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SURVIVAL ANALYSIS ON THE REPRODUCTIVE AND PRODUCTION PERFORMANCES OF DAIRY COW IN BOGOR

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Abstract

The aim of this study was to analyze the reproductive performance (empty period) and production (peak time of milk production) of 87 dairy cows (Friesian Holstein) at X dairy farm Bogor using survival analysis. The analysis results based on the Kaplan-Meier curve showed that the median total idle time, primiparous cow, multiparous cow, cow that gave birth in the rainy and dry seasons were 210; 335; 231; 272; and 397 days. The median value of the total peak milk production, primiparous cow, multiparous cow, cow that give birth in the rainy and dry seasons is 41; 41; 39; 41; 41 days. The Cox Proportional Hazard regression results on idle time showed that the multiparous cow was 1.84 times more likely ($P<0.05$) to have a shorter idle period than the primiparous cow. Cows that gave birth during the rainy season had a 1.80 times shorter chance than cows that gave birth during the dry season, although they were not statistically significantly different ($P=0.043$). The regression results on peak milk production showed no difference between cows and primiparous cows. Meanwhile, cows that gave birth during the rainy season experienced peak lactation 1.26 times and tended to be faster than cows that gave birth during the dry season, although this was not statistically significant. The study's conclusions show that it was necessary to improve the management of reproduction and production of X dairy farm in Bogor.

Keywords: survival analysis; dairy cows; day in milk; days open; lactation number.

INTRODUCTION

The potential for increasing livestock business in Indonesia is very high. The livestock sub-sector contributed 1.69% (260 189.6 billion rupiah) of Indonesia's total GDP (Gross Domestic Product) in 2020 (BPS 202:1). The data has continued to increase since 2016 with an average increase of 6% per year. This is a new challenge to realize a more efficient livestock business.

Dairy cattle business is one of the livestock businesses with great potential to be developed in Indonesia. The demand for cow's milk in Indonesia is high, it has not been met by local farmers in Indonesia. The government implements an import policy to meet the needs of cow's milk in Indonesia. Thus, it is necessary to study production efficiency so that the price of cow's milk from local farmers can compete with imported cow's milk.

The efficiency of dairy farming can be determined by the fertility of the mother cow and the milk yield produced. Some signs of good fertility are when adult heifers show clear signs of lust, have a high chance of bunting when mated, and have a short lambing interval. One of the management that is to increase efficiency is by improving the empty period and increasing milk production.

The empty period is one of the measurements of fertility indicators in dairy livestock. A short blank period will increase production efficiency. The empty period is influenced by

several factors, including the length of the lactation period (Grossman and Koops 2003), the lactation period Mitchell et al., (2005), the sex of the child born Córdova-Izquierdo et al., (2008), the level of milk production (Brotherstone et al. 2003), the season during lambing and the age of the cow Oseni, Misztal, Tsuruta, & Rekaya, (2003). So that the empty period will affect milk production in the next lactation.

The time change between the vacancy period and the previous production with the future one is a critical factor in dairy farming. For this reason, it is necessary to analyze the empty period and milk production. One analysis that can be used is survival analysis.

Survival analysis is a statistical procedure used to describe data related to time, from the time of organization of a particular study, to the time of emergence of events or end points. Events that occur can be recurrent events, new events, or responses from an experiment Collet, 2003; Kleinbaum & Klein, 1996; Muhajir & Palupi,(2018). The term survival analysis is often associated with survival time, failed cases, censored data, hazard's function, life table, Kaplan-Meier curve, and cox proportional hazard model (Taufik & Suriyasataphorn, 2008).

The cox proportional hazard model studies the occurrence of events in a certain time span. The occurrence of the event is calculated based on the occurrence of the same event from the initial time to a certain predetermined end time (Schneider et al., 2005). The length of time used cannot be ascertained, because the event may have occurred before the time frame specified when researching. The purpose of the cox proportional hazard model is to determine the hazard ratio (RH) used to estimate the occurrence (in this study i.e. the plantation) at a given value compared to the reference value. For example, if the deadlock in a particular event is >1, then the value is higher than the reference value.

One of the main problems experienced by some farmers is low milk production and the empty period of dairy cows that exceed the ideal limit. Córdova-Izquierdo et al., (2008) state that the period of vacancy is 85-115 days after lambing. Ali et al., (2000) add that there is no vacancy period of less than 30 days. The length of the normal empty period is 60 to 90 days, and it is relatively normal when it is not more than 120 days.

Research on the empty period of dairy cows in Temanggung, Central Java resulted in an empty period of 120-196 days Toharmat et al., (2007). While the research of Atabany et al., (2013) in Purwokerto, Central Java has an average blank period of 138 days. This shows that the empty period of dairy cows in Indonesia is still relatively long.

When compared to the empty period of dairy cows in Thailand, the length of the empty period shows no noticeable difference. Research by Taufik and Suriyasataphorn (2008) states that the vacant period of 143 dairy cows from 6 farms in Northeastern Thailand resulted in a median vacant period of 210 days. While Punyapornwithaya and Teepatimakorn (2004) in Northern Thailand resulted in a median vacancy period of 131 days. However, research on empty period and dairy cattle production with survival analysis in Indonesia has not been widely conducted. Therefore, it is necessary to conduct research with a survival analysis study of the influence of the season during lambing and lactation period on the empty period and milk production to implement proper maintenance management.

METHOD RESEARCH

Data Retrieval

Data was taken from production records of 87 lactation adult female dairy cows from Farm X in Bogor Regency, West Java. The parameters observed were cow identity (IDS), last lambing date (TBT), return bunting date (TBK), peak milk production (PPS), lactation period (JLA), and indicators of bunting or occurrence (1 = bunting; 0 = no bunting). Data is processed using Microsoft Excel. The data collection is used to identify vacancy and milk production for:

Lactation period: Primiparous (mother cow that has partus once) and multiparous (mother cow that has partus more than once) (Feliciano et al. 2003); Season when giving birth: dry and rainy.

Analysis and Data Variables

This study used a cox proportional hazard model to analyze the effect of season during lambing, lactation period on empty period and milk production. All data analysis uses Statistix 10.0 software.

This study used three variables: independent variables, dependent variables, and censored variables. The dependent factors in this study are the length of time (survival time), empty period and peak time of milk production production. The independent variables in this study were the season (dry or rainy) and the lactation period of cows (first lactation and more than one lactation). The censored variable is the number of cows that came out at the time of observation due to fall, death, or slaughter.

RESULT AND DISCUSSION

Kaplan Meier Curve and the Ratio of Empty Period to Lactation Hazard

The empty period or *open days* is the distance between lambing until pregnancy occurs or the days from after lambing to pregnancy. According to Warwick & Legates, (1979), the recommended vacancy period for lactation heifers is 90 days and for lactation mother cows for 60 – 90 days. The empty period in that time span, it is expected that the mother cow can produce high enough milk at the end of lactation. But the shorter the empty period can also reduce production in lactation. This can occur due to udder gland regression caused by competition for the use of nutrients for fetal development (Brotherstone et al., 2004).

An optimal blank period is necessary to achieve milk production efficiency. Weller *et al*. Research states that, the optimal empty period is at 110 - 130 days. Cows that have an empty period of less than 60 days will decrease the total milk yield per year, both in walking lactation and subsequent lactation. While cows that have too long an empty period, will decrease milk production during productive life because it will decrease the frequency of births as the beginning of a new lactation process (Warwick & Legates, 1979).

Maintenance management is one of the factors that can regulate the vacancy period in dairy cows. Conventional rearing management uses a lambing interval of 12 months, so that births can occur every year and are able to produce milk optimally Schmidt & Van Vleck, 1974; Warwick & Legates, (1979). Nevertheless, rearing management in sow cows with high milk yield tends to delay the lambing interval by up to 15 months. Postponement of the lambing

interval aims to reduce the risk of mastitis and other metabolic symptoms (Rehn et al., 2000).. This certainly affects the empty period of dairy cows during rearing.

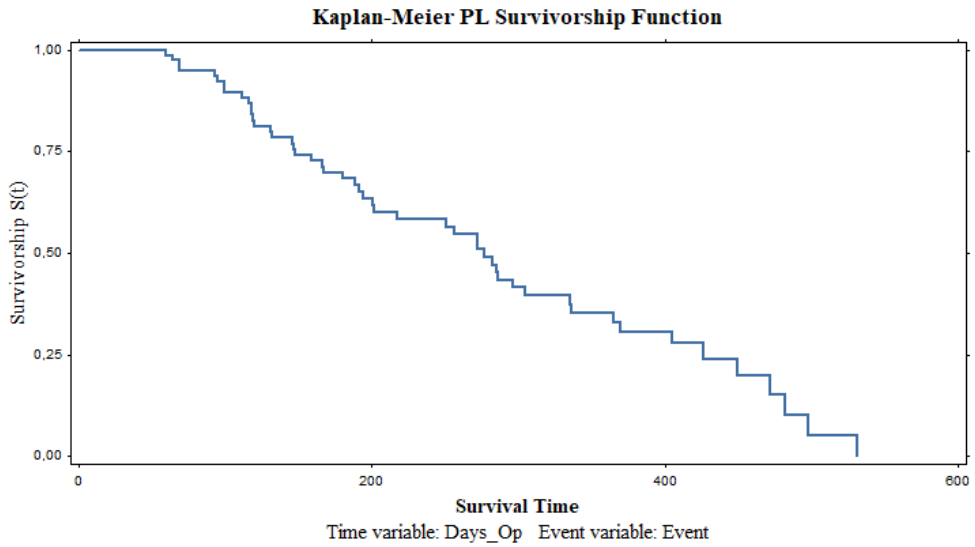

Figure 1 Kaplan-Meier *curve survival time* of the entire empty period (days) of the mother cow at farm X in Bogor

The Kaplan-Meier curve of the *overall survival time* of cow blanks is shown in Figure 1. Based on the curve, overall the mother cow at farm X Bogor produced a median of 274 days. This is higher when compared to the study of Taufik and Suriyasataphorn (2008) in Northeastern Thai people's farms which yielded a median of 210 days, while the research of Punyapornwithaya & Teepatimakorn, (2004) in Northern Thailand resulted in a median of 131 days.

The empty period of dairy cows in Indonesia is long when compared to other countries. Research by Iswati et al., (2020) resulted in a vacant period of 117.10 days of dairy cows in the cattle herd of Tegalombo District, Pacitan, East Java. Vacant period research by Anggraeni et al., (2014) resulted in a blank period of 66.9 - 215.3 days at BPPT SP Cikole, Lembang, West Java. Meanwhile, the vacant period research at BPPT Baturraden, Central Java resulted in an average empty period of 149 days Anggraeni et al., (2014) and 152.9±39.3 days with a range of 114 - 192 days (Abdallah, 2020).

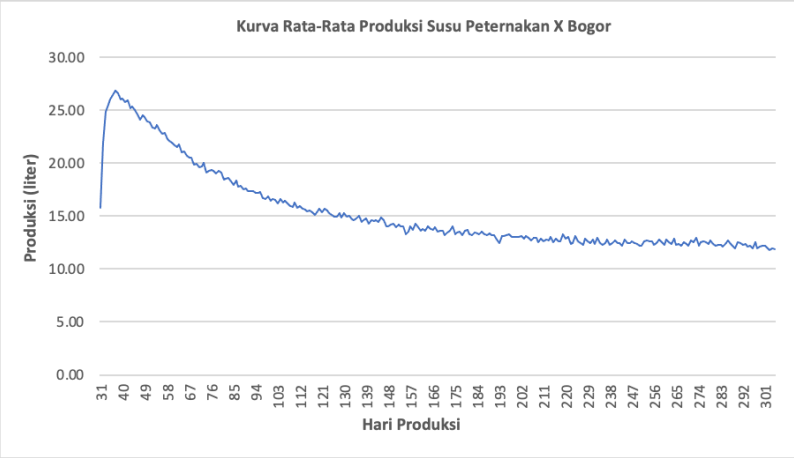

Figure 2 Curve of average milk production (liters) in Farm X Bogor

Figure 2 shows Farm X Bogor's daily milk production which is high at the beginning of production and tends to be stable after 305 days of milk production. Cows with high milk yield, secrete a high hormone prolactin. The secretion of the hormone prolactin can inhibit the hormone gonadotropin, so it can cause a delay in lust. This is in accordance with the statement Atabany et al., (2013) that cows that have high production at the beginning of lactation, have a longer empty period and have the potential to experience delays in lust.

Other factors that can extend the vacancy period of dairy cows include maintenance management factors. A longer vacancy period can maximize annual milk yield. Research Anggraeni et al., (2014) stated that the extension of the vacancy period of about 60 days provided additional milk production from 3639 kg to 5119 kg at BPTU Baturaden and provided an additional from 2782 kg to 3189 kg in assisted community farms. Anggraeni *et al.* (2010) also added, compared to milk production from an empty period of 60 days, extending the empty period to 200 days can increase milk production by up to 18%.

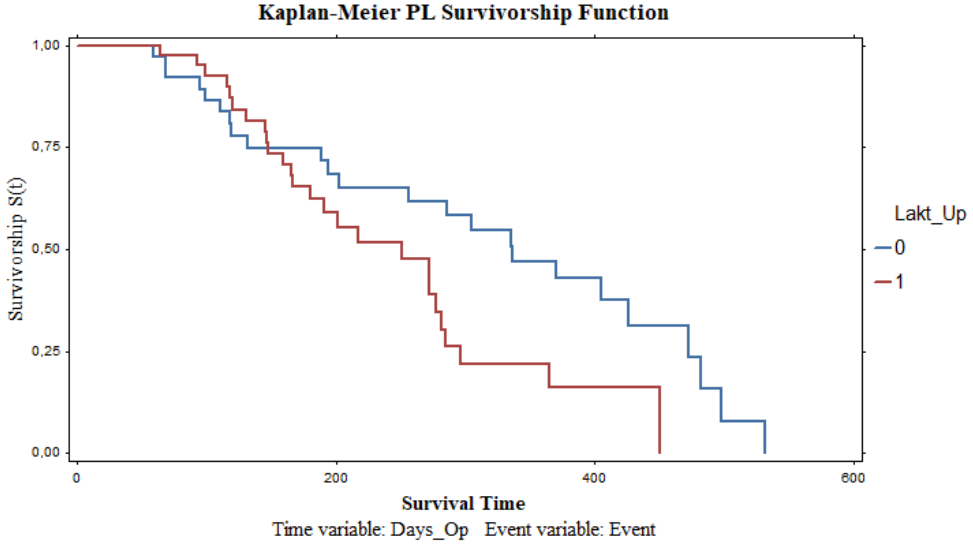

Figure 3 Kaplan-Meier *curve survival time* empty period (days) to lactation period (1=multiparous; 0=*primiparous*).

Primiparous cows experience a longer empty period than *multiparous* cows. Based on figure 3, the Kaplan-Meier *curve of empty period survival time* with *events* (bunting or not

bunting) to lactation yields a median of 335 days for primiparous cows, and 231 days for *multiparous* cows. The median of cows by lactation period showed markedly different results (P = 0.0476). This shows that *multiparous* cows markedly have a shorter vacancy period. When compared to the research of Taufik and Suriyasataphorn (2008), the median result resulted in higher data. The research of Taufik and Suriyasataphorn (2008) resulted in a median of 226 days for primiparous cows, and 207 days for *multiparous* cows. Nevertheless, the results show the equation that the median vacancy period in *multiparous* cows is shorter than in *primiparous* cows.

Table 1 1*Cox Proportional Hazard* Model vacant period at Farm X Bogor

Variable	β	ONE β	P	Hazard Ratio
Lactation period				
Lactation 1	-0.61246	0.30198	0.0476	0.54
Lactation >1	0.61246	0.30918	0.0476	1.84

Remarks : = coefficient; SE = default errorββ

The results of the analysis of data from the *Cox Proportional Hazard* model of cow vacancy against lactation period are shown in table 1. The results of the analysis showed clearly (P<0.05) that *multiparous* cows were 1.84 times more likely to experience a shorter empty period than *primiparous* cows. The results of this study are in accordance with research conducted by Taufik and Suriyasataphorn (2008) and research by Punyapornwithaya and Teepatimakorn (2004) which states that *multiparous* cows have the opportunity to experience a shorter empty period than *primiparous* cows.

Research by Hadisutanto and Parera (2014) states that in fact *multiparous* cows experience a shorter empty period than *primiparous cows*. This is because *primiparous* cows are higher in using food substances for their body growth which has only reached 82-90% for 3 weeks before partus and 3 weeks after partus. *Multiparous* cows are more efficient than *primiparous* cows, because *multiparous* cows have mature cells and hormonal systems so they are better prepared to reproduce (Anggraeni *et al.* 2010). Ismail (2009) adds that the lust of *primiparous* cows is more difficult to detect than *multiparous* cows.

Kaplan Meier Curve and the Hazard Ratio of Empty Time to Lambing Season

The majority of dairy cows from Peternakan X Bogor give birth in the rainy season. Based on figure 4, Bogor X Farm is in area 72. The region experiences a rainy season in late August to early June of the following year. Region 72 is the area with the longest rainfall when compared to other regions in West Java Province, which is for 290 days with rainfall of 3360 mm / year (BMKG 2021).

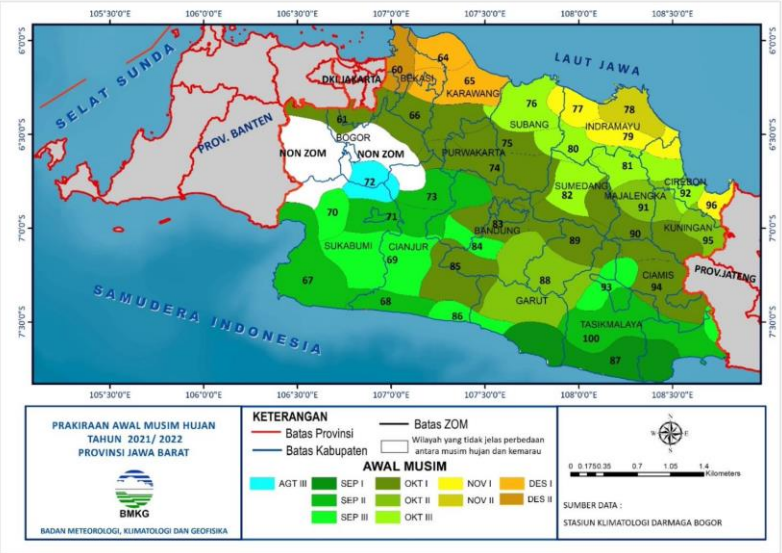

Figure 4 The beginning of the rainy season in West Java Province (Source: BMKG, 2021)

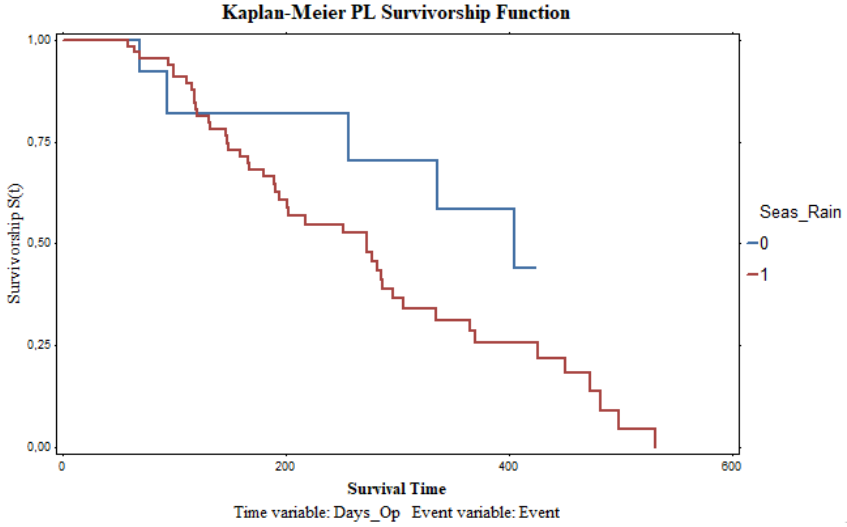

Figure 5 Kaplan-Meier *curve survival time* of empty period (days) against lambing season (1=rain; 0=drought)

Cows that give birth in the rainy season, tend to experience an empty period faster than cows that give birth in the dry season. Based on figure 5, the Kaplan-Meier *curve of empty period survival time* to *events* (bunting or not bunting) to the lambing season, yields a median of 272 days for cows that lamb in the rainy season, and 397 days for cows that give birth in the dry season. The median showed no noticeable difference (P = 0.2194). The results are higher when compared to the research of Taufik and Suriyasataphorn (2008) which resulted in a median of 231 days in summer and 204 days in other seasons (cold and rainy) in Thailand. However, these results show the equation that the median vacancy period of cows that lamb in the rain/winter season is shorter than in the dry/hot season.

Table 2 2*Cox Proportional Hazard* Model of vacant period at Farm X Bogor

Variable	β	ONE β	P		Hazard Ratio
Birth season					
	Rain	0.58976	0.48024	0.2194	1.80
	Dry season	-0.58976	0.48024	0.2194	0.55

Remarks : = coefficient; SE = default errorββ

The results of data analysis of the *Cox Proportional Hazard* model of cow vacancy against the birth season are shown in table 2. Cows that give birth in the rainy season are 1.80 times more likely to experience a shorter vacancy period than cows that give birth in the dry month even though the results are not statistically real (P = 0.2194). These results are in accordance with the research of Taufik and Suriyasataphorn (2008) which states that cows born in the rainy and winter seasons have a greater chance than cows born in the dry season.

Seasonal conditions can affect the reproductive performance of dairy cows. Research Farin *et al*. (1994) states that cows that give birth in the summer are less likely to get pregnant than cows that give birth in the colder season. Cows that give birth in the dry season, will experience heat stress, so the efficiency of energy use will be reduced due to increased energy for basic living and thermoregulation activities. Insufficient feed intake can interfere with the synthesis and regulation of reproductive hormones that play a role in the appearance of lust symptoms (Abidin *et al.* 2012).

Kaplan-Meier Curve and Hazard Ratio of Peak Milk Production to Lactation Period

Dairy farming business will provide a good level of production efficiency if the mother cows raised are able to convert feed into milk production efficiently. Production efficiency can be determined by the persistence of milk production after reaching peak production. Anggraeni *et al.* (2000) states that environmental factors greatly influence the daily milk production curve. Factors that can affect milk production include the lactation period (Mitchell *et al.* 2005) and the season of lambing (Oseni *et al.* 2013).

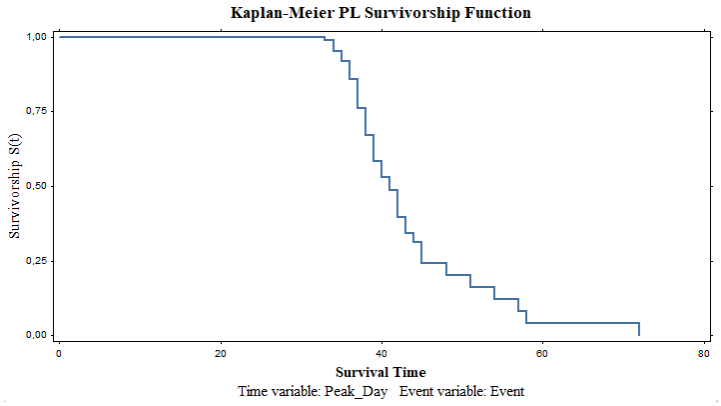

Figure 6 Kaplan-Meier *curve survival time* of peak milk production (day -) of all mother cows at farm X in Bogor

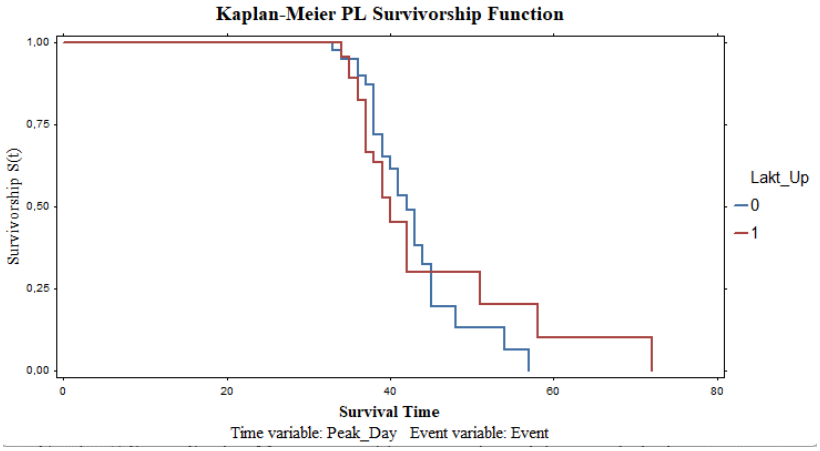

Figure 7 Kaplan-Meier *curve survival time* of peak milk production (day -) to lactation period (1=multiparous; 0=*primiparous*).

The Kaplan-Meier curve of peak survival *time* of overall milk production is shown in Figure 6. Based on the curve, the peak day of milk production of mother cows at farm X Bogor yielded a median of 41 days.

Based on Figure 7, primiparous cows tend to reach peak milk yield faster than *multiparous* cows . This is indicated by the Kaplan-Meier curve of peak milk production survival time with *events* (bunting or not bunting) to lactation resulting in a median of 41 days for primiparous cows and 39 days for *multiparous* cows. Rahman *et al.* (2015) in UPBS Pangalengan which states that *multiparous* cows reach peak milk production days faster than *primiparous* cows. Atashi *et al.* (2009) states that the average peak milk production is reached on the 49th day after partus. While Fadlemoula *et al.* (2007) states the peak of cow's milk production occurs on the 64th day. Nevertheless, the median cow by lactation period showed no markedly different results (P = 0.7367).

Table 3 3*Cox Proportional Hazard* Model of peak milk production in Farm X Bogor

Variable	β	ONE β	P	Hazard Ratio
Lactation period				
Lactation 1	-0.09794	0.29074	0.7362	0.91
Lactation >1	0.09794	0.29074	0.7362	1.10

Remarks : = coefficient; SE = default errorββ

Table 3 shows the results of data analysis of *the Cox Proportional Hazard* model of peak cow milk production according to lactation period. The results of the analysis showed that the lactation period had no real effect (P = 0.7362) on the peak of cow's milk production. Research by Rao and Sundaresan (19, 81) states that the udder glands of primiparous cows take longer to reach peak milk production than *multiparous* cows.

Kaplan-Meier Curve and Hazard Ratio of Peak Milk Production to Lambing Season

The shape of the milk production curve is influenced by the time of peak milk production, the level of milk production, and the rate of decline in milk production after reaching peak production. The peak time of milk production can be reached when the cow has undergone uterine involution, 40 to 60 days *post partus* (Atabany *et al.* 2013).

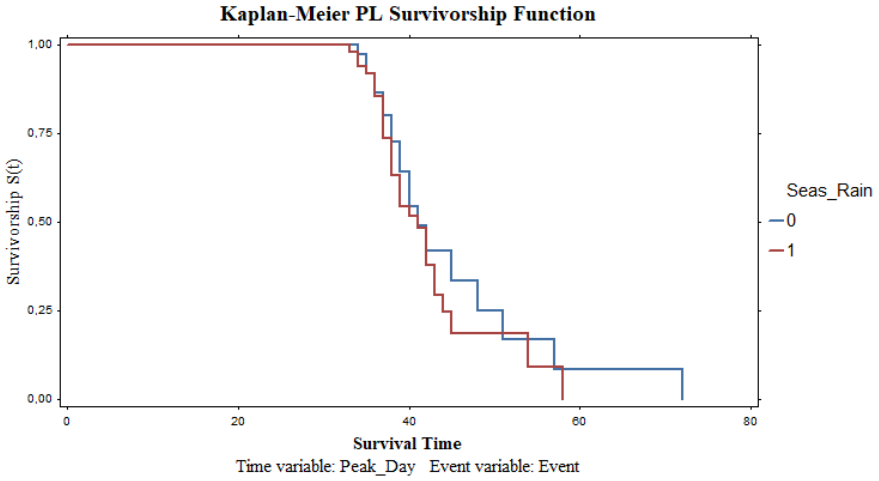

Figure 8 Kaplan-Meier curve *survival time* of peak milk production (day-) to lambing season (1=rain; 0=drought)

The Kaplan-Meier *curve of peak milk production survival time* with *events* (bunting or not bunting) with lambing seasons, yields a median of 40.5 days for cows that lamb in the rainy season and 40.8 days for cows that lamb in the dry season. The median showed no noticeable difference (P = 0.4325).

Table 4 4*Cox Proportional Hazard* Model of peak milk production in Farm X Bogor

Variable	β	ONE β	P	Hazard Ratio
Birth season				
Rain	0.23052	0.29593	0.4360	1.26
Dry season	-0.23052	0.29593	0.4360	0.79

Remarks : = coefficient; SE = default errorββ

Table 4 shows the results of data analysis of the *Cox Proportional Hazard* model of peak cow milk production according to the season at lambing. The results of the analysis showed that the season during lambing had no real effect (P = 0.4360) on the peak of cow's milk production. Cows that lamb in the rainy season, reach the peak of lactation 1.26 times tend to be faster than cows that give birth in the dry season, although statistically it is not significantly different. This is in accordance with the research of Anggraeni *et al.* (2000) which states that seasons have no noticeable influence on the daily milk yield curve.

The achievement of a faster peak milk production period (*primiparous* cows and lambing cows in the rainy season) at Farm X Bogor showed poor performance. Cows that reach peak milk yield faster will decline faster until day 301 (Atabany *et al.* 2013; Dekkers *et al.* 1998). The peak period of milk production is influenced by the ability of aveolar cells and the comfort of the surrounding environment. Cows that lamb in the rainy season experience high humidity stress, which causes cows discomfort.

CONCLUSION

The results showed that the empty period of multiparous cows is shorter than that of primiparous cows. The empty period of cows that give birth in the rainy season is shorter than cows that give birth in the dry season, although it is not statistically different. The time to reach

the peak of milk yield of multiparous and primiparous cows shows no difference. Cows that give birth in the rainy season tend to reach the peak of milk production less than cows that give birth in the dry season, although statistically it does not differ markedly.

The results of the analysis show that it is necessary to evaluate reproductive and production management in Bogor X dairy farm in order to improve the efficiency of reproductive and production performance.

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