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GENETIC AND NON-GENETIC EFFECT ON GESTATION LENGTH AND CALF SURVIVAL AT WEANING IN BALI CATTLE

Pengaruh genetik dan non genetik lama kebuntingan dan kemampuan hidup anak umur sapih pada sapi bali

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ABSTRACT.

The aim of this study was to evaluate effect of genetic and non genetic factor on the gestation length (GL) and calf survival to weaning (CS) of Bali cattle. Data were analyzed using Generalized Linier Model (SAS) to observe non-genetic effect. To evaluate the genetic effect, the estimations of heritability were done using Mixed Models analysis with the dam and sire as random effect and parity, year of birth and type of mating as fixed effect in the model besides the residual. The results showed non genetic factors except type of mating influenced the variability of gestation length (GL) and calf survival to weaning (CS) in Bali cattle. The result showed that dam year of birth and parity were found significant source of variation in the gestation length, whereas calf survival to weaning were affected of age of dam and year of birth. Estimated heritability of GL and CS were 0.68 ± 0.07 and 0.28 ± 0.09, respectively. With regards to genetic effect, estimated heritability of GL was considered higher (0.68), which means that GL information would be more effective as a selection criteria. Selection for shorter GL might be reduce calving problems with less impact on calf survival to weaning.

Keyword: Non genetic, heritability, gestation lenghtt, calf survival, Bali cattle

INTRODUCTION

Gestation length and calf survival at weaning are among the most important cow efficiency traits in cow calf operation. Gestation length (**GL**) is the interval from conception to subsequent parturition (Norman et al., 2007). Calf survival has major influence on the profitability of suckling cows production system (Phocas et al., 1998). Despite its economic importance for suckling cow production systems, non genetic and genetic studies on calf survival at weaning are scarce and little information is available compare to GL (Cundiff et al., 1986; Goyache et al, 2005). The relationship between gestation length (GL) and all health traits including calf survival (CS) should be considered in order to optimise genetic improvement in calf production. Genetic studies of GL have shown that heritability is rather high as compare with other reproduction traits. Most paper reported that GL shows from moderate to high heritability (Norman et al, 2007; Cerventas et al, 2006; Goyache and Gutierez, 2001). The heritability of GL was estimated which range 0.61 to 0.64. Hansen et al, (2004) and Jamrozik (2005) reported heritability of GL in Holstein cattle were 0.27 to 0.45, respectively. The inclusion of GL in selection program due to its potential genetics association with calf survival (stiilbirth) and calving ease (Majering, 1984; Hansen et al., 2004). GL has been reported to be related to dystocia and stillbirth (calf survival), particularly for first parturition (Hansen et al., 2004). One might be speculated that selection for shorter GL might be reduce calving problems with less impact on growth rate of calf survival at weaning.

Numerous studies have characterized non genetic factor and genetic parameter for GL and CS experimental in multibreed beef cattle populations such as Charolais (Crews, 2006), Asturiana de los Valles beef cattle breeds (Cerventas et al., 2006; Goyache et al., 2003), Brahaman (Riley et al., 2007), Simmental (Wray et al., 1987), Hereford (Orange et al., 2009) and Zebu (Messine et al., 2007). However, studies of GL and CS in indigenous cattle such as Bali cattle are scare. Therefore, the objective of this study was to evaluate genetic and non genetic genetic affect of gestation length and calf survival at weaning in Bali Cattle.

MATERIAL AND METHODS

Data description.

The data used in this study were collected from Breeding Centre of Bali cattle in Bali province during the period 2000-2007. The traits analyzed included gestation length (GL) and calf survival at weaning (CS). The records number of GL and CS were 96 heads and 330 heads, respectively. Detail of data structure according to traits studied with various classes and subclasses were described previously in Gunawan et al., (2011a) and (2011b). Data available for GL were from year of 2001-2006 and records for CS was available from 2007 to 2009 from artificial insemination and natural mating. The data structure are presented in Table 1.

Table 1. The data structure according to traits studied of Bali cattle

Traits	Number of records	Mean	Standar deviation	Coefficient variation	Min	Max
Gestation length (days)	96	270.93	4.47	16.10	194.00	348.00
Survival calf to weaning (%)	330	92.42	1.46	28.67	0.00	100.00

Non Genetic analysis.

In this study non genetic factor were parity, dam year of birth, age of dam and type of mating were describe previously in Gunawan et al., (2011a). Seasons are not included in this experiment as non genetic effect because breeding centre had breeding season that regularity as mating season on December. To assess the effect of non-genetic factor on gestation length and calf survival, least squares analysis of variance were performed using the MIXED model procedure of SAS Vesrsion 9.2 (SAS, 2000) since all the traits studied were measured repeatedly in individual. Mixed models contain both fixed effect and random effect were presented in Table 2.

Table 2. Fixed and random effect used for data analysis

Traits	Fixed effect	Random effect
Gestation lenght	Dam year of birth	Cows
	Type of mating	
	Parity	
	Age of dam	Cows
Calf survival at weaning	Year of birth	

Model used to analysis gestation length was used as random effect of cow, whereas dam year of birth (6 levels:2001-2005) and type of mating (2 levels: naturally and AI) and parity (3 levels:1-3) were used as fixed effect in the model. In case of calf survival to weaning are used as random effect of cows and age of dam (5 levels:2-7 year), dam year of birth (3 levels:2007-2009) and type of mating (2 level: naturally and AI) were used as fixed effect.

Genetic analysis.

To evaluate genetic effect, mixed models were performed to calculate the heritability of GL and CS which enable the implementation of additional random effect. In the heritability model, sire and dam were included as a random effect in the model which account for the genetic effect which also described previously in Gunawan et al., (2011b). The total variance and covariance components were sorted into additive and non-additive (environmental and residual genetic) components (Meyer, 1992).

$$Y_{ijk} = \mu + S_1 + D_{ij} + E_{ijk}$$

Where:

μ = common mean

S_i = effect of the i[th] sire

D_{ij} = effect of the ij[th] dam within the ith sire

E_{ijk} = uncontrolled environmental deviations associated with each record which is assumed to be random, independent and normally distributed with a mean 0 and a common variance

Heritabilities were estimated from dam and sire variance components, according to Becker (1992) as follows:

$$h^2d = \frac{\delta^2 d}{(\delta^2 s + \delta^2 d + \delta^2 w)}$$

where:

h^2_d =heritability from dam component

δ^2_s = sire variance component

δ^2_d = dam variance component

δ^2_w = within progeny variance component

Standard errors for heritability estimated were approximated following the method Becker (1992):

$$SE\ (h^2 s + d) = \sqrt[4]{\frac{\frac{2}{K_3^2}\left[\frac{MS^2 s}{s-1+2} + \frac{MSd^2}{d-s+2}\right]}{S^2 T}}$$

$$K_3 = \frac{1}{S-1}\left[\frac{N - \sum n^2 1}{n1}\right]$$

where:

MS_D = Mean square dam

MS_s = Mean square sire

d^2_T = Total variance

d = Number of dams

s = Number of sires

K_3 = Number of progeny per sire

RESULTS AND DISCUSSION

Gestation lenght

Gestation lenght (GL) of cows between 2001 to 2006, base on 96 observations averaged 270.93 ± 4.47 days (Table 3). This GL mean is smaller to others reported in beef cattle. Goyache et al., (2002) reported heritability of GL for the mean GL of Asturiana de Los Valles beef cattle was 287. Valejo et al (1989) obtained mean for GL in Simmental, Charolais and Rubia Galega cattle were 289; 284 and and 289, respectively. Differences between GL means varied by breed of cattle. Norman et al., (2007) reported Brown Swiss, Holsteins, and Jerseys, which had the most heifer gestations, had cow GL that was 0.3 to 1.6 d longer than heifer GL

Gestation length was significantly ($P<0.05$) affected by dam year of birth and parity but not by type of mating (Table 3). Gestation length was significantly affected by dam year of birth (2001-2005). The female younger calves born during year 2005 gave birth calve earlier than those born in 2001 to 2003 (Table 3). Older cows carried calves longer (< 1 d) than did younger cows (Norman et al, 2009). King et al., (1985) reported for embryo-transfer pregnancies in beef cattle showed that GL of young (< 4 yr old) recipients was 2.7 d shorter than for older recipient. Cundiff et al., (1998) reported that GL were shorter for calves born to cows calving at 3 year of age, and for calves born to calves of cows age 5 to 9 years compared with those cows > 12 year of age. The results of this study are in agreement with previous work wherein olders cows tended to produce calves having a longer GL (Norman et al., 2009; McClintock et al., 2003; Hagger et and Hofer, 1990)

In case of parity has been affected to GL was showed that cow parity 2 and 3 have longer GL than heifers (parity 1). Shorter GL for first parity or for younger ages is in agreement from several studies in heifers (Hagger et and Hofer, 1990; McClintock et al., 2003, Norman et al, 2009). King et al., (1985) cited 5 studied that indicated shorter GL for heifers than for cows. Hagger and Hoffer (1990) reported parity was 1 of the 2 largest effect on GL in a 3-bredd study (Braunvieh, Simental and Swiss Black) study. That pattern across and within parity could indicate that small size which is correlated with age, affected GL. However, animal weight were not available for confirmation.

Table 3. Least square means with their standard error (SE) for gestation lenght (days) of Bali cattle

Factors		N	Gestation lenght (days)
Type mating	Naturally	77	269.91+ 5.03
	AI	19	275.96+ 9.67
Dam year of birth	2001	7	310.00+ 9.04[a]
	2002	13	271.08+ 10.04[b]
	2003	35	271.11+ 7.63[b]
	2004	17	288.06+ 8.13[b]
	2005	24	246.67+ 9.00[c]
Parity	1	43	270.93+ 6.53[a]
	2	42	277.55+ 6.40[b]
	3	11	275.60+ 15.30[b]

Supercripts in a column indicating significant differences (P<0.05)

The type of mating had no influence on GL. It means that cow bred by artificial insemination had no differential effect on average GL than naturally bred cow (Table 3). No different calving of artificially bred cow compared to those mated by bulls was probably as a result good management for detection reproduction aspect in breeding centre.

Calf survival

The overall means for calf survival at weaning (CS) was 92.42 ± 1.46 %. Age of dam and year of birth were significantly (P < 0.05) influenced calf survival at weaning, while type of mating did not show any significant (P > 0.05) effect on calf survival at weaning (Table 4).

The average number of calf survival were lower in 2007 compare than 2008 and 2009. The average calf survival on 2007, 2008 and 2009 were 84.44; 93.33 and 97.50 %, respectively. The significant effect of year could be attributed to variability in management and climate especially between different years (Riley et al., 2007). The majority of lower calf survival to weaning in Bali cattle presumed to be caused in the dry season when feed resources are low in quality and quantity, leading to milk production as low as 1.5 L per day (Belli, 2002).

Age of dam was significantly affected on calf survival at weaning. Calf calved by young cows with 2 year old had lower calf survival than that calved after 2 year of age (Table 4). Lower calf survival at weaning occur in newborn calves and in absent of proper mothering and management supported. The lower calf survival in calf calved by younger mother are seem to be consistent with other age associated lower of cow performance (Riley et al., 2007). One of the most important age-dependent factors affecting lower calf survival is the structure and quality of

Table 4. Least square means with their standard error (SE) for Survival calf to weaning (%) of Bali cattle

Factors		N	Preweaning mortality (%)
Type mating	Naturally	241	92.95 + 1.65
	AI	89	91.01+ 3.05
Year of birth	2007	90	84.44.+ 3.84[a]
	2008	120	93.33+ 2.29[b]
	2009	120	97.50+ 1.43[b]
Age of dam (year)	2	16	75.00+ 11.20[a]
	3	42	88.10+ 5.06 [ab]
	4	72	94.44+ 2.72[b]
	5	59	93.22+ 3.30[b]
	6	72	90.28+ 3.50[b]
	7	45	97.78+ 2.20[b]

Supercripts in a column indicating significant differences (P<0.05) the dam's udder (Edwards, 1982). Maternal inclination of cows may be substandard relative to cows and therefore negatively affect calf birth vigour and lower calf survival to weaning. Abnormal maternal behaviour, especially among heifers was associated with increased time from birth to first nursing (Rowan, 1992). Another potential source of age-related stress (especially for heifers and aged cows) may be associated with the effort to match nutrient intake with lactation and body maintenance requirements (Riley et al., 2007).

The average percentage of calf of survival in Bali cattle was not depend largely on the mating system being practices. Although calf survival to weaning has been pointed out as a problem inherent to *Bos sondaicus* cattle such as Bali cattle. Poor suckling ability of weak calves may result in inadequate colostrum intake. Thus, the most frequent causes for calf losses are poor immune-competence, subsequent illness (gastro-respiratory diseases), starvation, and other secondary causes may have lower calf survival as the underlying cause (Rea et al., 1996).

Heritability

Heritability and standard error for gestation length (GL) and calf survival at weaning (CS) are presented in Table 5.

Gestation length (GL)

Heritability estimation for gestation length (GL) in Bali cattle was 0.68 ± 0.07 (Table 5). The heritability estimates for GL in this study correspond well with Crews (2006) who reported heritability estimated for GL for Canadian Charolais cattle which ranged from 0.61 to 0.64. However, these estimates are higher than those usually found in literature for beef cattle. Cervantes et al., (2006) and Goyache et al., (2005) reported heritability of GL for the Spanish beef cattle were 0.33 and 0.11, respectively. Norman et al., (2007) and Shook (2002) obtained heritability for GL in Holstein cattle were 0.20 and 0.24, respectively. Hansen et al., (2004) and Jamrozik et al., (2005) estimated direct heritabilites of GL Holstein were 0.27 and 0.45, respectively. Difference found among result probably due to breed differences, statistical analysis (animal or sire models), selection pressure within population, sample size and environmental effect (Abdullah and Olutogun, 2006). The higher estimate of heritability for GL observed in this study indicates that there is potential for improvement of this trait through selection. High heritability values of GL in Bali cattle suggest that selection on the basis of individual performance will be effective to achieve the decreasing of GL. GL information would be more effective as a selection criteria i.e to shorten average GL in the breed. Selection for shorter GL might be reduce calving problems with less impact on growth rate (Wray et al., 1987). The consequences (e.g calf mortality, reduced selection pressure) and expected benefits (e.g. improved rebreeding performance).

Table 5. Estimated Heritability and Standard Errors for gestation length and survival of calf preweaning in Bali Cattle

Traits	Number of Animal	VA	VE	VP	h2+SE
Gestation lenght (GL)	96	1088.98	505.30	1594.28	0.68+0.07
Calf of survival (CS)	330	15.139	372.404	52.379	0.28+0.09

VA=Variation of Aditif, VE=Variation of Environment, Vp=Variation of Phenotype

Calf of survival

Estimated heritability in Bali cattle breed for calf survival to weaning (CS) was 0.28± 0.09 (Table. 5). Prediction of heritability for CS of Bali cattle in this study also was included in range of CS of beef cattle as summarized by Roughsedge et al., (2005) and Cerventas et al., (2006). Roughsedge et al., (2005) calculated an average heritability of CS from 4 British beef breeds from 0.13 to 0.39. Cervantes et al., (2006) estimated heritability of CS in Spanish beef cattle was 0.22. Nevertheless, these estimates are higher than the value obtained in some literature. Goyache et al.,(2003) estimated heritability of CS in Spanish beef cattle was 0.14. Also, the estimate of heritability reported in multibreed beef cattle populations (from 0.04 to 0.19; Guerra et al., 2006), Brahman cattle (0.06; Riley et al., 2007) and Danish Holstein for calf survival (0.10; Hansen et al., 2004). The moderate estimated heritability for CS observed in this study indicates that there is potential for improvement of this traits through selection. The improvement of calf survival rates have been recommended to use a correlated response to direct selection for calving ease (Cubas et al., 1989). The high positive genetic correlation were reported between calf of survival with calving ease (Meijering, 1984; Cubas et al., 1989). This seemed to be more feasible alternative in view of the low to modearate heritability such as calf of survival. Selection to improve calf survival rate at weaning would lead to an improvement in calf viability at all earlier ages (Goyache et al., (2003).

CONCLUSIONS

Non genetic factors except type of mating influenced the variability of gestation length (GL) and calf survival to weaning (CS) in Bali cattle. Dam year of birth and parity were found significant source of variation in the gestation length, whereas calf survival to weaning were affected of age of dam and year of birth. Estimated heritability of GL and CS were 0.68 ± 0.07 and 0.28 ± 0.09, respectively. With regards to genetic effect, estimated heritability of GL was considered higher (0.68), which means that GL information would be more effective as a selection criteria. Selection for shorter GL might be reduce calving problems with less negative impact on calf survival to weaning.

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