto (1995) stated that the reproductive errors of a lactating dairy cow can be examined from the calving interval state of more than 400 days. Although the FH lactating dairy cow of the three study locations show ideal average values, but the amount of suspected cows containing reproductive error was high.

Conclusion

From the three different agro-ecosystems, it can be concluded that the whole reproductive performance of service per conception (S/C) and days open (DO) reproductive characteristics are different from the expected ideal value, i.e. S/C: 2.21±0.58 (1.6-2.0 times) and DO: 150.06 ± 56.88 (60-90 days), whereas the calving interval, 432.06 ± 56.49 days, was still in ideal value.

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