

Reproductive Performance of Bali Cattle at Different Altitude Areas in Ngada Regency, Flores, East Nusa Tenggara, Indonesia

Ngiso Bhae¹, M. Nur Ihsan², Suyadi^{2*}

¹Postgraduate Student, Faculty of Animal Husbandry, University of Brawijaya, Jl.Veteran, Malang 65145, Indonesia

²Department of Animal Production, Faculty of Animal Husbandry, University of Brawijaya, Jl.Veteran, Malang 65145, Indonesia

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*Corresponding author
Suyadi

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Abstract: Reproductive performance of cattle is influenced by environmental factors such as climate, feed, and management. The purpose of this study was to evaluate the reproductive performance of Bali cattle at two different altitude areas in Ngada Regency, East Nusa Tenggara, namely in Bajawa and North Bajawa Districts (1000 m above sea level) for the highland areas and West Riung and South Golewa Districts (100 m above sea level) for the lowland areas. The survey study was conducted on 59 Bali cattle which were selected by purposive sampling, with the provision of the cattle which had at least one time of calving. Primary data consisting of age of first mating (AFM), service per conception (S/C), days open (DO), calving interval (CI), and conception rate (CR) were obtained through interviews with farmers, while the fertility index (FI) was obtained through calculations involving CR, S/C, and DO data. The first mating of Bali cattle in Ngada was carried out by natural mating, while parity 2 and so on were carried out through artificial insemination. The results showed that the altitude area had no significant effect ($P > 0.05$) on AFM, S/C, CI, and CR (AFM: 1.87 ± 0.10 and 1.90 ± 0.10 years; S/C: 1.36 ± 0.49 and 1.16 ± 0.37 ; CI: 457.20 ± 7.65 and 459.60 ± 12.90 ; and CR: $76.38 \pm 14.06\%$ and $87.85 \pm 17.69\%$, for highland and lowland areas, respectively). The fertility index in highland and lowland areas were 29.96 and 36.67, respectively. There were significant differences ($P < 0.05$) of DO between the highland and the lowland area with the results of 151.20 ± 4.15 and 161.20 ± 11.72 days, respectively. In conclusion, the reproductive performance of Bali cattle in the highland areas of Ngada Regency is better than in the lowland areas.

Keywords: service per conception, calving interval, days open, conception rate, fertility index.

INTRODUCTION

Ngada Regency is one of the districts in the Flores Island, East Nusa Tenggara. This area has a population of Bali cattle as many as 40,048 heads in 12 districts with a population growth of 33.05%. This data shows that Ngada Regency has a great potency in developing Bali cattle. Seeing the potential that exists, Ngada Regency with other regency in East Nusa Tenggara had an important role to contribute in the fulfillment of national meat needs. Bali cattle can also improve the economy of Ngada Regency [1]. Bali cattle grow and develop in this area supported by adequate climate and feed as well as the breadth of pasture. The climate in Ngada regency consists of two seasons namely the dry and the rainy season with higher rainfall compared to the Timor Island which is still the same province. In the rainy season, the feed is abundant so that the weight gain is very good when compared to the dry season where the availability of feed is limited so that the growth of livestock becomes lower.

The cattle which is developed in East Nusa Tenggara, especially in Ngada Regency, is Bali cattle, which are dual-purpose cows, namely as meat-producing and draft livestock. Bali cattle are a local Indonesian breed which has a large share in the supply of meat for Indonesian consumption. As a national asset, Bali cattle germplasm need to be maintained and used sustainably, because Bali cattle have several specific advantages including having excellent reproductive properties and carcass quality, resistance to tropical environmental conditions and low feed quality, and high fertility.

The altitude of livestock rearing site could affect the reproductive appearance. Calderon *et al.* [2] and Wijono *et al.* [3] stated that there were significant differences in the reproductive performance of livestock in the lowland and highland areas. This difference was related to the air temperature and humidity factors. The interaction between temperature and humidity or Temperature Humidity Index (THI) could affect the

comfort of livestock. Berman [4] and Jordan [5] report that the direct effect of heat stress on reproduction was due to increased maintenance needs as an effort to eliminate the excess of heat, reduce metabolic rate, and feed consumption, resulting in negative energy balance which affected reproductive hormone secretion related to livestock fertility.

The effort to increase the productivity of Bali cattle requires objective, actual, and standard data and information.. To determine the potential productivity of Bali cattle in Ngada Regency, it is necessary to evaluate their production characteristics. This observation is needed to obtain data on the reproductive performance of Bali cattle and the process of developing Bali cattle in Ngada Regency. Reproductive performance is defined as the ability of the cows to get healthy and fertile calves. Environmental factors and genetic interactions can affect the reproduction of Bali cattle. Reproductive ability is closely related to the calving percentage, number of calves, and hormonal. Reproductive performance is all aspects related to the reproduction of Bali cattle. In general, the livestock reproduction performance is influenced by two factors, namely factors from the body of the livestock and from the environment. From inside of the body of livestock is related to the hormonal, while from the outside is the environmental factor. A cattle which has the high reproductive capacity with good management will produce good reproductive efficiency and produce good productivity. Reproductive performance of livestock can be seen through the value of Non-Return Rate (NRR), Conception Rate, Calving Interval, Service period, Service per Conception and Calving Rate. Good reproductive performance can be achieved if the value of these reproductive factors reaches the standard and this will show the optimal level of farmers livestock business.

Currently, the reproductive performance of Bali cattle which have been maintained with a traditional management in Ngada Regency is still not widely known. Therefore, this study aimed to evaluate the reproductive performance of Bali cattle which are maintained in different altitude areas in Ngada Regency.

MATERIALS AND METHODS

Location and time

This study was carried out in a local farm in Ngada District, Flores, East Nusa Tenggara. This study was conducted for 4 months starting from November 2017 to February 2018. The material used in this study were Bali cattle in 4 sub-districts, namely Bajawa and North Bajawa districts (highland areas) and West Riung and South Golewa districts (lowland areas). A total of 59 Bali cattle were observed in this study (30 heads in highland areas and 29 heads in lowland areas). All livestock used in this study were Bali cattle which had the first time of calving and later received Artificial Insemination. This study was carried out with a survey method, namely a study conducted by taking samples in a population by using a questionnaire as a primary data collection tool.

The choice of study location was done by purposive sampling which was based on the consideration that in the area which had the most Bali cattle population and had an altitude of ± 1000 m above sea level for highland areas and altitude of ± 100 m above sea level for lowland areas. Primary data was obtained through direct observation on the object of research and interviews with farmers and artificial insemination officers and by using a pre-prepared questionnaire. Secondary data were obtained from the observed sub-districts office and the Department of Animal Husbandry in Ngada Regency.

Study design

The sample used in this study were 59 female Bali cattle in 4 districts (Bajawa and North Bajawa districts representing the highland areas and West Riung and South Golewa districts representing the lowland areas) in Ngada District. This survey was conducted on 23 active farmers groups and 7 artificial insemination officer and field extension agents who were responsible in those districts.

Determination of the sample size can be based on the number of subjects, if less than 100, it is better to take all data so that it is become a population study. However, if the number of subjects is large, it can be taken between 10 to 15% or more, depending on: a) The ability of researchers, viewed from time, energy, and funds, b) The area of observation of each subject, and c) The size of the risk borne by the researcher. Furthermore, the characteristics contained in the subject are closely related to subject homogeneity in the population [6].

Table-1: Study plan

Area	Reproductive performance					
	AFM	S/C	DO	CI	CR	FI
Highland (± 1000 m above sea level)						
Lowland (± 500 m above sea level)						

The method of data collection was done by interviewing farmers with the help of the prepared questionnaire. Data taken from reproductive aspects include the age of first mating (AFM), service per conception (S/C), days open (DO), calving interval (CI), and conception rate (CR). Fertility index was calculated using CR, S/C and DO data [7] with the following formula:

$$FI = \frac{CR}{S/C} - (DO - 90).$$

Notes: FI = Fertility Index,
CR = Conception Rate (%),
S/C = Service per Conception,
DO = Days Open

STATISTICAL ANALYSIS

Analysis of reproductive performance of Bali Cattle in the highland and lowland areas in Ngada Regency was analyzed by using unpaired t-test [8] and descriptive analysis. The t-value calculation was done by a formula:

$$\frac{|\bar{X}_A - \bar{X}_B|}{\sqrt{\frac{(n_A)(S^2_A) + (n_B)(S^2_B)}{n_A + n_B} \times \left(\frac{1}{n_A} + \frac{1}{n_B}\right)}}$$

Notes: \bar{X}_A : Mean of sample A, \bar{X}_B : Mean of sample B, n_A : Amount of data of sample A, n_B : Amount of data of sample B, S^2_A : Variance of sample A, S^2_B : Variance of sample B

RESULTS AND DISCUSSION

Reproduction is an important factor that can affect the reproductive efficiency of a livestock. Reproductive efficiency is considered as good if the cow can produce a calf in a year. The results of reproductive performance of Bali cattle reared at highland and lowland areas in Ngada Regency were discussed below.

Age of first mating

Table-2 shows the age of first mating of Bali cattle reared at highland and lowland areas in Ngada Regency. Results showed that there was no significant difference in the age of first mating between Bali cattle in the highland areas and those in the lowland areas.

The average age of first mating in the highland and lowland areas were 1.87 ± 0.10 years and 1.90 ± 0.10 years, respectively. According to Toelihere [9], Bali cattle will reach sexual maturity at the age of 6 to 18 months. From the data above, it can be stated that Bali cattle in the lowland areas had a late age of first mating compared to those in highland areas. This result may be caused by the effect of heat stress in the Bali cattle reared in lowland areas which will reduce the secretion of luteinizing hormone and follicle stimulating hormone by the hypothalamus, resulting in the late development of follicles and finally could delay the ovulation. Jordan [5] also explained that the presence of environmental stress could reduce fertility.

Table-2: Age of first mating of Bali cattle reared at highland and lowland areas in Ngada Regency

Area	Age of first mating (years)
Highland	1.87 ± 0.10
Lowland	1.90 ± 0.10
Significance	No significance

Service per conception

Service per conception of Bali cattle in highland areas was not significantly different compared to those in the lowland areas (Table-3). The average service per conception of Bali cattle in the highland and lowland areas were 1.36 ± 0.49 and 1.16 ± 0.37 , respectively. The ideal service per conception ranged from 1.6 to 2.0 [10]. The lower service per conception value the more fertile the cows, on the contrary, the higher value of service per conception showed the low level of fertility in the cows [11]. Factors which expected to influence the service per conception of Bali

cattle in Ngada Regency were the inseminators and the farmers. In the inseminator level, the factors that influence were the distance between the inseminators and the receptor and in the process of frozen semen which will affect the success of artificial insemination. The farmers also had an important role in the success of artificial insemination where the farmers must be able to provide appropriate information to the inseminator so that the process of artificial insemination can take place on time. In the research locations, the use of artificial insemination still rare, the farmers usually use natural mating by bringing the female cattle to male cattle.

Table-3: Service per conception of Bali cattle reared at highland and lowland areas in Ngada Regency

Area	Service per conception
Highland	1.36±0.49
Lowland	1.16±0.37
Significance	No significance

The service per conception value in this study was higher than in Purwanto [12] with the service per conception value of 1.17 ± 0.38 times. The value of service per conception in this study was almost the same as that reported by Supriyantono [13] on Bali cattle in Karangasem, Tabanan, and Pulukan, with the value of 1.23 ± 0.31 , 1.02 ± 0.09 and 1.2 ± 0.27 , respectively. This finding showed the reproductive performance of Bali cattle in Ngada district was good because the value was less than the agreed standard of 1.5. The service per conception value can be used to test the fertility of the bulls and the cows. In order to select the bulls and the cows based on their fertility, this good value can be used as an additional guideline.

Days open

Days open is the time between the calving and the next gestation. The days open of Bali cattle reared at highland areas in Ngada regency were higher compared to those reared at lowland areas (Table-4). The average days open of Bali cattle in the highland and lowland areas were 151.20 ± 4.15 days and 163.20 ± 11.72 days, respectively. The days open at the two altitude areas were not ideal because according to Hafez [14], the good days open was between 55 to 85 days. Meanwhile, according to Hardjopranjoto [15], the good days open

was 90 days. The length of days open had a positive correlation with the calving interval. The greater value of days open, the greater calving interval, and vice versa. The cause of the long duration of the days open was presumed to be due to the failure in the mating and artificial insemination because of the low fertility rate of female Bali cattle due to low-quality feed. After the Bali cattle calving and milking a calf and then get the low quality feed with lack of energy content, it caused disruption of LH production, resulting in the smaller size of follicles in the ovary and may potentially not developed, causing an anestrous. This is in accordance with Pradhan [16] and Short and Adams [17] whose stated that due to lack of energy in the feed will cause fertility disorders. In Ngada district the longer days open may be because of Bali cattle were not only reared to produce meat but also reared as draft livestock, which was used to plow the fields so that the farmers postpone their livestock mating. Hardjosubroto [18] stated that the time between calving to the first estrus after calving was influenced by anestrous, which was the condition in the cows which showed symptoms of clinical estrus for a long time. In the beef cows which were milking their calf have a longer anestrous period depending on the length of the milking.

Table-4: Days open of Bali cattle reared at highland and lowland areas in Ngada Regency

Area	Days open (days)
Highland	151.20 ± 4.15^A
Lowland	163.20 ± 11.72^B
Significance	$P < 0.01$

^{AB} means followed by different superscripts are highly significantly different at $P < 0.01$

Calving interval

The longer calving interval, the lower income of farmers, because the number of children produced will decrease during the productive period [19]. In this study, there was no difference of calving interval between in the highland and lowland areas (Table-5).

This result can be seen from the calving interval value in the highland areas was 457.20 ± 7.65 days, while in the lowland areas was 459.60 ± 12.90 days. This result suggested that the difference in altitudes in Ngada Regency did not affect the calving interval of Bali cattle reared by the farmers.

Table-5: Calving interval of Bali cattle reared at highland and lowland areas in Ngada Regency

Area	Calving interval (days)
Highland	457.20 ± 7.65
Lowland	459.60 ± 12.90
Significance	No significance

The average value of the calving interval in this study both in highland and lowland areas was lower compared to the results of Sumadi [20] research in Bila River Ranch, South Sulawesi with a calving interval value reaching 17.5 ± 1.14 months. Furthermore, Tonbesi [21] in the East Nusa Tenggara reported that

the value of calving interval reached 17.03 ± 1.82 months (1.42 years). In another study, Rosnah [22] reported that calving intervals in West Timor in the highlands and lowlands were 15.42 ± 0.79 months and 15.75 ± 0.65 months, respectively. However, the results of this study were higher than those reported by

Supriyantono [13] who found that calving interval of Bali cattle in Karangasem, Tabanan, and Pulukan were 12.53 ± 0.83 months, 13.34 ± 1.28 months, and 13.33 ± 1.86 months, respectively. The value of calving interval in this study had not been ideal, because its value was still quite long with an average of more than 12 months. Hadi and Ilham [23] explained that the ideal calving interval was 12 months, which was 9 months of gestation and 3 months of milking periods. Ball and Peters [24] added that reproductive efficiency was

categorized as good if the cows can produce a calf in a year.

Conception rate

Conception rate is the percentage of the gestating cows in the first insemination [25]. Conception rate is influenced by the quality and handling of semen, female fertility, service time, estrous detection and insemination technique.

Table-6: Conception rate of Bali cattle reared at highland and lowland areas in Ngada Regency

Area	Conception rate (%)
Highland	76.38±14.06
Lowland	87.85±17.69
Significance	No significance

Conception rate was used to determine the fertility of livestock in a region. The greater percentage of conception rates, the greater fertility level, and vice versa. The conception rate of Bali cattle in the highland areas was $76.38 \pm 14.06\%$, while in the lowland areas was 87.85 ± 17.69 (Table-6). The result of conception rate in this study was not significantly different between in the highland and lowland areas. According to Ihsan and Wahyuningsih [26], an ideal value of conception rate is 60%. Conception rate is influenced by three factors including the fertility of the bulls and the cows, and breeding technique [9]. To improve livestock fertility, genetic and environmental improvements need to be made so that the ideal cows will be formed and able to optimize their reproductive performance. One of the possible factors which may cause low conception rate of Bali cattle reared in the highland areas was because of the some Bali cattle were used as draft livestock, resulting in the delay of mating.

Fertility index

In good rearing condition, reproductive performance of crossbred cattle remains good. However, there is often a delay in the calf weaning, resulting in longer days open, and the longer days open, even though the service per conception is low. The specialty of the local cattle is adaptive, high reproductive, resistant to tropical diseases, and good quality of skin and carcass. In conditions with the lack of feed, local cattle will be thin, but still able to estrous, ovulate, and gestating. The weakness of local cattle is less responsive to the high-quality feed, low average daily gain (ADG), low final body weight, and low milk production. When lacking feed, local cattle will produce a small calf and may die due to the lack of milk. The quantity and quality of feed are the keys to the success of artificial insemination so that the condition of crossbred cattle remains good and productive.

Table-7: Fertility index of Bali cattle reared at highland and lowland areas in Ngada Regency

Area	Fertility index
Highland	29.96
Lowland	36.67

Service per conception, days open, calving interval, and conception rate are common measures used to determine the reproductive efficiency of the livestock. In this study, the use of reproductive measurements was simplified to make it easy to draw conclusions by combining several of these variables into a fertility index. Table 7 shows the fertility index of Bali cattle reared at highland and lowland areas in Ngada Regency. Results showed that the fertility index of Bali cattle reared at highland areas was lower than those reared at lowland areas.

CONCLUSION

Based on the results of this study it can be concluded that Bali cattle reared in the highland areas of Ngada Regency show a better tendency of reproductive

performance compared to those reared in the lowland areas.

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