Milk production of imported Holstein cows over different environment

S Prastowo¹, T Nugroho¹, N Mahfudhoh¹, F Y Putra¹, Subiakti², A Ratriyanto¹, A Susilowati¹, Sutarno¹, N Widyas¹

¹Department of Animal Science, Sebelas Maret University, Surakarta Indonesia
²Baturaden Dairy Cattle Breeding Centre, Banyumas, Central Java, Indonesia

Email: prastowo@staff.uns.ac.id

Abstract. Indonesia is importing genetically superior Friesian Holstein (FH) cows as breeding stocks for domestic dairy cattle population. The milk production of these imported cows, however, are very much affected by temporary environmental effect due to the habitat changes and transportation. This study aimed to observe the consistency of milk production of imported cows viewed from the repeatability estimates. In total, milk yield records on lactation one (L1), two (L2) and three (L3) of 70 imported FH cattle were obtained from Baturaden Dairy Cattle Breeding Centre. The repeatability values were estimated with intraclass correlation method utilizing information from three lactation periods. Milk yield decreased over lactation periods which were 6077.55±1239; 4821.79±888 and 4374.6±1012 kg for L1, L2, and L3 respectively. The repeatability of milk yield trait in this population was 0.41. It indicates 59% of the variation in milk yield is controlled by the unknown error term, including temporary environmental effects. Imported cows undergone extreme adaptation processes to be able to live optimally in a new environment which would modify their physiology. We suspect environmental changes and resource differences between tropical and subtropical climates triggers different trait expression as the explanation of the phenomenon.

1. Introduction
Milk is food rich in nutrition which is commonly harvest from dairy cattle. In Indonesia, there were no native dairy cattle breeds, therefore importing dairy genetic is the strategy to overcome the national milk demand. Friesian Holstein (FH) is the breed which selected and imported from both Australia and New Zealand to establish dairy cattle breeding stock [1]. This breed carries superior genetic potential for milk production by able to produce 5217 kg milk per year. Also, FH is able to adapt with tropical and sub-tropical countries under temperatures range 5-25°C [2].

As generally known, milk production is the result of interaction between genetic and environment. Genetic itself is traits information written in the DNA sequence, inherited from both parents to the offspring [3]. However, its expression to phenotype depends on its interaction with environment. Due to the environmental different between Indonesia and Australia or New Zealand, imported Holstein cows would
facing climate adaptation process, feed sources, and dairy management. This situation leads to the different of milk resulted. Different environment change the set of genes expression controlling milk production to be different from its origin environment [4] in different time point such as lactation period.

For that, this study aims to evaluate the consistency of milk yield of imported Friesian Holstein which reared in Indonesia in different lactations period. The result could be useful for rearing management, specially to provide better environment to support milk production potential from superior genetic of imported dairy cattle.

2. Materials and methods

The materials in this study were 70 cows which imported from either Australia or New Zealand on 2015 when they are having their first pregnancy. All the cows were housed in Dairy Breeding Center Baturaden, Purwokerto at Limpakuwus farm under intensive production system to minimize variation due to management aspects. Milk yield data were obtained from production sheet at year 2015 to 2017, then standardized to 305 days from three consecutive lactations.

In order to separate the variance components due to genetic and permanent environmental effect versus temporary environmental effect, intraclass correlation was done with individuals as the main factor. The repeatability estimate was the outcome from the intraclass correlation. It represents the proportion of variation in milk yield due to genetic and permanent environmental effect. Whereas the residual represents the variation due to unknown aspect which we hypothesized as due to temporary environmental effect. The linear model for intraclass correlation is

\[ Y_{km} = \mu + \alpha_k + e_{km}, \]

where \( Y \) is the lactation of the individual, \( \mu \) is general mean, \( \alpha_k \) is the effect of the individual, and \( e_{km} \) is random residual. To obtain the parameter estimates, ANOVA table was built according to the intraclass correlation model (Table 1). The components of this table were then extracted to estimate the repeatability value.

| Source       | df   | SS    | MS   | EMS   |
|--------------|------|-------|------|-------|
| Between id   | (N-1)| SS_w  | MS_w | \( \sigma^2_{\alpha} + k_1 \sigma^2_e \) |
| Within id    | N(M-1)| SS_e  | MS_e | \( \sigma^2_e \) |

where,
- \( df \) = Degrees of freedom
- \( SS \) = Sum of squares
- \( MA \) = mean squares
- \( EMS \) = expected mean of squares
- \( N \) = number of observations per individuals
- \( M \) = number of individuals
- \( k_1 \) = M if the number of observations is equal
- \( m_k \) = number of repeated measurements of the k individual
- \( \sigma^2_{\alpha} \) = variance among individuals
- \( \sigma^2_e \) = residual variance

The variance component estimated from Table 1 were used to obtain the repeatability estimate according to the following formula:

\[ r = \frac{\sigma^2_{\alpha}}{\sigma^2_{\alpha} + \sigma^2_e} \]

where, \( r \) is repeatability estimate, \( \sigma^2_{\alpha} \) is variance among individuals, and \( \sigma^2_e \) is residual variance.
3. Results and discussions
In this study, the average of milk yield shows decline trend over lactations period. Highest average of milk yield was found in lactation 1, followed with lactation 2 and 3 (6077.5±1239; 4821.79±888 and 4374.6±1012 Kg). This result was in contrary with previous study, where milk yield tends to increase from first to the following lactations [6,7]. The different with our result is the milk yield obtained in these studies were obtained from the original environment as the dairy cattle origin.

As mentioned, female dairy cattle in this study were imported either from Australia or New Zealand, shipped to Indonesia in pregnant condition (4-6 months pregnancy). The change of environment later changes its effect on different milk yield over lactation period / number. In the 1st lactation, we found highest milk yield average which could explained that cow still carry environment effect from its original environment. Moreover, in the 2nd and 3rd lactation, cow start to adapt with Indonesian environment which might cannot support the genetic potential of milk production.

In the view of udder development physiology, our result also shows contrary concept. Normally, cattle udder will develop it size in term of its lobule, lumen, alveoli, and secretory cell capacity over lactation number [8,9]. In this study, it seems there is no development of udder size according to the milk yield resulted. There could be different expression of related hormone controlling udder development, such as bST (bovine somatotropin), in different environment. As explained, bST is a hormone which control the mammary gland development to support milk production [10].

The repeatability of milk yield trait in this study was found at 0.41. This mean there were 59% of the variation in milk yield is controlled by the unknown error term, including environmental effects. Considering the milk yield trend over lactations period, the repeatability value could explain that milk yield mostly affected by the environment. Our previous study also support this result [11], when we found a significant effect (p<0.05) of both lactation period and calving month to milk yield. In this regard, calving month represent different season that directly impact to the quality of feed supplied. Genetic and environment are the factors which interact to form the animal phenotype. Mostly environment shared bigger part in quantitative trait such as milk yield. Unsuitable environment would impact to the decrease of animal genetic potential expressed in phenotype. Therefore, an effort to provide better environment to the imported dairy cattle would improve the milk yield resulted.

4. Conclusions
It is concluded, there was a decrease of milk yield over lactation 1 to 3 of imported Holstein cows in Indonesia. First lactation shows highest milk yield followed with lactation 2 and 3 respectively. According to that, we consider environment factors is the most plausible explanation according to the repeatability estimation value in this study. In the effort to improve milk yield, serving better environment in term of feed, housing, and farm management could be a way to try.

5. References
[1] Pangestu M, Subagyo Y, Yuwonol P and Rustomo B 2000 Asian-Australasian J. Anim. Sci. 13 505–8
[2] Coffey E L, Horan B, Evans R D and Berry D P 2016 J. Dairy Sci. 99 5681–9
[3] Bourdon R M 2014 Understanding Animal Breeding (United State of Amerika: Pearson)
[4] Cromie A R, Kelleher D L, Gordon F J and Rath M 1998 Interbull Bulletin 17 17 100–5
[5] Hardjosubroto W 1994 Aplikasi Pemuliabiakan Ternak di Lapangan (Jakarta: PT. Gramedia Widiasarana Indonesia)
[6] Domecq J J, Skidmore A L, Lloyd J W and Kaneene J B 1997 J. Dairy Sci. 80 101–12
[7] Pösö J and Mäntysaari E A 1996 J. Dairy Sci. 79 1284–91
[8] Senger P 2005 Pathway to Pregnancy and Parturition (Washington: Pullman)
[9] Shennan D B and Peaker M 2000 Physiol. Rev. 80 925–51
[10] Mellado M, Antonio-Chirino E, Meza-Herrera C, Veliz F G, Arevalo J R, Mellado J and de Santiago A 2011 J. Dairy Sci. 94 4524–30
[11] Widyas N, Putra F Y Y, Nugroho T, Pramono A, Susilowati A, Sutarno and Prastowo S 2018 IOP Conference Series: Earth and Environmental Science vol 142 p 012005