NON GENETIC FACTORS EFFECT ON REPRODUCTIVE PERFORMANCE AND PREWEANING MORTALITY FROM ARTIFICIALLY AND NATURALLY BRED IN BALI CATTLE

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ABSTRACT

The aim of this study was to evaluate effect of non genetic factors on reproductive performance of Bali cattle. Data on reproduction performance were collected from Breeding Centre of Bali Cattle in Denpasar-Bali. Reproductive traits studied were age at first calving (AFC), calving interval (CI) and pregnancy rate (PR). To observe the effect of non genetic factors on the reproductive traits, a mixed model was used because all of the traits studied were measured repeatedly in individuals. The overall means for AFC, CI, PR and preweaning mortality were 43.86±0.70 months, 360.93±4.47 days, 88.44±1.91% and 7.58±1.07%, respectively. The results showed that AFC and PR were significantly ($P<0.01$) influenced by dam year of birth but mating system had no significant ($P>0.05$) effect. With regard to CI, dam year of birth and parity affected CI while mating system had no significantly affect ($P>0.05$) on CI. The preweaning mortality was only affected by the age of dam significantly ($P<0.01$). The average of reproductive performance and preweaning mortality in Bali Cattle were not depended remarkably on the mating system being practiced. It might be concluded that an improvement in Bali cattle reproductive traits is possible through improving management systems and utilisation of controlled breeding techniques.

Keywords: age at first calving, Bali cattle, calving interval, pregnancy rate, preweaning mortality

INTRODUCTION

Bali cattle are one of several Indonesian native cattle that plays major role for beef production. The population of Bali cattle in Indonesia were recorded 3.271.000 in 2010 of which 20% were concentrated in Bali province (Direktorat Jenderal Peternakan, 2010). Comparing to other breeds, Bali cattle have better adaptation especially in marginal environment (Zulkharniem *et al.*, 2010), have high meat quality and low fat percentage (Bugiwati, 2007). Bali cattle are considered as more fertile and have better reproductive performance compared to other breeds of cattle. Their fertility reached around 80-82% and have high heterosis effect in crossbred (Noor *et al.*, 2001). However, calf mortality in Bali cattle is high, reaching 30% (Toelihere, 2002). On the other hand, genetic improvements of reproductive traits are considered to be limited because of low heritability. Reproductive traits heritability range between 0.03 and 0.05 (Freeman, 1984). Lower heritability is partly affected by the existence of a very important environmental influence on these traits (Goyache and Gutierrez, 2001). To improve the reproduction traits of Bali cattle through selection programs, it is necessary to know the environment factor or non genetic factor that affect the reproductive of Bali cattle. Information of reproductive performance in Indonesian local cattle such as Bali cattle is very rare. Previous study reported that the average of service per conception in Bali cattle was about 1.8-2.0 and the calving rate was 64-78% (Bamualim and Wirdahayati, 2002). Therefore, it become highly imperative to study the influence of non genetic affect on the trait of economic interest such as reproductive performance

The objectives of this study were to assess reproductive traits in Bali cattle raised under intensive management system in breeding centre

and to examine the importance of non genetic factor affecting them.

MATERIALS AND METHODS

The data used in this study were collected from Breeding Centre of Bali cattle in Bali province from September, 2005 to September, 2008. A total of 465 cattle were used in this study consisting of 15 bulls and 450 cows with the average body weight of 180 kg or have reached sexual maturity. Reproductive management primarily involved artificial insemination (AI) using either frozen semen or natural breeding using purebred bulls. The data structure is presented in Table 1.

Data classification

Seasons were not included in this experiment as non genetic factor because breeding centre had breeding season that regularity as mating season in December. Age of dam, sex of calf and parity were reported as non genetic factor (Kempt *et al.*, 1984). In this study, non genetic factor were parity, dam's year of birth, age of dam and type of mating.

Data analyses

To assess the effect of non-genetic factor on reproductive traits, least squares analysis of variance were performed using the MIXED model procedure of SAS Version 9.2 (SAS, 2000) since all of the traits studied were measured repeatedly in individuals. Mixed models contained both fixed effect and random effects are presented in Table 2.

Model used to analyze age at first calving was used as random effect of cow, whereas dam year of birth (6 levels: 2001-2006) and type of mating (2 levels: naturally and AI) were used as fixed effects in the model. In the case of pregnancy rate (PR), cows were used as random effect and dam's year of birth (8 levels: 2000-2007) and type of mating were used as fixed effect. The model for calving interval included cows as random effect and parity (3 levels: 1-3), year of birth (5 level: 2000-2005) and type of mating were considered fixed effect. Preweaning mortality were 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:

Table 1. Reproductive Performance of Bali Cattle

Traits	No. of Records	Mean	Standar Deviation	Coefficient of Variation	Min	Max
Age at first calving (months)	138	43.86	0.70	18.81	25.00	100.00
Calving interval (days)	96	360.93	4.47	12.13	329.00	363.50
Pregnancy rate (%)	450	88.44	1.51	36.19	0.00	100.00
Preweaning mortality (%)	330	7.58	1.46	34.98	0.00	100.00

Table 2. Fixed and Random Effect Used for Data Analysis

Traits	Fixed effect	Random effect
AFC	Dam's year of birth	Cows
	Type of mating	
Pregnancy rate	Dam's year of birth	Cows
	Type of mating	
Calving Interval	Parity	Cows
	Year of birth	
	Type of mating	
Preweaning mortality	Age of dam	Cows
	Dam year of birth	
	Type of mating	

naturally and AI) were used as fixed effect.

RESULTS AND DISCUSSION

Age at first calving

Age at first calving was significantly affected by dam's year of birth (2001-2006). The female calves born during 2004 to 2006 year gave birth earlier than those born in 2001 to 2003 (Table 3). This results is in agreement with the results of Javed *et al.* (2000) who found that the dam's year of birth had significant effect on age at first calving in Sahiwal cows**.** The significant effect of dam's year of birth could be attributed to variability in management and climate especially between different years. It could be speculated that the age first at calving from 2004 to 2006 were earlier than 2001 to 2003 might be due to the increasing of supplementation and some veterinary inputs in breeding centre. The feed sources for Bali cattle were extremely variable: grazed forage from grasslands and estate cropping, cut and carry forages from on and off the farm, and crop residues. Without substantial additions to the diet in the form of mineral, protein and energy supplements, both reproduction and animal production were invariably poor.

The type of mating had no influence on AFC. It means that artificially inseminated cows had no differential effect on the average of AFC than naturally bred cow (Table 3). This result is in contrast with the previous study by Mwatawala and Kifaro (2009) who reported that artificially inseminated cows were older at calving than naturally bred cow by 3.9 month. This study showed that naturally bred cows were older at calving by 1.9 month than those born from artificially inseminated cow. The similar average of age at first calving between artificially and naturally bred cows could be as a result of high conception rate in artificially inseminated bred cows. No different calving of artificially bred cows compared to those mated by bulls was probably as a result of good management for detection reproduction aspect in breeding centre.

The mean of age at first calving of the 138 cows examined was 43.86± 0.70 months. Alberro (1983) reported that age at first calving for *Bos indicus* in the tropics was about 35.1-53 months. This study was also lower than the 45 to 53 months reported in other studies (Mukasa-Mugerwa *et al*. 1989; Haile-Mariam *et al.* 1993) for different *Bos indicus* cattle. Nevertheless, AFC in Bali cattle is higher than those obtained by Shamsudin *et al.* (2006) that reported the age at first calving in South Asian cattle were varied from 33 to 40 months. The age at first calving determines the attainment of physical and sexual maturity (Kuthi *et al.* 2007). The decreasing value observed for AFC from 2001 to 2006 in Breeding Centre indicated an improvement in the genetic

Table. 3. Least Square Means and Standard Error (SE) for Age at First Calving (Months)

Factors			n	Age at first calving (months)
Type mating	Naturally		108	45.82 ± 0.73
	AI		30	43.88 ± 1.99
Dam year of birth	2001	Naturally	7	60.28 ± 0.18^{a}
		AI	2	54.50 ± 5.50^{a}
	2002	Naturally	12	50.42 ± 1.17^{b}
		AI	2	49.50 ± 0.50^{b}
	2003	Naturally	38	44.32 ± 1.34^{bc}
		AI	4	40.00 ±.3.03^{bc}
	2004	Naturally	13	47.69 ± 0.83^{bc}
		AI	5	44.20 ± 2.54^{bc}
	2005	Naturally	34	39.85 ± 1.00^{d}
		AI	15	38.73 ± 1.10^{d}
	2006	Naturally	4	31.00 ± 3.56^{e}
		AI	2	36.50 ± 1.50^{e}

Supercripts in the same column indicate significantly different (P<0.01)

merit of this trait including managemental practices and nutritional management. Nutritional management strategies can reduce the age at puberty. Age of puberty in breeding centre is generally reached by both males and females between 12 and 24 months of age, at weights from 100–150 kg.

Calving Interval

Calving interval (CI) of cows from 2001 to 2005, based on 96 observations averaged 360.93 ± 4.47 days. The average calving interval in tropical cattle ranged from 365-536 days among the indigenous and crossbred cattle (Kamal, 2010). This result reflects the management adopted in the centre, which recommends the mating of cows at about 3 months post partum. Calving interval was significantly ($P<0.01$) affected by year of birth and parity but not by type of mating (Table 4). The cows giving birth during 2005 had calving intervals 2 months shorter than those of cows calveing in 2001. A shorter calving interval will lead to a higher calving rate in the following year. It may also lead to calves being born earlier in the calving period, when nutrition is better for the dam. The eastern parts including Bali in particular, is insufficiency of both quality and quantity of available feed for the whole year. The quality and quantity of forage available is not similar in every year. In the rainy season, individual growth is good because the quality and quantity of forage are abundant. Meanwhile, In the dry season feed availability becomes a serious problem that is very disturbing livestock productivity (Tahuk and Dethan, 2010). All these factors therefore are likely to have a profound effect on the reproductive performance of Bali cattle.

The significant effect of parity on reproductive performance especially in case of calving interval may be due to the changes in managerial systems and environmental conditions among parities in breeding centre. This result is in agreement with Bulman and Wood (1980) who reported that the incidence of silent oestrus was the highest in the primiparous cows and decreased with the advance in parity number. Oestrus is primarily a nocturnal event in Bali cattle, with an average duration of 18–19 hours (Fordyce *et al.*, 2002). The average length of the oestrus cycle is 21 days, with some evidence that is shorter when nutrition is more poor.

Cow bred by artificial insemination had no differences for the average of calving interval when compared to naturally bred cow. This result is in contrast with the previous study by Mwatawala and Kifaro (2009) who reported tht naturally bred cows tended to calve again about 50 days earlier than artificially bred cows. However, this study showed that naturally bred cows tend to calve again about 10 days earlier than artificially bred. Haile-Mariam *et al.* (1993)

Table 4. Least Square Means and Standard Error (SE) for Calving Interval (days)

Factors			n	Calving Interval (days)
Type mating	Naturally		77	356.97 ±6.34
	AI		20	366.42 ± 9.67
Dam year of birth	2001	Naturally	5	407.40 ± 10.09^{a}
		AI	2	381.50 ± 7.50^{a}
	2002	Naturally	11	377.50 ± 9.39^{ab}
		AI	6	379.04 ± 17.80^{ab}
	2003	Naturally	11	351.36 ± 9.09^{bc}
		AI	2	419.00 ± 9.00^{bc}
	2004	Naturally	32	359.19 ± 7.81^{bc}
		AI	3	381.70 ± 3.52^{bc}
	2005	Naturally	17	340.40 ± 12.40^{c}
		AI	7	327.57 ± 6.60^{c}
Parity	1		43	370.81 ± 7.39^{a}
	2		42	376.37 ± 7.13^{a}
	3		11	337.90 ± 13.05^{b}

Supercripts in the same column indicate significant differences ($P<0.01$)

also observed the same result that Boran cows naturally mated to Boran bulls had shorter CI than Boran cows artificially inseminated with Friesian semen by 50 and 87 days, respectively. The same reasons discussed above (under AFC) on superiority of naturally bred heifers over artificially bred cows could explain the similar phenomenon in cows. Haile-Mariam *et al.* (1993) reported the mean CI of approximately 464. Assuming a gestation period of 280 days, it means that the days open was averaged about 184 days or approximately 6 months. A multitude reasons could account for such a long calving to conception period including the ranch type of management, nutrition, bulls used and competence levels in conducting artificial insemination (Mwatawala and Kifaro, 2009)

Pregnancy rate

The average pregnancy rate (PR) in this study was 88.44 ± 1.51%. Highly significant ($P < 0.01$) influences of dam's year of birth on pregnancy rate was detected, while the type mating had no significant effect on pregnancy rate (Table 5).

The range of pregnancy during 2000-2005 and 2006-2007 were 84.14 to 99.90% and 70.02 to 73.41%, respectively. The average number of cows pregnant were higher in cows born between 2000 to 2005 year than those in 2006 to 2007. Borman *et al.* (2006) reported that cows pregnancy rate varied from 75 to 95% between herds and from 65 to 100% between sires, with an overall pregnancy rate of 93%. The lower pregnancy rate in this study occurred in case of the first calf heifers on 2006 and 2007 year. This result is in agreement with the previous study by Dearborn (1973) who reported the lower pregnancy rate noted in years when a larger percentage were the first calf heifers.

The fluctuation of values observed for pregnancy rate from 2000 to 2007 indicated that environment may play a great role in the ability of a cow to become pregnant in the breeding centre. Oestrus is primarily a nocturnal event in Bali cattle (Fordyce *et al.*, 2002). Expertise of the oestrus detector and the AI technician could influence overall pregnancy rate. In the breeding centre mating is dependent on bull and female condition, nutritional status and bull-to-female ratio. The average percentage of pregnancy rate in Bali cattle was not depend largely on the mating system being practiced. However, in case of uncontrolled natural breeding, the pregnancy rate

Table 5. Least Square Means and Standard Error (SE) for Pregnancy Rate (%)

Factors			N	Pregnancy Rate (%)
Type mating	Naturally		330	85.39 ± 2.99
	AI		120	88.14 ± 2.03
Dam year of birth	2000	Naturally	7	99.90 ± 8.10[a]
		AI	8	99.90 ± 8.10[a]
	2001	Naturally	23	95.65 ± 4.35[a]
		AI	62	88.71 ± 4.05[a]
	2002	Naturally	22	86.36 ± 7.49[a]
		AI	50	96.00 ± 2.80[a]
	2003	Naturally	20	80.00 ± 9.18[ab]
		AI	66	86.36 ± 4.26[ab]
	2004	Naturally	9	88.90 ± 11.10[a]
		AI	29	93.10 ± 4.79[a]
	2005	Naturally	22	95.45 ± 4.55[a]
		AI	71	92.96 ± 3.06[a]
	2006	Naturally	10	70.00 ± 15.30[b]
		AI	24	70.83 ± 9.43[b]
	2007	Naturally	7	57.10 ± 2.20[b]
		AI	20	80.00 ± 9.18[b]

Supercripts in a column indicate significant differences ($P<0.01$)

was always not lower than that of artificial insemination. In the Breeding Centre Bali Cattle (BPTU), cows those were allocated to bulls for natural mating produced the same services to conceive with natural insemination.

Preweaning mortality

The overall means for preweaning mortality were 7.58 ± 1.46 %. Only age of dam were highly significantly ($P < 0.01$) influenced preweaning mortality, while year and the type of mating did not show any significant ($P > 0.05$) effect on preweaning mortality (Table 6).

The average number of preweaning mortality were not significant ($P>0.05$) from calves born between 2007 to 2009. The average preweaning mortality on 2007, 2008 and 2009 were 15.56; 6.67 and 2.50%, respectively. It has been suggested that the preweaning mortality rates of at least 30% is normal for cattle in the tropics (Holroyd *et al.,* 1993). This result is in contrast with the previous study by Riley *et al.* (2004) who reported that the year had effect on preweaning mortality in Brahman calves. Morever, the significant effect of year could be attributed to variability in management and climate especially between different years (Riley *et al.*, 2004). Higher levels of calf mortality in the breeding centre occur in newborn calves and in absent of proper mothering and management supported. Furthermore, the majority of calf mortality 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).

Calf calved by 2 years old young cows had greater preweaning mortality than that calved after 2 year of age. The greater preweaning mortality in calf calved by younger mother are seem to be consistent with other age associated with lower of cow performance (Riley *et al.,* 2004). Hansen *et al.* (2003) reported tht the higher postnatal mortality of Danish Holstein calves born to young cows (23 month of age or less) than that of calves born to older cows. Cloete and Scholtz (1998) reported higher desertions, higher frequency of avoidance, and less cooperation with their lambs' first attempts to nurse in young (first parity) vs. older ewes. One of the most important age-dependent factors affecting calf mortality (and possibly birth vigor) was the structure and quality of the dam's udder (Edwards, 1982). Cows in their prime production years may give birth to a physiologically more competent calf and/or be maternally more attentive, and therefore be more successful at raising calves to weaning. Maternal inclination of cows may be substandard relative to cows and therefore negatively affect calf birth vigor and preweaning mortality. Abnormal maternal behavior, especially among heifers was associated with the increase 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

Table 6. Least Square Means with Their Standard Error (SE) for Preweaning Mortaility (%)

Factors			N	Preweaning mortality (%)
Type mating	Naturally		241	7.05 ± 1.65
	AI		89	8.99 ± 3.05
Year of birth	2007	Naturally	60	15.00 ± 1.65
		AI	30	8.99 ± 3.05
	2008	Naturally	90	7.78 ± 2.84
		AI	30	3.33 ± 1.33
	2009	Naturally	90	2.22 ± 1.56
		AI	30	3.33 ± 0.34
Age of dam (year)	2		16	25.00 ± 1.12[a]
	3		42	11.90 ± 2.72[b]
	4		72	5.56 ± 2.72[b]
	5		59	6.78 ± 3.30[b]
	6		72	9.72 ± 3.52[b]
	7		45	2.22 ± 1.22[b]

Supercripts in a column indicate significant differences ($P<0.01$)

to match nutrient intake with lactation and body maintenance requirements (Riley *et al.,* 2004).

The average percentage of preweaning mortality in Bali cattle was not depended largely on the mating system being practiced. It was not always lower in case of artificial insemination than that of uncontrolled natural breeding. Although preweaning mortality has been pointed out as a problem inherent to *Bos sondaicus* cattle such as Bali cattle. However, preweaning mortality has also been reported in Angus, Hereford, Chianina, Jersey, Holstein, Limousine, and Brown Swiss (Landaeta *et al.,* 1997). Recently, peri-natal calf mortality in F1 Red and Grey Brahman x Hereford calves was reported to occur without a relationship to dystocia or any pathology (Riley *et al.,* 2004). Inbreeding might be related to the occurrence of preweaning mortality (Landaeta *et al.,* 1997). Tropical herd management practices perpetuate the risk of inbreeding due to the lack of records and the fashionable use of bulls and breeds (Landaeta *et al.,* 1997). Poor suckling ability of weak calves may result in inadequate colostrum intake. Thus, the most frequent causes for calf losses were poor immune-competence, subsequent illness (gastro-respiratory diseases), starvation, and other secondary causes (Rea *et al.,* 1996) that may cause preweaning mortality.

CONCLUSION

Non genetic factors except type of mating influenced the variability of reproductive performance included AFC, CI, PR and preweaning mortality in Bali cattle suggested strengthening management for Bali cattle under intensive conditions in the local region. Therefore, an improvement of Bali cattle reproductive traits is possible both through improving management systems and utilisation of controlled breeding techniques.

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