

Genetic Parameters Estimation on the Reproductive Characteristics of Friesian Holstein Crossbred (PFH) Dairy Cows

Sucik Maylinda¹, Ganda Pria Bachtiar²

^{1,2}Faculty of Animal Science, University of Brawijaya, Malang, East Java, Indonesia-65145

Email address: ¹sucik@ub.ac.id

Abstract— The research aims to estimate the genetic parameters of Friesian Holstein crossbred (PFH) dairy cows which determines its reproductive efficiency based on the repeatability value. The research was conducted in the Agro Niaga Cooperatives dairy farm in Jabung, Malang Regency. The materials used in this research were the reproduction data of 50 PFH dairy cows collected through direct observation and interview with the dairy farmers and inseminators. In addition, the data in this research were obtained from PFH dairy cows which gave birth for three to four times, thus a total of 125 data for each reproductive characteristics were collected. The observed reproductive characteristics data include service per conception (S/C), days open (DO), and calving intervals (CI). The obtained data were then analyzed with one-way analysis of variance (ANOVA) in intraclass correlation unbalanced model. The results showed that the mean S/C, DO, and CI was 2.68 ± 1.52 ; 146.39 ± 76.89 days; and 420.63 ± 79.71 , respectively. The repeatability value of S/C was categorized as low (0.112 ± 0.093), while the observed DO and CI were categorized as medium (0.258 ± 0.081 and 0.318 ± 0.076 , respectively). The research concluded that the PFH dairy cows' selection should follow the DO or CI, and not on its S/C as it showed low repeatability value.

Keywords— Friesian Holstein crossbred, reproductive efficiency, repeatability, MPPA.

I. INTRODUCTION

The effort to fulfill milk demand in Indonesia still faced several problems, and the low milk production of local dairy cows is one of them. The low milk productivity is not only affected by the poor feeding and rearing management, but also by the genetic qualities of the dairy cows. The lack of genetic parameters estimation is known to be the cause of poor genetic qualities of the reared dairy cows, noting that the estimation would determine the success of breeding management.

A good breeding selection practice should be done based on the reproductive characteristics of the dairy cows, such as its service per conception (S/C), days open (DO), and calving interval (CI). Thus, the dairy cows which showed good S/C, DO, and CI characteristics should be selected for breeding. The evaluation of the reproductive characteristics could be done by measuring the repeatability value of the respected characteristics. The dairy cows which had less than 20% repeatability value of the preferred reproduction characteristics is then categorized to have poor qualities, thus should not be selected for breeding.

The repeatability value would be different between dairy cow breeds or populations in different region. The

measurement of reproductive characteristics based on the repeatability value then should be done specifically to conduct more effective breeding program by following the S/C, DO, and CI of the dairy cows in the population.

Agro Niaga Cooperative is a dairy cooperative operated in Jabung, Malang Regency, which reared more than 7,000 Friesian Holstein crossbred (PFH) dairy cows. Our early survey and interview showed that the PFH dairy cows reared by the cooperative had low production performance, thus a reproductive characteristics evaluation of the PFH dairy cows become essential to improve the breeding management.

Based on above description, repeatability measurement of the reproductive characteristics, added with most probable producing ability (MPPA) measurement to determine the production performance of the PFH dairy cows in the population of Agro Niaga Cooperative farm is required to select the cows for breeding. In this research, we measure the reproductive characteristics (S/C, DO, and CI) of the PFH dairy cows to evaluate the repeatability value and determine which of the characteristics should be used for breeding selection.

II. MATERIALS AND METHODS

The research was conducted in Agro Niaga Cooperative dairy farm in Gading Kembar Village, Jabung, Malang Regency. A purposive sampling of recording data, which consisted of S/C, DO, and CI, was done to obtain the research material. A total of 50 PFH dairy cows' data were collected through direct observation and interview with dairy farmers and inseminators. In addition, the data in this research were obtained from PFH dairy cows which gave birth for three to four times, thus a total of 125 data for each reproductive characteristics were collected. The obtained data was then measured for the repeatability value and analyzed with one-way classification analysis of variance (ANOVA) in intraclass correlation unbalanced design by following [1], as follows:

$$Y_{km} = \mu + a_k + e_{km} \quad (1)$$

Description:

Y_{km} = (m) times observation at (k) individuals

μ = total mean value (population)

a_k = the (k) individual effect

e_{km} = deviation effect of uncontrolled environmental factors

The formula to measure the repeatability value is as follow:

$$R = \frac{\sigma_w^2}{\sigma_w^2 + \sigma_e^2} \tag{2}$$

$$\sigma_e^2 = KT_E \tag{3}$$

$$\sigma_w^2 = \frac{KT_W - KT_E}{k_1} \tag{4}$$

$$k_1 = \frac{1}{N-1} \left(m - \frac{\Sigma M_k^2}{m} \right) \tag{5}$$

$$SE = \sqrt{\frac{2(m-1)(1-R)^2(1+(k_1-1)R^2)}{k_1^2(m-N)(N-1)}} \tag{6}$$

The MPPA measurement is as follows [1]:

$$MPPA = \frac{nr}{1+(n-1)r} (\bar{P} - \bar{H}) \tag{7}$$

Description:

MPPA = *Most Probable Producing Ability*

n = total individuals

r = repeatability

\bar{P} = mean value of individual production

\bar{H} = mean value of production in a population

III. RESULTS AND DISCUSSIONS

The S/C, DO, and CI measurement of PFH dairy cows in this research is presented in Table I below:

TABLE I. Reproductive performances.

Parities	Parameters		
	S/C	DO	CI
1	2.90±1.432	150.78±78.938	426.90±84.938
2	2.48±1.542	139.04±77.184	413.62±80.099
3	2.64±1.630	152.32±73.963	422.12±69.390
Total	2.68±1.517	146.39±76.889	420.63±79.713

A. Service per Conception (S/C)

The mean S/C of PFH dairy cows in this study from parities I to III was 2.90±1.432; 2.48±1.542; and 2.64±1.630 times respectively, with the total mean S/C value was 2.68±1.517 times. The high S/C value in this research (more than 2 times) showed that the PFH dairy cows had poor fertility and/or insemination. Research by Sulistyowati et al. [2] showed that the average S/C of PFH dairy cows in Indonesia is around 1.72 to 3.13 times. Moreover, Toelihere [3] showed that the normal S/C of cows is around 1.6 to 2.0. The lower S/C value indicates higher fertility of dairy cows.

The S/C value in this research is higher compared to other previous research. The S/C measurement of dairy cows in Ponorogo Regency showed that the average S/C is around 2.1 [5]. Other research by Kustanti [5] showed that a good farming management would produce cows with good fertility

with the S/C value at 1.5. In this research, the S/C value was varied from 1 to 2 times. The high S/C value is allegedly caused by several factors, such as postpartum recoveries, disease, poor feeding, insemination, and housing management.

Moreover, the high S/C value is also known to be affected by repeated breeding. The repeated breeding is caused by the late heat detection, thus followed by late insemination and ended with the insemination failure. The condition is then resulted in increased days open and calving interval. Pratiwi et al. [6] explained that the days open directly affect S/C, and longer calving interval. However, the dairy farmers and inseminators in this research had showed adequate skills in heat detection and insemination, thus the insemination management factor gave little effect to the high S/C value.

B. Days Open (DO)

The mean DO of this research from parities I to III was 150.78±78.938; 139.04±77.184; and 152.32±73.963 days, respectively, with the total mean DO was 146.39±76.889 days. The observed DO in this research is categorized as long and inefficient as the value is 5 times longer than the heat cycle. According to Zainudin et al. [7], the standard DO is around 60-90 days, while the good DO is around 80-85 days for better reproduction efficiency. Moreover, the longer DO indicates more reproduction inefficiency.

The observed DO in this research is also longer compared to other research. Kurnia et al. [8] found that the dairy cows' DO during parities I to III was 66.6; 77.4; and 72.2 days, respectively. Other research [9] showed that the mean DO in his research was around 138.8 days. Furthermore, the DO in this research is varying from 23 days to as long as 364 days. According to the data recording, the varying DO is caused by the disrupt in the oestrous cycle of the PFH dairy cows, which caused abnormal oestrous cycle, whether longer or even shorter. The condition thus inhibits inseminators to conduct proper insemination, thus resulted in repeated breeding as well.

The occurred abnormal oestrous cycle is allegedly caused by reproductive disruption in postpartum. The weakened physiological condition of the PFH dairy cows after delivering the calves is not supported with proper feed to support its recoveries. Noting that the given feed in the Agro Niaga Cooperative was only consisted of 6 kg of concentrates and 35 kg of forages for each cows daily. According to Pratiwi et al. [6], the long DO is the mainly caused by disrupted reproduction, as it would cause longer oestrous cycle, thus resulted in longer DO. In addition, the long DO would directly affect CI. It is regarding that the CI measurement is based on the DO added with time of pregnancy.

C. Calving Interval (CI)

In this research, the overall mean CI was 420.63±79.713 days, while the CI during parities I to III was 426.90±84.938; 413.62±80.099; and 422.12±69.390 days, respectively. According to Jainudeen and Hafez [10], the ideal calving interval was around 12-13 months, thus the CI in this research is considered poor. The CI in this study is also longer than

research by Kurnia et al. [8] that showed the mean CI of dairy cows in their research during parities I to III was 374; 364; and 386 days, respectively.

The long calving interval in this research is caused by the long S/C and DO. According to Reswati et al. [11], the ideal calving interval (12-13 months) could only achieved only if the DO is around 85-115 days. Similar to the DO, the long CI is allegedly caused by oestrous cycle disruption which caused repeated breeding. Fanani et al. [4] explained that long postpartum oestrous and postpartum mating, added with long S/C would resulted in longer CI.

Aside from reproductive problem, the feeding management would also affect the long calving interval. It is regarding that sufficient nutrition should be provided in feed for postpartum recoveries. The nutritional deficiency thus caused poor postpartum recoveries, which resulted in long DO and CI as well. According to Marume et al. [12], the feed supplementation for postpartum dairy cows would significantly affect the body recoveries and improve the fertility. Amin [13] also added that providing sufficient nutrients to the dairy cows would support the postpartum recoveries.

Rasad [14] stated that the time of pregnancy would also affect calving interval, even though the effect is relatively low. The condition is also found in this research, which showed that the time of pregnancy affect the calving interval. Moreover, Prasojjo [15] added that the time of pregnancy is affected by maternal and environmental factors. In addition, [16] showed that the mean calving interval for *Bos taurus* is 279 days.

D. Repeatability

The repeatability value of PFH dairy cows' S/C, DO, and CI in this research is presented in Table II.

TABLE II. Repeatability value of S/C, DO, and CI.

Parameters	Repeatability±SE
S/C	0.112±0.093
DO	0.258±0.081
CI	0.318±0.076

The repeatability measurement on reproductive characteristics in this study showed that the PFH dairy cows had low S/C repeatability, and medium DO and CI according to standard by [17] that divided the repeatability into three categories, which were low (<0.2), medium (0.2-0.4), and high (>0.4). Research by Warwick et al. [18] showed that the repeatability value of S/C and CI was around 0.05-0.1, while research by Kurnianto [17] is around 0.15. The different repeatability value in this research is allegedly caused by the different total data and the used estimation method. It is in accordance to Stansfield and Erlod [19] and Un et al. [20], which showed that the repeatability value is affected by the total data population and the method of estimation. Moreover, [18] showed that the different genetic parameters of dairy cows in a population could indicates the selection management of the farm.

The highest repeatability value of the observed parameters was found in CI, followed by DO, and the least repeatability value was shown in S/C. The results showed that the S/C and DO of dairy cows would be less inherited than CI, thus the PFH dairy cows selection with the best CI would be recommended. Moreover, the results also showed that the temporary environment would highly affect the genetic parameters and reproductive characteristics of the dairy cows, especially its S/C, DO, and CI. Widodo and Hakim [21] stated that the different genetic parameters and environment between cows would resulted in bigger variances followed with higher repeatability (close to 1.0). Consequently, an improvement to the environmental factors such as feeding and artificial insemination management would also be recommended to increase the S/C, DO, and CI.

E. Most Probable Producing Ability (MPPA)

The result of MPPA measurement on the PFH dairy cows' S/C, DO, and CI in this research is presented in Table III.

TABLE III. MPPA measurement of S/C, DO, and CI.

Parameters	MPPA			
	Below Average	Total Cows	Above Average	Total Cows
S/C	-0.46 – -0.04	24	0.06 – 0.57	24
DO	-49.21 – -0.78	27	1.16 – 50.69	23
CI	-56.35 – -0.06	28	0.99 – 71.55	22

The MPPA measurement of the PFH dairy cows' S/C in this research is around -0.46 to 0.57, with each 24 PFH dairy cows' were categorized in below and above average, and the other 2 PFH dairy cows' were categorized in the average. The results predicted that the average S/C value of the offspring would be around 2.22 to 3.25 times, with the low S/C is around 2.22 to 2.64 times, and the high S/C is around 2.74 to 3.25 times. Moreover, the MPPA measurement of the PFH dairy cows' DO in this research is around -49.21 to 50.69. Based on the MPPA of the DO, as much as 27 PFH dairy cows were categorized as below average (-49.21 to -0.78), and 23 PFH dairy cows were categorized as above average (1.16 to 50.69). The result predicted that the average DO of the offspring would be 97.18 to 197.08 days, with the low DO is around 97.18 to 145.61 days, and the high DO is around 147.55 to 197.08 days. Furthermore, the MPPA measurement of the PFH dairy cows CI in this research is around -56.35 to 71.55. As much as 28 PFH dairy cows are categorized in below average with CI at -56.35 to -0.06, and the other 22 dairy cows are categorized in above average with CI at 0.99 to 71.55. The result thus predicted that the average CI of the offspring would be around 364.28 to 492.18, with the low CI is around 364.28 to 420.57 days, and the high CI is around 421.62 to 492.18 days.

The result suggested that the selected PFH dairy cows for breeding should be the cows that are categorized in below average. It is regarding that the lower MPPA value of S/C, DO, and CI indicates better reproductive characteristics. Thus, the selected PFH dairy cows for breeding based on the S/C were 24 cows, based on DO were 27 cows, and based on CI

were 26 cows. However, the dairy cows' selection based on the MPPA measurement of reproductive characteristics is not guaranteed to be inherited by the offspring. The inheritance probability of the reproductive characteristics could be determined from the repeatability measurement. Among the observed reproductive characteristics, CI showed higher repeatability value compared to S/C and DO. Dalton [22] explained that the different MPPA value is caused by different repeatability. Overall, the result of this research showed that CI is more preferable than S/C and DO to be used as breeding selection, as the CI had higher probability to be inherited. In addition, about 50% of the PFH dairy cows in this research is categorized in above average and recommended to be culled.

IV. CONCLUSIONS

The research concludes that that:

1. The service per conception repeatability of the dairy cows in this research is categorized as low, which was 0.112 ± 0.093 . However, the days open and calving interval repeatability were categorized as average, which were 0.258 ± 0.081 and 0.318 ± 0.076 , respectively.
2. The MPPA value of the service per conception, days open, and calving interval were 2.22-3.25 times, 97.18-197.08 days, and 364.28-492.18 days, respectively.
3. There were around 50% of the dairy cows in this research that should be culled.

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