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Estimates of Genetic and Phenotypic Trends of Growth Traits in Bali Cattle

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ABSTRAK

Penelitian ini bertujuan untuk menghitung pola genetik dan fenotipik sifat pertumbuhan bobot lahir, bobot sapih, dan bobot umur satu tahun sapi bali. Total sapi yang digunakan untuk menentukan bobot lahir, bobot sapih, dan bobot umur satu tahun masing-masing 235, 215, dan 178 ekor. Nilai pemuliaan, korelasi fenotipik, dan genetik dihitung melalui analisis *restricted maximum likelihood* dan *general linier model* (GLM). Selanjutnya untuk mengetahui pola genetik sifat pertumbuhan dihitung melalui analisis regresi rataan nilai pemuliaan terhadap tahun kelahiran. Hasil penelitian ini menunjukkan bahwa korelasi fenotipik dan genetik antara bobot lahir dan bobot sapih masing-masing adalah 0,10; 0,08; dan 0,70 dan 0,90 untuk bobot sapih dan bobot setahun. Pola fenotipik sifat pertumbuhan bobot lahir dan bobot sapih adalah relatif tetap, sedangkan bobot setahun menunjukkan adanya fluktuasi antara tahun 2000-2008. Hal yang sama ditunjukkan pada pola genetik, bobot lahir dan sapih yang menunjukkan adanya kecenderungan tetap antara tahun 2000-2008 kecuali pada bobot sapih tahun 2005, sedangkan pola genetik bobot setahun menunjukkan adanya fluktuasi yang sangat besar. Menurut pendugaan nilai pemuliaan, pejantan No. 0565 merupakan pejantan terbaik dengan nilai pemuliaan BW, WW, dan YW masing-masing +0,07; +2,79; dan +10,25 lebih tinggi daripada rataan populasinya. Pola genetik tersebut menunjukkan kecenderungan positif yang berarti bahwa seleksi terhadap sifat pertumbuhan akan efektif dalam perbaikan mutu genetik. Nilai korelasi genetik antara bobot sapih dan bobot setahun adalah 0,70 (tinggi) yang mengindikasikan bahwa seleksi terhadap bobot sapih akan meningkatkan bobot setahun pada sapi bali.

Kata kunci: sifat pertumbuhan, pola genetik, bobot lahir, sapi bali

ABSTRACT

The aim of this study was to estimate genetic and phenotypic trends for growth traits including birth (BW), weaning (WW) and yearling weight (YW) in Bali cattle. The number of cattle used to determine growth traits of BW, WW, and YW were 235, 215, and 178 heads, respectively. Estimation of breeding value, phenotypic and genetic correlation were calculated by Restricted Maximum Likelihood and General Linier Model (GLM) procedures, respectively. Genetic trends analysis was performed using the regression mean breeding values on birth year. Phenotypic and genetic correlation among BW and WW were 0.10 and 0.08 respectively and 0.90 and 0.70 for WW and YW respectively. The phenotypic trends for traits of birth and weaning weight were constant, whereas yearling weight was fluctuating from 2000 to 2008. Likewise, in the case of genetic trends, the birth and weaning weight were constant from 2000 to 2008 except for WW in 2005, whereas the genetic trends for yearling weight showed a fluctuation of wide range. According to the breeding value estimated for all traits, the best was the sire No. 0565, whose breeding value for BW, WW and YW were +0.07, +2.79, and +10.25 kg, respectively higher than the mean value of the population. The genetic trends showed that there have been a significant and positive genetic improvement in all growth traits and indicate that selection would be effective. Genetic correlation between WW and YW was high (0.70) which indicates that the selection on weaning weight might also increase yearling weight in Bali cattle.

Key words: growth traits, genetic trends, Bali cattle

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INTRODUCTION

Growth performance of Bali cattle has been a major concern especially in the character of body weight at a certain age, birth weight, weaning and yearling weight (Supriyantono *et al.,* 2011). Those of traits are of primary economical importance in selection programmes for cow calf production system due to these traits are easily measured and have medium to high heritability cow calf production system. The heritability of weaning and yearling weight were considered as moderate to high (0.33-0.43) which means that the selection program will be more effective and efficient in improving the genetic merits in Bali cattle (Gunawan & Jakaria, 2011). Another factor has to be considered when selecting for growth traits that may be phenotipically and genetically correlated (Mohktari & Rashidi, 2010). The genetic correlation between weaning weight and post weaning weight showed a positive value which indicates that the selections on weaning weight might also increase the yearling weight and body weight gain (Supriyantono *et al*., 2011).

Genetic aspect of growth traits through selection become important role in calf production system. High growth performance has been the primary selection emphasis in beef cattle breeding. In order to achieve optimum progress for cow calf production system, selection of animals has to be base on genetic parameter such as estimated breeding value (EBVs) and genetic correlation. Estimation breeding value is important because it will pass onto the offspring (Susanto *et al*., 2010). Accurate prediction of breeding value of animals is one of the best tools available to maximize response to selection program (Mokhtari & Rashidi, 2010). Apart from this, annual genetic trends for calf growth traits should be monitored over time to check the validity of the prediction made and to investigate direction of genetic change (Intaratham *et al.,* 2008).

Genetic trends reflect the amount of genetic improvement in a population over time (Zishiri *et al.,* 2010). Estimates breeding value and genetic trends on growth traits of different tropical cattle breeds have been reported by several studies (Boligon *et al.,* 2011; Araujo *et al.,* 2010; Vergara *et al.,* 2009; Sukmasari *et al.,* 2002). However, the estimation of breeding value and genetic trends of growth traits for indigenous Bali cattle are very rare. The research of Sukmasari *et al.* (2002) revealed no increase in genetic trend during period of 1983-1986 and 1988-2000.

Evaluation of breeding programs is needed to be show as a measurement in genetic merit with environmental condition and factor of limitation. In this study, field data during 2000 to 2008 are performed base on applicable breeding program for measuring genetic progress in Breeding Center of Bali cattle. The aim of this study was to estimate genetic parameters and genetic trends of growth traits of Bali cattle in Breeding Centre.

MATERIALS AND METHODS

Source of Data

The breeding program was undertaken at Breeding Center of Bali cattle, located in Jembrana District, Bali Province. Data used in this study were collected during the period of 2000 to 2008. The traits investigated included: growth traits at birth (BW), weaning (WW) and yearling weight (YW). The records number of BW, WW, and YW were 235, 215, and 178 heads, respectively. Detail of data structure according to traits studied with various classes and subclasses were described previously in Gunawan & Jakaria (2011). Data on WW and YW at several calf ages were corrected based on 205 and 365-d age respectively. Data on BW of Bali cattle were available. The quotients used in weaning weight and one year weight correction based on 205 and 365-d age (BIF, 2002) were as follows:

WW205: {[(actual weaning weight − birth weight)/actual age] x 205 d} + birth weight
YW365 : {[(actual yearling weight − W205)/(actual age −205)] x 160 d} + W205

Data Analysis

For each traits, restricted maximum likelihood estimates of EBVs were obtained from the multiple trait derivative-free restricted maximum likelihood (MTDFREML) program (Boldman *et al.,* 1993) using a unitrait animal model which included sex (male, female), parity (1, 2, 3, 4, 5), year of birth (2006, 2007, 2008, 2009), and season (dry, rainy), as fixed effect, and sire and dam as random effects. Data of each replicate were analyzed using the following model:

$$Y= Xb + Za + e,$$

Where:
Y = the vector of BW, WW, and YW,
X = incidence matrices associated with the fixed
Z = incidence matrices associated random effects
b = the vector of fixed effects
a = the vector of animal direct additive effects, and
e = the vector of random errors.

"Y" is traits used in the model and "b" is the solutions for fixed effects for traits associated with the values of the incidence matrix X. The genetic random effects "a" is associated with the incidence matrix Z, and "e" are residual random effects for traits.

Phenotypic and genetic correlations were estimated to know relationship among growth traits.

$$r_G = \frac{cov_o}{\sqrt{\delta_{ox}^2 + \delta_{oy}^2}}$$

$$r_P = \frac{cov_o + cov_e}{\sqrt{(\delta_{ox}^2 + \delta_{ex}^2) \times (\delta_{oy}^2 + \delta_{ey}^2)}}$$

Where:
o = random effects
e = fixed effects
x or y = traits a given value refers to (BW, WW, and YW)

The phenotypic and genetic trends for growth traits BW, WW, and YW were calculated by regression of average BW, WW, and YW and average predicted breeding values for the traits versus the dam's birth year according to Filho *et al.* (2005).

$$Y = a + bX$$

Where:
Y = BW, WW, and YW or breeding value
a = Intercept
X = Year of birth
b = The regression coefficient for Y on X

RESULTS AND DISCUSSION

Comparison of Growth Traits

The mean of BW, WW, and YW were 18.0, 86.78, and 144.56 kg respectively (Table 1). The mean of BW in this study was higher than the value obtained by Panjaitan *et al.* (2003) which showed the mean of BW for Bali cattle in the dry tropics Sumbawa was 14.2 kg. However, the BW value was lower compared with tropical cattle (Bonczek *et al.*, 1992; Demeke *et al*., 2004). This may be due to the breed factor and effect of environment (Jurado *et al.*, 1994).

Table 1. Data of growth traits including birth weight (BW), weaning weight (WW), and yearling weight (YW) in Bali cattle (kg)

Traits	Birth weight	Weaning weight	Yearling weight
n (heads)	236.00	215.00	168.00
Mean	18.00	86.78	144.56
Stdev	4.00	1.95	5.03
Minimum	16.82	84.15	133.34
Maximum	18.90	89.55	155.12

The WW value was lower than the values obtained by Sukmasari *et al.* (2002) and Praharani (2009), who reported the WW mean in Bali cattle were 92.62 and 90.5 kg, respectively. The WW value was also lower compared to other results. Dominguez *et al.* (2003) obtained WW value of Tropicarne cross breed (63% Senepol, 23% Barzona, 9% Brahman, and 5% Charolais) in Mexico was 220.2 kg. Riley *et al.* (2007) estimated WW in Angus, Romosinuano, and Brahman crossbreds in USA was 219.9 kg. The WW mean revealed in Zebu, Angus, Holstein, Simmental, and Criollo crossbreds in Colombia was 191 kg (Arboleda *et al.*, 2007). The small body weight at weaning in Bali cattle compare to other tropical cattle may be a characteristic of Bali cattle. However, the mean of WW could be improved in Bali cattle by placing dams and calves in paddocks that have better quality pastures. The higher WW will also allow replacement heifers to breed earlier, thus reducing replacement costs, and perhaps resulting in longer productive lives (Vergara *et al.*, 2009).

The YW mean of Bali cattle in this study was higher than those reported by Sukmasari *et al.* (2002) and Praharani (2009) who obtained mean YW in Bali cattle were 140.92 and 139.50 kg, respectively. Contrarily, the mean YW here was lower than Tropical cattle crossbreed value reported by Arboleda *et al.* (2007) who estimated YW in *B. taurus-B. indicus* crossbred cattle and Blanco Orejinegro cattle were 225 kg and 147 kg, respectively. The higher body weight at YW in Bali cattle in this study compare to previous study may be due to good supplementation in dry season. The low YW mean obtained here suggest that supplementation provided to cattle during the dry season was insufficient to meet their nutritional requirements for growing, thus resulting in low weight gains (Vergara *et al.*, 2009).

Breeding Value

According to the breeding value estimation, No. 0565 was the best sire among others, whose breeding value for BW, WW, and YW were +0.07, +2.79, and +10.25 kg, respectively higher than the mean value of the population (Table 2). It can be stated that the sire whose breeding values estimation on BW are good, has similar breeding values according to WW and YW. However, in the rank line of breeding values estimation on growth

Table 2. Estimated breeding value and the rank line of the tested sire of Bali cattle

ID of Sire	Birth weight			Weaning weight			Yearling weight		
	n	EBV	Rank	n	EBV	Rank	n	EBV	Rank
565	23	0.07	1	20	2.79	1	20	10.25	2
IB	68	0.01	4	64	1.24	2	50	1.82	5
3038	53	-0.08	6	52	-0.44	4	34	5.53	3
705	26	-0.07	5	23	-1.13	5	9	10.96	1
551	25	0.12	3	22	-0.05	3	19	-4.09	6
525	24	0.14	2	19	-3.31	7	19	-4.47	7

Note: EBV= estimated breeding value.

traits can be found a higher deviation, e.g. the sire No. 0525, which is on the 7th place according to the WW and YW, but on the 2nd place when it was estimated according to BW. It can also be observed in case of the sires No. 0705. Differences in rank appear when animals are ordered by breeding value estimation for two or more traits, indicating that selection base on these criteria could achieve different result (Pena *et al*., 2004). Selection criteria base on growth trait, such as WW and YW, would distinguish sire with higher genetic merit and more uniform progeny. This result were supported by our result that the sire ID 0565 whose breeding values estimation on WW was good, had similar breeding values according to YW. The sire ID 0525 whose breeding values estimation on WW was negative value, had similar breeding values according to YW. Genetic variance of WW and YW of Bali cattle was quite moderate (30%-40%) (Praharani, 2009). The selection program on WW and YW were expected effective to improve genetic quality of growth trait. Selection in Breeding Centre has been done to evaluate sire through the progeny test. Three were five males selected for the end of performance test in which the phenotype was deviate as Bali cattle with best vital statistic (Supriyantono *et al*., 2011).

Genetic and Phenotypic Correlations

The phenotypic correlations between all traits of growth traits were consistently low to high and positive. They range between 0.10 for BW and WW and 0.90 for WW and YW (Table 3). The low correlations between BW and WW are favourable because selection for traits like pre-weaning weight is not expected to have an effective correlated response in birth weight. This would be useful in avoiding problems related to calving difficulties. However, the estimate of phenotypic correlation between WW and YW in this study was higher (0.90) indicated a strong positive relationship between the two traits. These results were consistent with that reported by Eler *et al.* (1995), Sukmasari *et al.* (2002), and Pico (2004), they were still positive indicating that selection for high WW will result in higher YW. The reason for the diversity of estimates reported could be due to the fact that all estimates depend on the models that were utilized as well as the random factors included in the model development (Zishiri *et al*., 2009).

The genetic correlations were consistently followed the same trend with phenotypic correlation. Genetic correlations were good indicating that selection for one trait will improve others in a desired direction. They ranged between 0.08 for BW and WW and 0.70 for WW and YW. In the present study, BW had low correlations with the remaining variables ranging from 0.08 to 0.22 for genetic correlations and from 0.10 to 0.13 for phenotypic correlations. This result correspond well with El-Saied *et al.* (2006) who reported birth weight had lower genetic and phenotypic correlation. However, the same result which showed higher value genetic correlation between WW and YW followed phenotypic correlation. The estimate of genetic correlation between WW and YW in this study was higher (0.70) and this implies that WW is a good indicator of subsequent development of the calf. The genetic correlation estimates in this study correspond well with Sukmasari *et al.* (2002) who reported genetic correlation for WW and YW for Bali cattle of 0.72. This estimated was higher compare to Eler *et al.* (1995) who reported a value 0.16. Nevertheless, compared to other literature estimates the obtained estimates were lower for all the traits studied. Meyer (1994) reported a value of 0.95 and 0.79 for Angus and Zebu cross cattle, while Pico (2004) reported a 0.88 genetic correlation estimation. The high and positive genetic correlations between WW and YW traits in this study implies that they are all being controlled by similar genes and thus selection for any one of these traits would lead to positive changes in the other. This results were in agreement with the report of Abdullah & Olutogun (2006) and supports the contention that both traits are essentially the same measure of growth and are thus under the influence of similar genes. Thus the two traits can be regarded as the same trait in a selection programme.

Table 3. Genetic and phenotypic correlation of birth weight, weaning and yearling weight of Bali cattle

Traits	Birth weight	Weaning weight	Yearling weight
Birth weight	-	0.10^{A}	0.13
Weaning weight	0.08^{B}	-	0.90
Yearling weight	0.22	0.70	-

[A]Phenotypic correlations above diagonal
[B]Genetic correlations below diagonal

Genetic and Phenotypic Trends

The phenotypic trends generally showed constant increase overtime for all traits during 2000 to 2008 (Figure 1). The phenotypic trends for traits of birth and weaning weight were constant, whereas yearling weight was fluctuating from 2000 to 2008. The smallest amount was decrease for YW was in the year of 2003, after this time a constant increase continued up to year 2008. The phenotypic trend of BW was positive 0.22 kg/yr. Range least square means for BW were range from 16.82 to 18.90 kg. In contrast to BW, the phenotypic trend for WW and YW were found to be -0.01 and -1.21 kg, respectively. Ranges of least square means for WW (adjusted 250 d weight) and YW were from 84.15 to 89.55 kg and 133.34 to 155.12 kg, respectively (Table 4). The phenotypic result in this study correspond well with Intaratham *et al.* (2008) who reported phenotypic trend in Thai cattle for BW was positive value (0.18 kg/yr) and negative value for WW (-1.36 kg/yr). The phenotypic YW decreased from 2003 and thereafter increased from 2004 to 2008. The reduction in YW for calve born from 2003 was mainly due to a larger proportion of calves selected in previous years in order to increase the population for selected bull and heifers. Phenotypic performance in YW could be improved also through management strategies. Changes in management such as pasture improvement, grazing strategies and culling procedures needed to be

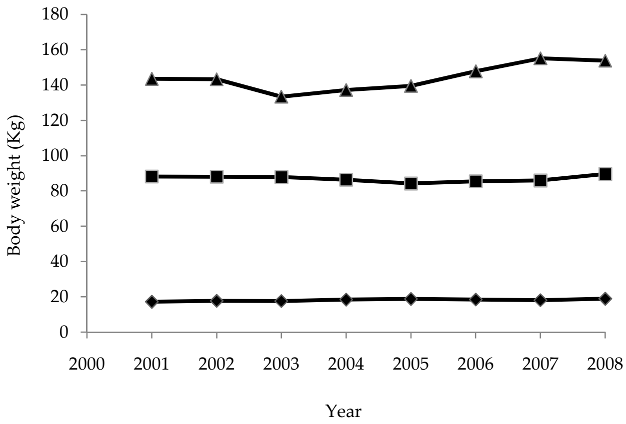

Figure 1. Phenotypic trend of birth weight (-♦-), weaning (-■-), and yearling weight (-▲-) of Bali cattle

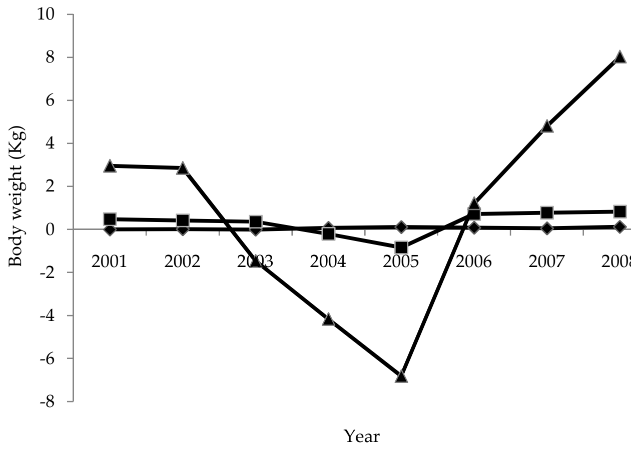

Figure 2. Genetic trend of birth weight (-♦-), weaning (-■-), and yearling weight (-▲-) of Bali cattle

Table 4. Phenotypic and genetic of growth traits

	Regression equation	R^2
Phenotypic trend	BW= 17,1+0,22	76.0
	WW= 86,8-0,01x	84.8
	YW= 140,0-1.21x	80.0
Genetic trend	EBV BW= -0,28+0.02x	50.7
	EBV WW= -0,08+0,08x	15.2
	EBV YW= 0,74+0.15x	18.9

Note: BW= birth weight, WW= weaning weight, YW= yearling weight, EBV= estimated breeding value.

measured and monitored in order to evaluate the benefit of change (Intaratham *et al.*, 2008).

Likewise, in the case of genetic trends, the birth and weaning weight were constant from 2000 to 2008 except for WW in 2005, whereas the genetic trends for yearling weight showed a fluctuation of wide range. The smallest amount was decrease for WW was in the year of 2005, after this time a constant increase was continued up to year 2008. There were decreasing genetic trend for YW from 2002 to 2005. Morever, the genetic means of YW was sharply decrease in 2005, but increased after 2006 (Figure 2). However, the promising positive trends for WW and YW were detected after the year of 2005 and the highest mean EBV was found in the last year. This result is in agreement with the previous study by Sukmasari *et al.* (2002) who reported that the fluctuation of genetic trends values were observed for WW and YW in Bali cattle. The genetic trend of BW, WW, and YW were 0.02; 0.08; and 0.15 kg/yr, respectively (Table 4). Intaratham *et al.* (2008) using Thai cattle estimated genetic trend for BW and WW were 0.04 and 0.32 kg/yr, respectively. Differences between estimated genetic values for these traits in comparison with other studies in general is due to difference in animal breeding standard and follow that different program selection, difference between models and calculation method and also effects of environmental and breed factors (Shaat *et al.*, 2004; Jurado *et al.*, 1994). However, the genetic trends estimation showed that there was a significant and positive genetic improvement in all growth traits and indicated that selection would be effective. Higher genetic progress for growth traits have been reported for various beef cattle breeds in tropical countries (Sarmiento & Garcia, 2007; Mourao *et al.*, 2007; Demeke *et al.*, 2004). Consequently, beef cattle breeders with lighter calves at birth tend to put a lot of selection emphasis on WW and YW than would breeders of beef cattle breeds with heavier calves at birth (Orenge *et al.*, 2009). Irregular fluctuations were observed in yearly mean predicted breeding values for YW in 2003 to 2005. The decrease of predicted breeding value mean of YW from 2003 to 2005 was apparently due to selection sire with low breeding value. It seems that this low selection response implying that introduction of outside sire was bases on phenotypic characteristics. These annual fluctuations for these traits also may be due to sudden changes in climate condition, management changes, nutrition, and hygienic levels or interaction between genetic and environment (Yaeghoobi *et al.*, 2011). Furthermore, to perform breeding programs, prior to any action optimal environment condition must provide for appearance herds genetic potential (Shaat *et al.*, 2004).

CONCLUSION

The genetic correlation between weaning (WW) and yearling weight (YW) was high (0.70). Breeding bulls selected at earlier age can be effective in improving weights at later ages. There has been a significant and positive genetic improvement in all growth traits especially for WW.

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