Most Probable Producing Ability of Bali Cows for Calving Interval and Calf Growth Performance

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Most Probable Producing Ability of Bali Cows for Calving Interval and Calf Growth Performance

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Abstract: Most probable producing ability (MPPA) is the one factor used to compare the performance potential of dam based on the data of their progeny. The purpose of the research was to study the genetic ability of weaning weight, yearling weight and calving interval of Bali cows. The weaning weight data of 296 cows derived from 99 dams, yearling weight data of 245 cows derived from 86 dams and calving interval data of 194 cows from 63 dams were used to estimate repeatability and MPPA of Bali cows in a herd for the three traits. Repeatability of three traits was estimated by analysis of intra-class correlation, and these in turn were used for calculating the estimated MPPA of cows. The results showed that the means of weaning weight of males and females were 95.56 ± 17.25 kg and 87.57 ± 18.45 kg, respectively; means of yearling weight were 143.39 ± 25.78 kg and 136.90 ± 22.01 kg, respectively; and mean calving interval was 391.62 ± 22.59 d. The estimated repeatability of weaning weight, yearling weight and calving interval were 0.006 ± 0.059, 0.022 ± 0.068 and 0.115 ± 0.078, respectively. The best 10 dams in the herd based on the estimates of MPPA for weaning weight, yearling weight and calving interval were not the same for the three traits.

Key words: Weaning weight, yearling weight, calving interval, most probable producing ability, Bali cows.

1. Introduction

Beef cattle were grown to produce meat and other products which were utilized by human beings. Meat is an important food source to fulfill the need of protein of human. Meat demand in Indonesia was increased by 6%-8% each year, especially in densely populated areas, such as Java. The fulfillment of the meat is partially supplied by local beef cattle, such as Bali, Ongole, Madura and some other breeds. Bali cattle represent the greatest percentage (26.92%) among all cattle breeds, which means that the contribution of Bali cattle to meeting the needs for the meat is very significant. However, the performance of Bali cattle in producing meat has not yet reached a maximum so that efforts are still needed to optimize it.

The advantage characteristics of Bali cattle breed are its high fertility, high meat quality, low fat percentage [1], its survival and capacity to perform under poor environmental and climatic conditions in harsh dry land areas, such as in Eastern Indonesia [2]. In beef cattle production, such as Bali cattle, selective breeding mainly has been purposed to improve production trait, such as average daily gain (ADG), growth rate and very rare in reproduction trait. However, reproduction traits appear most economically important in meat production whatever the production system. Economic losses from impaired reproductive traits, such as fertility, are main cause of the production loss as a result of prolonged calving interval, increased insemination costs, reduced return from calves born and higher replacement costs [3].

Most probable producing ability (MPPA) is a means of comparison of the maternal performance potential of dam based on the data of their progeny. An MPPA value could be meant as a deviation in maternal performance from the average value for the herd [4]. Maternal performance means to a composite of characteristics of the dam, such as the ability to keep a calf with a good weaning weight. Calving

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interval is also an important reproduction trait in selecting cows to be retained in a herd, as it is an indicator of lifetime maternal ability of the cow.

In this sense, MPPA could be used by the owner of the animal as the basis for culling cows within a herd. It could not be used for comparing among cows in other herds, since it is estimated as the deviation of the individual performance from its herd average. The aim of the research was to study the genetic ability of weaning weight, yearling weight and calving interval of Bali cows.

2. Materials and Methods

2.1 Data Collection

Records on 735 registered Bali cattle managed by Livestock Center of Excellence (Balai Pembibitan Ternak Unggul, BPTU) were used to study cow performance in terms of MPPA. The data consisted of the weaning weight data of 296 cows derived from 99 dams with 2-7 records per dam, yearling weight data of 245 cows derived from 86 dams with 2-6 records per dam, and calving interval data of 194 cows from 63 dams with 2-7 records per dams. A summary of the data structure from 1994 to 2006 for each trait is presented in Table 1. Completeness of records for the traits considered in the study is presented in Table 2. The data were used to estimate the repeatability and MPPA values of weaning weight, yearling weight and calving interval for the Bali cows.

2.2 Management of Animals

The project on the genetic improvement of growth performance of the Bali breed was initiated in 1976 by the Agriculture Ministry of Republic Indonesia. In the

Table 1 Mean, standard deviation (SD) and coefficient of variation (CV) of weaning weight, yearling weight and calving interval.

Items	Traits		
	Weaning weight	Yearling weight	Calving interval
Number of records	296	245	194
Total number of dams	99	86	63
Number of dams with			
2 records	46	44	23
3 records	26	21	23
4 records	16	12	9
5 records	5	6	6
6 records	5	3	1
7 records	1	0	1
Mean	88.59	120.09	560.65
SD	15.78	22.01	255.02
CV	17.81	18.33	45.49
Min.	55.68	68.68	347.67
Max.	163.38	183.13	1475

Table 2 Completeness of 735 records for the three traits.

No. of records of data	Weaning weight	Yearling weight	Calving interval
579	x	x	x
6	-	-	x
13	x	-	x
105	x	x	-
26	x	-	-
6	-	x	-

x:Trait data were available for the records; -: trait data were not available for the records.

project, animals were selected at one-year old from village breeding centers (Tabanan and Karang Asem). Then, the animals were located into herds in Pulukan to join in performance test under controlling of Bali Breeding Center. In these herds, pedigree and some other information, such as growth traits and reproduction traits, were collected and recorded in the database of Bali Breeding Center for the purpose of investigating the success of the Bali project. Mating for these herds was by artificial insemination (AI) and natural mating. The mating period was started from July to December. Calving was commenced from April to October of the following year. After birth, the calves were weighed and ear-tagged within 12 h. Data of newborns, like their sire, their dam, date of birth, sex and birth weight, were recorded. The calves and their dam were assigned together until weaning. Period of the suckling for all calves was not the same. During the suckling period, there were additional feed for the calves, such as king grass and concentrate. Most of the calves were weaned in May when they were 210 ± 15 d of age. After weaning, the calves were separated from their dams and put in different herds. From 18 months of age, the animals were managed similarly for one year in order to evaluate their performance. All young cattle were fed the same grasses and put in the same paddock.

2.3 Data Analysis

All weaning weights and yearling weights were adjusted to the average age of 205 d and 365 d, respectively. The formulas for adjusting them are according to Hardjosubroto [5], as the following Eqs. (1) and (2):

$$WW_{205} = \left(\frac{BW - BB}{age} \times 205 + BB\right) \times CFD \quad (1)$$

$$YW_{365} = \left(\frac{BY - BW}{time} \times 160\right) + WW_{205} \quad (2)$$

where, WW_{205}: adjusting body weight at 205 d; BW: weaning weight; BB: birth weight; CFD: correction factor of dam age; YW_{365}: adjusting body weight at 365 d; BY: yearling weight; time = grace period: the different age between yearling and weaning.

Due to sex, there was a significant source of variation in weaning weight in cattle, so it was decided to adjust all the females to males. The adjusting data was only for estimating repeatability.

Estimates of the variance components were obtained by equating the mean squares (MS) to the expected mean squares ($\sigma_e^2 + k_1\sigma_w^2$ for between dam and σ_e^2 for within dam, respectively). Only dams having two or more progeny were included in the analysis. The repeatability estimates for weaning weight, yearling weight and calving interval were determined by analysis of intra-class correlation coefficient (r) according to Becker [6] based on Eq. (3):

$$r = \frac{\sigma_w^2}{\sigma_w^2 + \sigma_e^2} \quad (3)$$

And the standard error of repeatability (SE_r) is calculated by Eq. (4):

$$SE_r = \sqrt{\frac{2(m-1)(1-r)^2[1+(k-1)r]^2}{k^2(m-N)(N-1)}} \quad (4)$$

where, N = number of individuals; m = total number of measurements; k = number of measurements per individual. Due to unequal number for each individual, k was calculated by Eq. (5):

$$k = \frac{1}{N-1}\left(m - \frac{\sum m_k^2}{m}\right) \quad (5)$$

The estimated repeatability for weaning weight, yearling weight and calving interval were used to calculate the MPPA of the cows for the respective traits according to Hardjosubroto [5], using the following Eq. (6):

$$MPPA = \frac{nr}{1+(n-1)r}(\bar{P} - \bar{\bar{P}}) \quad (6)$$

where, MPPA = most probable producing ability; n = number of data; r = repeatability; $\bar{P}$ = average of trait estimated; $\bar{\bar{P}}$ = average of trait population.

3. Results and Discussion

Table 3 showed the mean of weaning weight, yearling weight and calving interval by year. The mean of weaning weights and yearling weights for males and females were 95.56 ± 17.25, 87.57 ± 18.45, 143.39 ± 25.78 and 136.90 ± 22.01 kg, respectively. The mean calving interval was 391.62 ± 22.59 d.

Both weaning weights and yearling weights were higher for males than that for females. This is in agreement with a number of studies on Bali cattle and other breed [7-10]. The mean calving interval indicated that reproduction efficiency of the cows was in accordance to other studies for Bali breed and other beef and dairy cattle breeds [10-12]. Hafez [13] stated that calving interval depends on the efficiency of heat detection (in the case of AI) and fertility of the males and females. In addition, weaning age, days open, body condition, pregnancy diagnosis and diseases control are some factors which can influence calving interval. Mating system adopted for the herd may also affect calving interval. Most of the cows (90%) were mated using AI with the rate of services per conception (S/C) of about 1.2 ± 0.06. The other 10% of the cows were mated naturally using the best bull from the performance test. The bulls were progeny tested for certain traits, which included weaning weight and yearling weight.

The repeatability estimates for weaning weight, yearling weight and calving interval are given in Table 4. The values of repeatability are somewhat lower than the estimates reported by Arango et al. [14] and Suhad et al. [15]. The low repeatability estimate would limit the usefulness of MPPA as an estimate of future cow productivity. Other sources of environmental and non-additive genetic variation, such as age of dam, year of birth and season of birth, may have to be accounted for in the estimation of repeatability. Then, the value of repeatability may be higher and more accurate.

Of the 99 cows tested on weaning weights, 45.45% had MPPA values above the herd average. Percent with MPPA above herd average for yearling weights and calving interval were 50% and 36.51%, respectively. Cows with low MPPA for weaning weight, yearling weight and calving interval should be culled from the herd in order to improve future cow productivity of the herd. The best 10 cows with the highest MPPA estimates for weaning weight, yearling weight and calving interval are listed in Table 5.

Table 3 Mean of weaning weight, yearling weight and calving interval from 1994 to 2003.

Year	Weaning weight		Yearling weight		Calving interval (d)
	Male (kg)	Female (kg)	Male (kg)	Female (kg)	
1994	93.45 ± 16.09	83.56 ± 17.78	142.46 ± 23.76	134.45 ± 16.26	400.00 ± 15.67
1995	93.52 ± 13.68	83.13 ± 14.22	142.36 ± 28.12	134.34 ± 20.16	396.00 ± 21.18
1996	94.56 ± 18.70	84.33 ± 16.52	143.53 ± 23.30	135.30 ± 21.21	396.00 ± 20.22
1997	92.51 ± 12.14	89.93 ± 10.61	143.16 ± 25.46	138.68 ± 14.15	385.78 ± 17.81
1998	94.50 ± 38.70	82.30 ± 16.50	144.30 ± 36.00	135.30 ± 26.20	396.00 ± 16.34
1999	93.45 ± 15.12	89.75 ± 15.60	143.66 ± 20.36	138.70 ± 15.43	385.78 ± 19.92
2000	93.65 ± 10.15	89.83 ± 12.50	143.75 ± 15.45	138.98 ± 17.23	395.78 ± 18.98
2001	93.26 ± 12.14	90.50 ± 10.61	145.26 ± 25.46	139.68 ± 14.15	388.00 ± 20.79
2002	91.10 ± 19.60	85.88 ± 26.12	142.20 ± 20.14	132.51 ± 16.20	385.98 ± 22.16
2003	115.60 ± 19.60	96.50 ± 14.45	143.24 ± 24.43	141.05 ± 29.67	386.83 ± 21.56
Mean	95.56 ± 17.25	87.57 ± 18.45	143.39 ± 25.78	136.90 ± 22.01	391.62 ± 22.59

Table 4 Repeatability estimates for characters measured.

Traits	Repeatability
Weaning weight	0.006 ± 0.059
Yearling weight	0.022 ± 0.068
Calving interval	0.115 ± 0.078

Table 5 The best 10 cows based on MPPA for weaning weight, yearling weight and calving interval.

Rank	Weaning weights			Yearling weights			Calving interval		
	No. of records	Dam code*	MPPA	No. of records	Dam code	MPPA	No. of records	Dam code	MPPA
1st	3	716.87	0.55	5	701.90	2.75	2	745.93	192.26
2nd	4	833.85	0.49	2	724.87	2.72	3	512.90	164.37
3rd	3	506.90	0.47	3	506.90	2.15	2	859.92	124.60
4th	3	505.90	0.41	3	505.90	2.03	2	716.87	121.30
5th	6	702.90	0.36	2	790.89	1.91	2	809.91	114.49
6th	7	718.90	0.36	3	833.85	1.88	3	701.93	96.31
7th	3	766.88	0.34	3	766.88	1.59	3	741.91	95.66
8th	2	790.89	0.34	3	840.90	1.53	3	746.88	85.56
9th	3	724.87	0.33	2	798.90	1.51	2	833.90	85.10
10th	3	725.87	0.32	6	718.90	1.32	5	742.88	84.84

* No unity for dam code, that was only ear tag used to distinguish from a cow to another cow. Ranks were made for the dam (cows) based on MPPA value.

The dam code of the top 10 cows for each trait was different, meaning that cows predicted to have the best performance for one trait are not among the top for the other traits. There is no dam in the top 10 cows for all three traits, but there are three dams (506.90, 505.90 and 766.88) which had the same ranking for weaning weight and yearling weight. MPPA estimate depends on the value of repeatability for the trait, the performance of the animal for the trait and the number of records available for the animal for the trait. Based on the formula for MPPA, higher repeatability values and higher performance of the animal would result in the higher MPPA estimates. In terms of maternal performance, MPPA does not provide a complete evaluation of the cow, as each estimate is for a single trait. Furthermore, the economic value of the individual traits is not considered. It was believed that culling cows on the basis of calving interval could improve average reproductive performance of herds [4].

4. Conclusions

From the findings of the present study, it may be concluded that the repeatability estimates for weaning weight, yearling weight and calving interval in the Bali cattle are rather low. However, selection for the dam based on MPPA value could be done on their herd to improve future cow productivity. Depend on the traits which will be selected, about 45.45% of the dam could be chosen as cow for the next generation for weaning weight, 50% for yearling weight and 36.51% for calving interval, respectively.

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