Variation in Reproductive Efficiency of Indonesian Native Cows

Umar Paputungan
Animal Production Department, Faculty of Animal Husbandry, Sam Ratulangi University, Manado 95115, Indonesia

ABSTRACT : This study was conducted in North Sulawesi, Indonesia to identify the factors affecting reproductive efficiency and to determine the contribution of each factor in reproductive efficiency of Indonesian native cows. Records of reproductive efficiency, body size (hip height, body weight, body length, heart girth) as well as age on one hundred and sixty seven Indonesian native cows (seventy six cows of the Bali breed and ninety one cows of the synthetic breed from unknown proportion of the Madura, the Sumba and the Ongole breeds) of 58 farmers were available in this research. The data were analyzed by covariance analysis using SAS package including reproductive efficiency as a dependent variable and breed, body size (hip height, body weight, body length, heart girth) and age of cows as independent variables. The contribution of each independent factor to dependent variable was estimated as the percentage of the sum of square in the corrected total sum of squares. The results showed that body weight and body size of cows would be considered as the most important factors affecting reproductive efficiency of Indonesian native cows. Therefore, the reproductive efficiency could be increased by 1) using cows that reached a target weight of at least 250 kg, 2) using cows with relatively well developed height at hip of at least 117 cm, heart girth of at least 150 cm, and body length of at least 125 cm, 3) keeping breeding cows that reach a target age of 24 months old with the maximum interval between postpartum and next breeding season of 90 days for each year, and 4) using good nutritional feeding to reach the optimum weight and body condition.
(**Key Words** : Indonesian Native Cow, Reproductive Efficiency, Body Size)

INTRODUCTION

Relatively little is known about the factors affecting reproductive rates of Indonesian native cattle breeding herds maintained on pastures in tropical regions. A lower nutritional regime is probably the major reason, but some tropically adapted genotypes have shown a weakness in reproductive capacity (Seebeck, 1973; Rudder et al., 1981).

A short calving season and calving early in the calving season are two conditions that are associated with reproductive efficiency. The body condition of the cows as affected by pre- and post-partum nutritional management of the cows and their level of milk production are considered to have significant influences on the interval between parturition and the first postpartum oestrus as well as on the first service pregnancy rate (Wiltbank et al., 1964; Corah et al., 1975; Richard et al., 1986).

Lamond (1970) reported that in breeding cows there is a critical live weight for regular reproduction, but there are few reports of relationships between joining live weight and reproductive rates in tropically adapted genotypes. A critical joining live weight is important because high annual reproductive rates in cows depend upon conception within 90 days postpartum. If live weight is markedly below the critical level at the start of the joining season, time taken to reach the critical level will result in lower reproductive efficiency.

The objective of this study was to identify the factors affecting reproductive efficiency and to determine the contribution of each factor in reproductive efficiency of Indonesian native cows.

MATERIALS AND METHODS

Reproduction records of 167 Indonesian native cows of the farmers (58 owners) in Bolaang Mongondow regency, North Sulawesi, were used in this study. The

[1] Address reprint requests to Umar Paputungan.
Received June 5, 1996; Accepted October 29, 1996

cows were from two breed groups, 76 Bali breed and 91 Synthetic native breeds composed of unknown proportion of the Madura, the Sumba and the Ongole breed combinations, all were combined into a single group because it was impossible to delineate the exact breed composition.

All cows used in this study were not pregnant. Each cow was weighed using electrical scales and measured the height at hip (the vertical distance from the ground to the top of the hip), body length (the horizontal distance between tuberosities lateralis os humerus and tuber ischia) and heart girth (the circumference of the body heart behind the shoulder) which were stratified by age for each breed group.

Cows used in this study were tied with limited length of tether (average of 7.5 m) for grazing as the main management system practised by 58 farmers as the owners of the animals. Animals were tied by around the neck connecting to the nasal cavity. All animals were used by farmers to plow their garden starting at 07:00 to 11:00 a.m. and taken out to graze on local grass pasture from 11:00 a.m. to 17:00 p.m. The animals were moved to graze onto other place within local grass pasture after 17:00 p.m. without supplementary feeds of concentrate.

The breeding herds were on the range pasture year around and the farmers supervised and mated their cows with a local bull when they showed signs of oestrus. During calving period, the pregnant cows showing signs of parturition were put in a calving pen and observed continuously by the owners. During parturition, the cows which had the calf's forelimbs and head presenting at the vulva and ceased to complete birth normally until 1 to 2 hours were also assisted by the owners.

Reproductive trait examined in this study was the reproductive efficiency (R. E.). The R. E. was assessed by formula according to Banerjee (1982) as follows:

$$\text{R. E.} = 12 \times \frac{\text{Number of calves born}}{\text{Age of cow (months) - age at first breeding}} \times 100$$

The data were analyzed by covariance analysis using SAS package with the following basic model:

$$Y_{ijkl} = \mu + A_i + B_j + C_k + (AB)_{ij} + \Sigma b_t X_{(t)ijkl} + \in_{ijkl}$$

where Y_{ijkl} was reproductive efficiency, μ was overall mean, A_i was the effect of the i-th cow age, B_j was the effect of the j-th breed group, C_k was the effect of the k-th private farm, $(AB)_{ij}$ was the effect of interaction between the i-th cow age and the j-th breed group, b_t was partial regression coefficient of reproductive efficiency on the t-th continuous independent variable ($X_{(t)ijkl}$), and $\in_{ijkl}$ was a random error.

The continuous independent variables were x1 = cow body weight (BW), x2 = cow height at hip (HH), x3 = cow body length (BL), x4 = cow heart girth (HG), x5 = BW/HH, x6 = BW/BL, x7 = BW/HG. Ratios of BW to HH, BL and HG were included in the model to obtained effect of body condition indexes according to the methods described by Makarechian and Arthur (1990) on reproductive efficiency.

The contribution of a factor to reproductive efficiency was estimated as the percentage of the sum of squares (due to the factor after adjusting for other factors in the model) in the corrected total sum of squares. This was equivalent to the reduction in the coefficient of determination (R^2) after dropping that factor from the model.

RESULTS AND DISCUSSION

The means of body weight, height at hip, body length and heart girth are presented in table 1. Difference between the two breed groups with respect to body weight was not significant ($p > 0.05$). However, the Synthetic native breed had higher ($p < 0.05$) height at hip and body length that the Bali breed cows, while the Bali breed cows had larger ($p < 0.05$) heart girth than the Synthetic native breed cows. There is indication that comparable larger size of heart girth at maturity in the Bali breed reflects the body weight which tends to be heavier compared with that in the Synthetic native breed cows. This finding is similar to that of McCurley and McLaren (1981).

In this study, mean of heart girth in the Bali breed at 4 years old of 161.52 cm was larger than that reported by Mansjoer et al. (1978) of 157.5 cm, but smaller than that reported by Manggung (1979) of 175.75 cm. The magnitudes of heart girth in both breed groups increased significantly according to magnitude of age up to six years old, except for body weight and body length which increased significantly ($p < 0.05$) only in the Synthetic native breed cows as the age increased. Ovejera (1960) reported that the magnitude of 1 cm heart girth caused the increase of 6.31 kg body weight in the Philippine native cattle and the magnitude of 1 cm body length also caused the increase of 6.04 kg body weight.

The analysis of variance and percent change in the coefficient of determination (R^2) for each of the factors were considered in the model associated with the reproductive efficiency (table 2). The factors considered in this model accounted for over 26% of the total variation in reproductive efficiency. In the model, body weight appeared to be the most important factor affecting reproductive efficiency explaining over 12 percent of the

variation in reproductive efficiency.

Increases in cow body weight, height at hip, body length and hearth girth were associated with higher reproductive efficiency as the partial regression coefficient of reproductive efficiency on those independent variables were positive ($p < 0.05$) for all models in table 2.

The important contribution of cow body weight to the variation in reproductive efficiency observed in this study was in agreement with other reports (Gallina and Arthur, 1989) who reported that pregnancy did not occur if a heifer had not reached a target weight of at least 220 kg in Zebu cattle. However, the probability of conception increased as the animals went from 220 to 260 kg.

The height at hip of cows in this study had a significant effect on reproductive efficiency for 5.41 percent of the variation in reproductive efficiency when ratios of cow body weight to body length and heart girth were excluded from the model (Model 2). Similarly, the body length of cows had a significant effect on reproductive efficiency for 6.88 percent of the variation in reproductive efficiency when ratios of body weight to heart girth and height at hip were dropped from the model (Model 3), and heart girth of cows had also a significant effect on reproductive efficiency for 5.41 percent of the variation of reproductive efficiency when ratios of body weight to height at hip and body length were removed from the model (Model 4), indicating the confounding of the ratios of body weight to height at hip, body length and heart girth with other body measurements.

Table 1. Least square means and standard errors of body size in Indonesian native cows

Variable	Age (Year)	Breed			
		n	Bali	n	Synthetic
Body weight (kg)	3	15	255.20 ± 20.82	18	250.50 ± 17.46^{a}
	4	31	283.00 ± 8.36	28	281.21 ± 8.80^{abc}
	5	18	298.37 ± 16.46	21	289.24 ± 10.16^{bc}
	6	12	295.58 ± 13.44	24	305.54 ± 9.50^{c}
	All age groups	76	283.04 ± 7.73	91	281.62 ± 5.82
Height at hip (cm)	3	15	117.40 ± 3.20	18	118.75 ± 2.53^{a}
	4	31	118.22 ± 1.28	28	122.96 ± 1.35^{b}
	5	18	118.00 ± 2.53	21	123.14 ± 1.56^{bc}
	6	12	117.42 ± 2.06	24	124.08 ± 1.46^{c}
	All age groups	76	117.76 ± 1.19^{z}	91	122.23 ± 0.89^{y}
Body length (cm)	3	15	122.20 ± 3.63	18	125.00 ± 2.87^{a}
	4	31	125.00 ± 1.46	28	128.21 ± 1.53^{a}
	5	18	128.12 ± 2.87	21	129.29 ± 1.77^{a}
	6	12	128.67 ± 2.34	24	134.37 ± 1.66^{b}
	All age groups	76	126.00 ± 1.35^{z}	91	129.22 ± 1.01^{y}
Heart girth (cm)	3	15	151.40 ± 4.22^{a}	18	148.87 ± 3.33^{a}
	4	31	161.52 ± 1.69^{b}	28	157.46 ± 1.78^{b}
	5	18	164.87 ± 3.33^{b}	21	155.09 ± 2.06^{ab}
	6	12	165.33 ± 2.72^{b}	24	162.42 ± 1.92^{c}
	All age groups	76	160.78 ± 1.56^{z}	91	155.96 ± 1.18^{y}

^{a,b,c} Means within a column and subclass of age bearing different letters are significantly different ($p < 0.05$).

^{y,z} Means within a row between two breed groups for the same variables bearing different letters are significantly different ($p < 0.05$).

Table 2. Variations in reproductive efficiency explained by variables measured on Indonesian native cows

Variable	d.f.	F calculated	Change in R^2 (%)
Model 1:			
Age of cow (A)	3	0.46	3.44
Breed group (B)	1	0.14	0.35
A × B interaction	3	0.36	2.69
Private farm	57	0.01	1.42
Body weight (BW)	1	4.93	12.29*
Height at hip (HH)	1	0.41	1.02
Body length (BL)	1	0.43	1.07
Heart girth (HG)	1	0.42	1.05
BW/HH	1	0.33	0.82
BW/BL	1	0.51	1.27
BW/HG	1	0.34	0.85
Total variation explained			26.27
Model 2:			
Age of cow (A)	3	0.36	2.69
Breed group (B)	1	0.05	0.12
A × B interaction	3	0.41	3.07
Private farm	57	0.02	2.84
Body weight (BW)	1	2.46	6.13*
Height at hip (HH)	1	2.17	5.41*
Body length (BL)	1	0.72	1.79
Heart girth (HG)	1	0.35	0.87
BW/HH	1	2.33	5.81*
Total variation explained			28.74
Model 3:			
Age of cow (A)	3	0.31	2.32
Breed group (B)	1	0.48	1.20
A × B interaction	3	0.21	1.57
Private farm	57	0.02	2.84
Body weight (BW)	1	2.14	5.33*
Height at hip (HH)	1	1.46	3.63
Body length (BL)	1	2.76	6.88*
Heart girth (HG)	1	0.12	0.30
BW/BL	1	2.02	5.03*
Total variation explained			29.11
Model 4:			
Age of cow (A)	3	0.28	2.09
Breed group (B)	1	0.41	1.02
A × B interaction	3	0.24	1.79
Private farm	57	0.01	1.42
Body weight (BW)	1	2.27	5.66*
Height at hip (HH)	1	0.93	2.32
Body length (BL)	1	1.01	2.52
Heart girth (HG)	1	2.17	5.41*
BW/HG	1	2.56	6.38*
Total variation explained			28.62

* $p < 0.05$.

Age, breed and their interaction had no significant effect on reproductive efficiency. However, the average of reproductive efficiency was minimum among the cows in the Synthetic native breed at age of three years old and tended to increase considerable up to six years old. This pattern tended to be in the reverse order of those among cows in the Bali breed (table 3).

The average of first breeding in Indonesian native cows ranged from 24 months to 36 months old. Reproductive efficiency of cows in the Bali breed was maximum at four years old then declined slightly with the increase of age. However, the average of reproductive efficiency of cows in the Synthetic native breed was minimum at three years old then increase considerably up to six years old (table 3). Results in this study were generally in agreement with the studies by Rao and Rao (1980) who reported that cattle form crossbred indigenous breeds with the Jersey were observed in oestrus for the first time on the average age of 22.9 months old. In addition, Rao et al. (1981) reported that cows in the Zebu breed (the Ongole) were observed in oestrus for the first time on the average age of 23.3 months old and the conception rates increased following the magnitude of age.

In conclusion, the results of this study showed that body weight and body size of cows would be considered as the most important factors influencing the reproductive efficiency of Indonesian native cows. Therefore, these studies suggested that the reproductive efficiency of native cows could be increased by the following strategies: 1) Using cows that reached a target weight of at least 250 kg, 2) Using cows with relatively well developed height at hip of at least 117 cm, heart girth of at least 150 cm, and body length 125 cm, 3) Keeping breeding cows that reach a target age of 24 months old with the maximum interval between postpartum and next breeding season of 90 days for each year, and 4) Using good nutritional feeding to reach the optimum weight and body condition.

ACKNOWLEDGEMENTS

The financial supports of the Facility Maintenance and Operational Project of Directorate General of Higher Eduction Ministry of Education and Culture Republic of Indonesia as well as the Eastern Indonesia Universities Development Project of the Canadian International Development Agency through their Partnership Program are gratefully acknowledged.

Table 3. Least square means and standard errors of reproductive efficiency of Indonesian native cows

Variable	Age (Year)	Breed			
		n	Bali	n	Synthetic
Reproductive efficiency (%)	3	15	80.00 ± 6.15[b]	18	75.00 ± 4.60[a]
	4	31	82.26 ± 4.88[b]	28	76.79 ± 5.13[a]
	5	18	72.50 ± 6.60[a]	21	77.46 ± 5.93[ab]
	6	12	73.80 ± 6.84[a]	24	80.04 ± 4.54[b]
	All age groups	76	77.14 ± 4.51	91	77.32 ± 3.39

[a,b] Means within a column and subclass of age bearing different letters are significantly different ($p < 0.05$).

REFERENCES

Banerjee, G. C. 1982. A Textbook of Animal Husbandry. 5th Ed. Oxford & IBH Publishing Co. New Delhi.

Corah, L. R., T. G. Dunn and C. C. Kattenbach. 1975. Influence of prepartum nutrition on the ruproductive performance of beef female and the performance of their progeny. Journal of Animal Science 41:819-824.

Galina, C. S. and G. H. Arthur. 1989. Review of Cattle reproduction in the tropics. Part 1. Puberty and age at first calving. Animal Breeding Abstract 57:583-588.

Lamond, D. R. 1970. The Influence of undernutrition on reproduction in the cows. Animal Breeding Abstract 38:359-372.

Makarechian, M. and P. F. Arthur. 1990. Effects of body condition and temporary calf removal on reproductive performance of range cows. Theriogenology Vol. 34 (No. 3) :435-443.

Manggung, R. I. R. 1979. Estimation of liveweight and carcass weight in Bali cattle based on morphological measurements. Faculty of Graduates Studies, Bogor Agriculture Institute, Indonesia.

Mansjoer, S. S., H. Martojo and E. Gumadi. 1978. Production Performance of Bali Cattle in Bali Island. Proceeding Seminar of Ruminansia, Ciawi, Bogor.

McCurley, J. R. and J. B. McLaren. 1981. Relationship of body measurements, weight, age and fatness to size and performance in beef cattle. J. Anim. Sci. 52:493-499.

Ovejera, A. A. 1960. The Determination of Liveweight Based on Body Measurements of Philippine Native cattle. Thesis, College of Agriculture, Univ. of the Philippines, College Laguna.

Rao, C. C. and A. R. Rao. 1980. Involution of Genitalia of Ongole and Crossbred Cows. Indian J. Anim. Sci. 50:834-837.

Rao, C. C., A. R. Rao and A. S. Rao. 1981. Post-partum ovarian activity and conception in crossbred cows. Indian Veterinary Journal 58:400-402.

Richards, M. W., J. C. Spitzer and M. B. Warner. 1986. Effect of varying levels of postpartum nutrition and body condition at calving on subsequent reproductive performance in beef cattle. Journal of Animal Science 62:300-306.

Rudder, T. H., P. C. Venamore and G. W. Seifert. 1981. The effect of qunotype on reproductive rates in a commercial herd. Proc. of the second conference of the Australian Assoc. of Anim. Breeding dan Genetics.

SAS Institute Inc. 1985. SAS uner's guide: statistics, version 5 edition. SAS Institute Inc. Box 8,000, Gary, North Carolina.

Seebeck, R. M. 1973. Sources of variation in the fertility of a herd of Zebu, British and Zebu × British cattle in Northern Australia. Journal of Agricultural Science, Cambridge 81:253-262.

Wiltbank, J. N., W. W. Rowden, J. E. Ingalis and D. E. Zimmerman. 1964. Influence of post-partum energy level on reproductive performance of Hereford cows restricted in energy intake prior to calving. Journal of Animal Science 23:1049-1053.