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(RESEARCH ARTICLE)

Reproductive performance of Bali breed and the Indigenous local breed cows mated by Ongole breed bull applying the artificial insemination techniques

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Abstract

The selection and use of cow breeds with high growth rates of the offspring weights produce a correlated response to birth weight and therefore increases the incidence of difficult calving (*dystocia*) in cows. The artificial insemination (AI) using semen from the prominent Ongole bull is now commonplace in North Sulawesi Province of Indonesia. The risk of selecting Bali breed and other Indigenous local breed cows for artificial insemination technique with semen from heavier Ongole bull remains questionable due to the association with increased birth weight, leading to a higher incidence of dystocia. Calf birth weights of 92 four-year-old cows, accumulated over five years (2020-2025), were used to directly assess the impact of Bali breed and other Indigenous local breeds mated with artificial insemination involving Ongole bull semen on calf weight, and calving ease in Bali breed cows and the Indigenous local breeds. Data were analyzed using a covariance model. The results of the study indicated that Bali breed and other Indigenous local breed cows can be used as the potential animal parental stock in the program for improving and developing Indonesian tropical cattle to increase the live weight of crossbred calves from superior bulls of the Ongole breed without causing more cases of calving difficulties (dystocia). The birth weight of male calves resulted from crossbreeding between Indigenous local breed cattle with Ongole bull was significantly heavier than the birth weight of female calves resulted from crossbreeding between Bali breed cows and Ongole bull applying the artificial insemination techniques. Selection of Bali breed cows and other Indigenous local breeds that have given calf birth greatly supports the crossbreeding program with an artificial insemination (AI) mating system to minimize cases of calving difficulties (*dystocia*) in the parturition process of the cows.

Keywords: Bali Breed Cows; Dystocia; Indonesian Local Breed Cows; Ongole Bull

1. Introduction

The birthing process of cattle refers to an important part of the reproductive process that begins with natural mating or artificial insemination, and the gestation period ends with the birth of a calf. Cow parturition is the process of the fetus leaving the uterus after a normal gestation period of 275 to 285 days [1, 2]. Good reproductive conditions in cattle are characterized by a normal birth process, resulting in healthy cow and calf by avoiding serious economic losses due to increased mortality of both cow and calf due to dystocia or difficulty giving birth [3, 4].

The normal birthing process in cows is divided into three stages of events, namely the dilation of the base of the uterus within two to six hours, the release of the fetus within half an hour to one hour, and the release of the placenta within four to five hours [5]. Cows that show the process of parturition more than eight hours from the initial signs of parturition show difficulty in giving birth (dystocia) which can cause the death of the calf [6]. The incidence of difficult calving on farms reaches 3.3 percent of the total animal population which causes serious economic losses due to increased mortality of cows and calves [7].

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Difficult calving (*dystocia complex*) is a major cause of calf mortality, with 50.9 percent of all deaths falling into this category [7]. Small body size in heifers and cows is a barrier to normal calving [8, 9]. Calf birth weight has been reported to be the most important factor influencing calving difficulty, and there is little correlation between pelvic size and calving performance [10, 11, 12]. Synthetic heifers (crossbreds) in beef cattle have a higher rate of difficult calving than synthetic heifers in dairy cattle [5]. Body weight and body size are considered important factors influencing the reproductive efficiency of cattle in the village [13, 14, 15]. The incidence and severity of difficult calving in first-calving heifers can be significantly reduced by using low birth weight sires, which will produce low birth weight calves [16, 17].

Most Bali breed cattle in rural Indonesia are owned by household farmers and rural farmers. Marketing of livestock is often based on visual assessment, while medication is largely estimated. Accurate live weight criteria for feeding, marketing, and medication administration typically require sophisticated equipment such as scales (electronic digital weighing monitors), which are expensive and unaffordable for many rural households [18, 19]. Beef cattle production by local livestock farmers is difficult to predict practically due to the limited availability of weighing machines in the field [20]. Therefore, body weight prediction is carried out through morphometric measurements of the cattle's body and incorporated into a regression model for cattle [21].

Rapid genetic improvement is the goal of animal breeders [22]. Moreover, accurate prediction of the performance record of the parents is the most crucial factor. Cattle and buffalo play an important role in smallholder livestock farming in most developing countries as they provide meat, milk, draft power, and manure in integrated crop and livestock farming systems [23]. While selecting the best-evaluated animals as reproductive surrogates, farmers can rank the herds and eliminate those with the poorest evaluation results [24]. Lighter female offspring are also produced by sires with low birth weights compared to sires from bulls with high birth weights at birth, one-year-old, and two-year-olds [16]. Selection and use of sires with high growth rates and mature weights reproduces a correlated response in birth weight and thus increases the incidence of calving difficulties [25, 26].

To determine the economic value in the livestock industry, livestock growth characteristics are always a primary concern in breeding programs. It has become commonplace in North Sulawesi Province to breed cattle using artificial insemination (AI) techniques using semen from Ongole breed bulls obtained from the "Artificial Insemination Center" in Singosari Regency, East Java Province, Indonesia. Therefore, the question that arises from this practice is what are the risks of selecting local Indonesian cattle cows with light body weight that are mated by the Artificial Insemination with heavier breeds of Ongole sires? Therefore, the purpose of this study was to examine the direct impact of breeding the Indonesian tropical cattle cows mated with AI methods involving Ongole sires on the reproductive performance of Bali breed and other Indigenous local breed cows dealing with the calf weight and calving ease of these local Indonesian cow beef cattle.

2. Materials and Methods

2.1. Research Procedures

This study involved Bali cattle and other Indigenous Local breeds in several villages serving artificial insemination (AI) services in North Sulawesi Province. Calf birth weight records from 92 four-year-old cows after calving, accumulated over five years (2020–2025), were used in this study. All of the cows were raised on private land by 38 breeders. The weights of the 92 cows and calves (Table 1) were measured using body measurements [15]. The population of Bali breed and Indigenous local breed cows as the generation (G1) producers was born from Bali breed and Indigenous local breed cows mated by artificial insemination (AI) with Ongole bulls. Breeding applying the artificial insemination (AI) technique is supported by the development of livestock breeding programs by the government for Indonesian beef cattle. Calf weight is adjusted to the age of the cows using the following formula [3]:

Age adjustment data were analyzed using simple software from the Excel XP 2007 statistical program function. The number of parental cows (G0) mated by the Ongole breed bull group using the AI method is shown in Table 1. The mating system was carried out in a single bull group, in each Bali breed and Indigenous Local parental cow groups using the AI method (Ongole bull) to produce offspring (G1) from the original cows (G0).

2.2. Research Animal Management

Indonesian local cattle are raised under traditional management using local grasses around coconut plantations and open pastures in the surrounding villages by 38 smallholder farmers in a rural area of North Sulawesi province [15]. The cows (G0) and their offspring (G1) are grazed from 7:00 AM to 5:30 PM WIB without additional concentrate. The herd is kept on pasture year-round. The cows are supervised by their owners and when they show signs of estrus, they

are taken to a government-owned rural artificial insemination (AI) service center for mating using frozen, thawed semen from Ongole bulls stored in liquid nitrogen with the consent of the cow owners (Figure 1).

Calves (G1) were also grazed on local pastures with supplementary feed in the form of livestock concentrate in the livestock pen in the afternoon [14]. Calves (G1) born were measured within 24 hours after birth for calf birth weight. The average conception rate (C/R) was 75.7% and services per conception (S/C) was 1.21 based on annual data from the AI Service Center of North Bolaang Mongondow Regency and Minahasa Regency, North Sulawesi Province.

A. Photo of Bali breed cow being mated using semen of the Ongole breed bull applying the Artificial Insemination (AI) technique

B. Photo of the Indigenous Local breed cow being mated using semen of the Ongole breed bull applying the Artificial Insemination (AI) technique

C. Photo of a 2-day-old white crossbred calf delivered in normal calving of Bali breed cow mated by the Ongole breed bull applying the AI technique

D. Photo of weaned crossbred calf from the Indigenous local cows mated by the Ongole breed bull applying the AI technique.

E. Photo of heavy pulling assistance in a difficult calving process in Bali breed cow mated by the Ongole breed bull applying the AI technique

F Photo of light traction assistance in a difficult calving process in Bali breed cow mated by the Ongole breed bull applying the AI technique

Figure 1 Observation of calves resulted from artificial insemination (IB) with the help of pulling in cases of calving difficulty (*dystocia*) in Bali breed cows mated by Ongole breed bull applying AI technique

The C/R value indicated that 75.7% of cows were pregnant during the first AI implementation and 44.4% were pregnant during the second AI implementation in the following estrus period. The S/C value indicates that 100 pregnant cows require 121 AI services using frozen semen. These values are classified as moderate to high reproductive performance of local Indonesian cattle using the AI method [27]. This moderate reproductive performance of Indonesian local cattle may be caused by the lack of farmer monitoring of signs of estrus resulting in the cows not being inseminated during the AI implementation [28].

The difficulty of calving cows was assessed on a scale of 0 to 5 (0 = normal calving, 1 = moderately difficult calving, 2 = difficult calving without assistance, 3 = more difficult calving requiring simple assistance, 4 = most difficult calving requiring intensive assistance, and 5 = most difficult calving requiring surgery). These scores were transformed to Snell scores (ranging from 0 = normal to 100 = most difficult calving) for estimation of normality [29].

Category of difficulty of cows giving birth to calves were observed in each group of Bali breed cows and other Indigenous local breed cows (Table 1). Furthermore, the frequency of calving difficulties in cows mated by the Ongole bull using the Artificial Insemination and categories of calving difficulties transformed into Snell scores as presented in Table 2.

Table 1 Frequency of calving difficulties in cows mated by the Ongole bull using the Artificial Insemination and categories of calving difficulties transformed into Snell scores

Cow Breed	Category of difficulty of cows giving birth to calves			Total (N)
	0	1	2	
Indigenous Local (n)	41	4	1	46
Bali (n)	35	5	6	46
Total (N)	76	9	7	92

2.3. Statistical Analysis

Phenotypic weight data of the offspring (G1) were analyzed by covariance analysis using the General Linear Model (GLM) procedure of SAS (2003) with the following mathematical model [30]

$$Yijk = \mu + Bi + Cj + eijk$$

Where, Yijk = observed offspring weight of the jth offspring (G1) in the kth mating interaction associated with the i-th parent group (G0); μ = general average for all animals in the observation; Bi = fixed effect associated with the i-th cow breed groups (i=2, Bali breed, Indigenous Local breed); Cj = fixed effect associated with the j-th offspring sex groups (j=2, male, female); eijk = random effect unique to each individual offspring.

The fixed linear model used for the analysis included the influence of the Bali breed and Local breed progeny group and the offspring's birth year. These factors were considered for all analyzed traits. Other influences, such as the age of the cows (G0), were trait-specific and were considered for the analysis of that particular trait. Analysis of variance, mean, and standard error were performed and tested using the PDIFF option.

Table 2 Cumulative proportion of relative dystocia categories from calf birth observations to total calves born

Cow Breed	Cumulative proportion (P_{IJ})		
	0	1	2
Bali	0,90	0,97	1,0
Indigenous Local	0,72	0,85	1,0
Snell's score	0	98,37	100

3. Results and Discussion

3.1. Birth weights of the crossbred calves

Breeds of local tropical cows mated with semen from Ongole bulls by artificial insemination (AI) technique produced birth weights of male and female calves that were not significantly different birth weight among both male and female calves of the Indigenous Lokal breed cows and the male calves of Bali breed cows. However, the birth weight of female calves produced from mating the Bali breed cows and male calves produced from mating the Indigenous Local breed cows with Ongole bulls showed a significant difference ($p<0.05$), which were heavier by 25.14 ± 3.03 kg of male calves from Indigenous Lokal breed cows compared to birth weight of female calves from Bali breed cows of 21.10 ± 1.70 kg (Table 3).

The dominant genetic influence in this study was from the pacing bull. The traits that are genetically passed down to their offspring are primarily those inherited from the bull [10]. Given that the management of cattle maintenance and feeding is generally uniform at the research site, the genetic role of the bull is very important. Based on this, reviewing

all the vital statistics measurements used as parameters in this study, it can be seen that the one that can be used as a genetic parameter from the parents is animal body weight and height [15].

Factors that influence birth weight are the breed of the parent, the nutrition of the parent and the health of the livestock [31]. In this study, the birth weight of Bali breed cow resulting from Ongole bull crosses is 21.10 kg (female) and 23.37 kg (male) which is different from the birth weight calf of Bali breed cows in East Nusa Tenggara province of Indonesia which was around 11.9 kg, while in West Nusa Tenggara province of Indonesia, it was 12.7 kg, in South Sulawesi province, it was 12.3 kg and on the island of Bali the average is 16.8 kg [31]. These data indicated that crossbreeding of Bali breed cows with the Ongole breed bull by the artificial insemination technique in this study compared with linebreeding of Bali breeding cows produced the increasing calf birth weight of 39.11 to 77.31 percents.

Year of calf birth did not affect performance at birth because calves were born to cows who received the same maintenance and feeding management treatment at the research site. In other animal breed, the calf birth weight of Madura breed cattle ranged from 18±2.16 kg in year of 2015 and around 19±1.75 in year of 2016 [32]. The condition of the cows, including the nutritional intake obtained by the cow during pregnancy, the age of the cow, the body weight of the cow, and the management of the cow's maintenance during pregnancy, greatly influenced the performance of the calf at birth. The performance of the cow influenced the performance of the calf at birth. One of these performances was cow body weight which influenced the growth and development of the calf during the fetal period [32].

3.2. Calving easy of the cows mated by Ongole breed bull

The birth weight of calves resulted from the mating of Bali breed cows and the Indigenous Local breed cows with Ongole breed bull that have these similarities of AI technique has resulted in the birth process of calving with the relatively normal Snell scores showing the lowest Snell score of 10.49 ± 4.48 in Indigenous Local breed cows and the highest of 21.00 ± 7.16 in Bali breed cows (Table 3).

Table 3 The average and standard deviation of the characteristics of calves (G1) of both Bali breed and Indigenous Local breed cows mated with Ongole breed bull using the Artificial Insemination (AI) technique

Calf (G_1) birth weight and cow G_0 body weight	**Calves from both Bali breed and Indigenous local breed cows mated with Ongole breed bulls using the Artificial Insemination (AI)**			
	Local crossbred calves		Bali crossbred calves	
	Male	Female	Male	Female
Calf birth weight (kg)	25.14 ± 3.03 ^{a} (n = 46)	22.98 ± 2.42 ^{ab} (n = 46)	23.37 ± 2.04 ^{ab} (n = 46)	21.10 ± 1.70 ^{b} (n = 46)
Snell Score*	10.49 ± 4.48		21.00 ± 7.16	
Cow body weight (kg)	343.45 ± 46.98 ^{a} (n = 92)		280.1 ± 4.55 ^{b} (n = 92)	

*) Transformed into a Snell score ranging from 0 (normal delivery) to 100 (most difficult delivery requiring assisted extraction or surgery) [29]. ab) Means in the same row without the same letter indicate significantly different ($p<0,05$)

The Snell score for calving difficult (*dystocia*) indicated the cases of cows with relatively more difficult calving requiring simple assistance (Figure 1) specifically in Bali breed cattle. These results are consistent with those reported by previous researchers stating that cows with higher body weights compared to cows with lighter body weights have a relatively lower incidence of calving difficulty [33].

The weight of the cow in this study showed that Indigenous local breed cattle had a significantly higher body weight of 343.45 ± 46.98 kg ($p<0.05$) compared to Bali breed cattle of 280.1 ± 4.55 kg (Table 3). Body weight of Bali breed cows in in this study was in agreement with those in East Nusa Tenggara province, in West Nusa Tenggara province, in South Sulawesi province and in the island of Bali province of Indonesia [31].

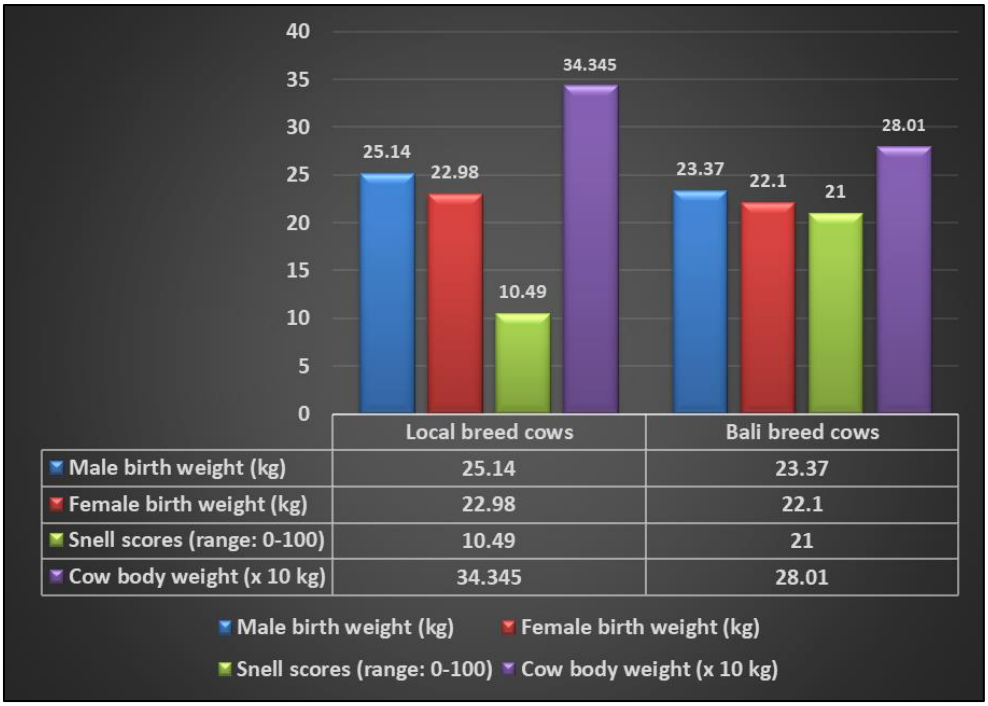

Figure 2 Calf birth weight, Snell score, calving difficulty (G1) and cow body weight of both Bali breed and Local breed cows (G0) mated with Ongole breed bull using artificial insemination (AI) techniques

Cases of difficult calving based on studies conducted on Bali breed cows giving birth to calves mated with Brahman and Simmental bulls showed that about 7.04 percent caused calf death and 2.8 percent caused calf and cow death which may be caused by small pelvic diameter compared to Indigenous local tropical Indonesian cattle breeds [15, 21].

In addition, the difficulty in calving calves (G1) originating from Bali breed cows that were artificially mated with Ongole breed bulls was not significantly different from the difficulty in calving calves (G1) originating from Indigenous local breed cows that were also artificially mated with the same Ongole breed bulls with Snell scores ranging from 10.49 ± 4.48 to 21.00 ± 7.16, respectively (Figure 2). This may be due to small differences in the birth weight of calves produced by the Indigenous Local breed cows and Bali breed cows mated by the Ongole breed bulls compared to the birth weight of calves produced by Brahman and Simmental breed bulls [16, 33, 34]. In order to avoid the incidence of calving difficulty in animal crossbreeding program, it is suggested to involve the cows with all have the experiences of calving more than once instead of involving heifers for the crossbreeding program [20].

4. Conclusion

Indonesian Bali breed and Indigenous Local tropical Indonesian breed cows can be used as the potential replacement parental stock to be mated with the superior Ongole bulls to increase the live weight gain of crossbred calves (G1) without causing more cases of calving difficulty (*dystocia*). Superior Bali breed cows and other Indonesian tropical Indigenous Local breed cows should be selected for crossbreeding programs through a crossbreeding system with superior bull breeds using the artificial insemination technique to avoid cases of difficult calving (*dystocia*) in breeding cows to support the genetic development of local cattle farming communities in rural areas. Male birth weights as crossbred calves derived from the Indigenous Local breed cows and Ongole bull were significantly heavier than the female birth weights as crossbred calves derived from Bali breed cows and Ongole bull by the artificial insemination technique.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

All authors declare and confirm that the version of the submitted manuscript have been read and approved.

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