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Estimation of Heritability Values of Birth Weight, Weaning Weight, and Yearling Weight in Bali Cattle at BPTU-HPT Denpasar-Bali

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ABSTRACT

Estimating heritability values can be used to implement selection programs and evaluate more targeted breeding programs in Bali cattle. This study aims to estimate the heritability value of birth weight, weaning weight and yearling weight of Bali cattle at Balai Pembibitan Ternak Unggul dan Hijauan Pakan Ternak (BPTU-HPT) Denpasar Bali. The research material used is the recording data of 500 Bali cows originating from 24 males (sire)with 500 Bali cows (dam) that produce offspring of as many as 500 calves. The data was secondary data, obtained by taking records of body weight data, including birth weight, weaning weight, and yearling weight, along with pedigree data of Bali cattle raised from 2017 to 2021 at BPTU-HPT Denpasar. Estimating the heritability value is done using a one-way unbalanced layout model. The results showed that the heritability values of birth, weaning, and yearling weights were 0.25±0.09, 0.23±0.08, and 0.16±0.07, respectively. Based on these results, it can be concluded that the heritability value of birth weight, weaning weight and yearling weight in BPTU-HPT Denpasar Bali is included in the moderate category so that it can be used as a selection guide to increase the productivity of Bali cattle as local Indonesian cattle.

Keywords: body weight, heritability, Bali cattle

INTRODUCTION

Bali cattle is one of Indonesia's indigenous beef cattle originating from Bali Island and has been widely distributed in various parts of Indonesia. Bali cattle are domesticated beef cattle from wild bulls and are one of the potential germplasm to be developed (Crisdayanti et al., 2020). Bali cattle can adapt well to the tropical environment, as seen from their varied production performance and high reproductive ability. Bali cattle have high economic value and are most widely kept by small farmers because they have a high fertility rate, low mortality, easy environmental adaptation, and a high carcass percentage (Sari et al., 2020). Based on some of its advantages, Bali cattle deserve to be improved and developed in terms of population and genetic quality (Warmadewi et al., 2017).

Genetic parameters are one of the methods used in breeding programs and are very important in livestock selection. The selection results will shape the appearance of individuals controlled by genetic and environmental factors (Setiawan et al., 2018). Genetic parameters can be predicted from measurable performance, such as birth weight, weaning weight and yearling weight. One of the important genetic parameters in the success of breeding programs in selection is heritability. Heritability can be used as a guide for improving a livestock trait's performance through improved management or environmental conditions in addition to genetic selection (Krisnamurti et al., 2019). The heritability value obtained is used to implement selection programs and evaluate more targeted breeding programs in Bali cattle at BPTU-HPT Denpasar.

MATERIALS AND METHODS

This research was conducted at Balai Pembibitan Ternak Unggul dan Hijauan Pakan Ternak (BPTU-HPT) Denpasar Bali from September to November 2023. The research material used was the recording data of 500 Bali cattle derived from 24 males and 500 Bali cattle that produced 500 offspring. The secondary data is obtained by taking records of body weight data, including birth weight, weaning weight, and yearling weight. The data is pedigree data of Bali cattle raised from 2017 to 2021 at BPTU-HPT Denpasar.

Data Analysis

This study uses the unbalanced pattern method (One-way Layout) model, where each male marries several females, but the number of offspring per male differs. The statistical model (Kurnianto, 2012) used is :

$$Y_{ik} = \mu + \alpha_i + e_{ik}$$

Information :

Y_{ik} = Measurement value in daughter k of stud i

μ = General average

α_i = Effect of i-th male

e_{ik} = Effect of environment and uncontrolled genetic drift

Analysis of variance and separation of variance components of heritability values according to Kurnianto (2012) are presented in Table 1.

Table 1. Analysis of Variance and Separation of Variance Components

Source of Diversity	Free Degree	Sum of Squares	Center Square	Mean Square of Expectations
Correction Factor	1	FK = (Y…^{2}) / n•		
Stud (s)	S - 1	JKs = $\sum_i \frac{Yi•^2}{ni} - FK$	KTs = jks/dbs	$\sigma^2w + k.\sigma^2s$
Between males (w)	n• - S	JKw = $\sum_i \sum_k Y^2_{ik}$ - $\sum_i \frac{Yi•^2}{ni}$	KTw = jkw/dbw	σ^2w

The calculation of heritability value can be calculated by the formula (Kurnianto, 2012):

$$h^2 = \frac{4.\sigma^2 s}{\sigma^2 s + \sigma^2 w}$$

The standard error of the heritability value is *:*

$$SE\ (h^2) = 4\sqrt{\frac{2\ (1-t)^2\ (1+(k-1)\ t)^2}{k\ (k-1)\ (s-1)}}$$

RESULT AND DISCUSSION

The average birth weight (BW) was 18.17±2.40 kg, the average weaning weight (WW) was 92.39±17.85 kg, and the average yearling weight (YW) was 132.71±27 kg. According to Setiyabudi et al. (2016), the average body weight of Bali cattle in BPTU-HPT Denpasar in the 2008-2013 period includes birth weight (BW) is 17.91 ± 1.26 kg, the average weaning weight (WW) is 85.06 ± 16.55 kg, and the average yearling weight (YW) is 117.56 ± 19.40 kg. The results of this previous study are lower than the results. The increased performance in Bali cattle can be explained by the selection applied at BPTU-HPT Denpasar values can be caused by differences in calculation time. Still, they can also be caused by environmental factors such as feed nutrition, livestock management, and climate change. Year of birth affects performance due to fluctuations in feed availability from year to year or instabi (Chaerunnisa and Nurgiartiningsih, 2022). According to Sudarmawan et al. (2023), differences in average lity in management practices related to feeding methods, animal health management and changes in climatic factors and parental influences (Setiyabudi et al., 2016).

The estimated heritability values of birth weight, weaning weight and one-year weight obtained in this study from 2017 to 2021 were 0.25±0.09, 0.23±0.08, and 0.16±0.07, respectively (Table 2). The heritability value of birth weight in the results of this study is higher than the results of Setiyabudi's (2016) research on Bali cattle calculated through mixed model analysis using the R.Model program and the estimation of heritability values calculated from the variance components of males and females based on Becker's 1992 formula. Meanwhile, the value of weaning weight and yearling weight is lower than the results of Setiyabudi's research (2016), which comes from genetic data from the BPTU-HPT Denpasar collection from 2008-2013, including records of birth weight, weaning weight, and yearling weight with the number of livestock respectively 573, 541 and 523 heads.

Table 2. Mean and standard deviation of birth weight, weaning and yearling weight of Bali cattle

Parameter	Mean (kg)	SD (kg)	CV (%)
Birth weight	18.17	2.40	0.13
Weaning weight	92.39	17.85	0.19
Yearling weight	132.71	27	0.20

Table 3. Heritability values of birth, weaning weight and yearling weight of Bali cattle

Properties	Heritability ± SE
Body weight	0.25 ± 0.09
Weaning weight	0.23 ± 0.08
Yearling weight	0.16 ± 0.07

Based on Table 3. it can be concluded that the heritability estimation value produced is included in the medium category with the heritability value of birth weight (0.25 ± 0.09); weaning weight (0.23 ± 0.08), and one-year weight (0.16 ± 0.07). According to Warmadewi (2014), the higher the genetic variation, the higher the heritability value. Conversely, the higher the environmental variation, the lower the heritability value. Kurnianto (2012) stated that the value of heritability is categorized into three: low if it has a value of 0 ~ 0.15, medium if it has a value of 0.15 ~ 0.30 and high if it has a value of ~ 0.30.

Different calculation times and populations will cause differences in heritability values obtained due to changes in livestock composition and genetic diversity contained in the population (Hardjosubroto, 1994). According to Noor (2010), heritability values can be caused by differences in livestock breeds, environment, production time, number of observations and estimation methods. In addition, differences in population size are thought to cause differences in the heritability values of birth weight, weaning weight and weight at one year of age. The heritability value depends on the diversity of the environment, the method of analysis and the number of samples used (Kaswati et al., 2013). The standard error is relatively small and smaller than the heritability value, meaning that the heritability value is reliable or trustworthy, so it is feasible to be applied in activities to improve the genetic quality of Bali cattle.

The heritability value of the birth weight of Bali cattle in BPTU-HPT Denpasar is 0.25 ± 0.09, which is in the medium category. The heritability value of 0.25 means that the difference (diversity) of birth weight appearance between individual calves in the population is 25%, caused by additive genetic diversity between individuals. In beef cattle, the heritability value of birth weight ranges from 0.24 to 0.43 (Kurnianto, 2012). The heritability value of body weight at birth age is lower than the results of research by Setiawan et al. (2018) of 0.46 ± 0.41 and the results of research by Kaswati et al. (2013) of 0.85 ± 0.44. Warwick et al. (1995) state that some environments can cause greater expression of genetic differences that increase genetic diversity and heritability.

The heritability value of birth weight of Bali cattle in BPTU-HPT Denpasar was 0.23 ± 0.08, which is in the medium category. In beef cattle, the heritability value of weaning weight ranges from 0.27 - 0.46 (Kurnianto, 2012). The heritability value of body weight at weaning age is higher than the research of Setiawan et al. (2018) of 0.03 ± 0.17 and lower than the results of research by Kaswati et al. (2013) of 0.51 ± 0.32. Environmental diversity, analysis methods, the number of samples used and heritability change according to the type of livestock, traits, population, nation, time and region (Warwick et al., 1995; Putra et al., 2014).

The heritability value of the yearling weight of Bali cattle at BPTU-HPT Denpasar is 0.16 ± 0.07, which is in the medium category. The heritability value of yearling weight in beef cattle ranges from 0.26 - 0.49 (Kurnianto, 2012). The heritability value of body weight at one year of age is higher than the results of research by Setiawan et al. (2018) of 0.03 ± 0.16 and lower than Kaswati et al. (2013) of 0.54 ± 0.32. The estimated heritability value tends to decrease from birth to yearling weight, so the evaluation must be done gradually and directed to selection. The variable heritability value is due to genetic variation in the population. At the same time, environmental factors are considered to have no effect due to the maintenance management carried out by BPTU-HPT Denpasar (Setiawan et al., 2019).

CONCLUSION

The heritability values of birth weight, weaning weight and yearling weight of Bali cattle at BPTU-HPT Bali are in the moderate category. They can be used as selection guidelines to increase the productivity of Bali cattle as local Indonesian cattle. The heritability results of the three body weight traits tend to decrease from birth weight to yearling weight. Hence, the evaluation of breeding programs needs to be carried out gradually and purposefully in Bali cattle at BPTU-HPT Denpasar.

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