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Factors affecting calf parturition of the Ongole grade beef heifers

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Abstract

Serious economic losses due to calf or heifer increasing mortality during parturition, the normal calving period without human interference was urgently needed. The most important internal factor influencing calving difficulty was Calf birth weight (CBW). Other external factors considered to contribute calving difficulty were heifer live weight (HLW), heifer body length (HBL), and heifer chest girth (HCG), calf parturition durability (CPD) representing linear CBW. Objective of this study was to estimate above factor mostly affecting calving difficulty of Ongole Grade heifers mated by artificial insemination method. Study was involving 126 Ongole Grade heifers at the artificial insemination center of North Sulawesi province, Indonesia. Data on HLW, HBL, HCG, CPD and CBW were collected from 126 heifers at ages of two to three years old. All linear body measurements were included as independent variables in multiple regression equation affecting dependent variable of CBW in the models using statistical datasheet of Microsoft Office Excel 2007. Results showed that HCG, HBL and CPD as independent variables can be recommended to predict CBW representing internal factor of Ongole Grade heifers in the multiple regression model as follows: Calf birth weight (*Y in kg*) = 26.871 + 0.0033 heifer body length *(X1 in cm*) – 00.0255 heifer chest girth (*X2 in cm*) + 0.032 calf parturition durability (*X3 in minute*) with determination coefficient (R2) of 0.91.

Keywords: Calf Parturition; Internal and External Factors; Ongole Grade Beef Heifer; Heifer morphometric; Heifer body weight; Ongole grade beef heifer

1. Introduction

Parturition of heifers was process of fetus delivery from the uterus of dam passing the normal pregnancy period of 275 to 285 days [1, 2]. Delivery process of dam was referring to an important parts of reproduction process started from either natural mating or artificial insemination, and pregnancy period and ended at fetus parturition process. These important stages of parturition process including durable parturition could be observed by breeders to define external factor contributing a normal parturition of pregnant heifers using shortly time without difficult Cy. Good reproductive condition of the cows was indicated by normal parturition process, leaving a healthy cow with a viable calf to avoid serious economic losses due to the increase mortality of both dam and calf [3].

Rapid recovery development of both calves and cows facing the next reproduction stages including the next mating and pregnant seasons was importantly affected by the healthy cows and their calves after easy calving. Breeders should actively observe the characteristic signs of the animal parturition, mainly at the end of pregnant period in addition to animal factors. Breeders should also actively play role to assist parturition process of the pregnant cows. Sleep restless symptoms, beat around the bush, high frequent defecation, existence of swell and mucus vulva should be the characteristic signs of the cow parturition. Normal parturition process of cow was divided into three stages of events including the widening of uterus base during period of two to six hours, the releasing fetus during period of half to one hour and the releasing placenta during period of four to five hours [4]. Cows showing parturition process of more than eight hours from the first characteristic sign of parturition, indicated calving difficulty of delivery (dystocia) might be

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causing calf mortality [5]. Calving difficulty incident in animal farm reached 3.3 percent from the total of animal population causing serious economic losses due to the increase mortality of both dam and calf [6].

Calving difficulty (dystocia complex) was the most important cause of calf death, with 50.9 percent of all death falling into this category [7]. Small body size of heifers was an impediment to normal parturition [8, 9]. Calf birth weight was reported to be the most important factor influencing calving difficulty and there was little correlation between pelvic measurements and calving performance [10 4, 11, 12]. Beef Synthetic heifers had more difficult calving than Dairy Synthetic heifers [13]. Body weight and body size of cows would be considered as the important factors influencing the reproductive efficiency of the Indonesian native cows [14 , 15 , 16]. The incidence and severity of calving difficulty in the first calving heifers could be significantly reduced by using sires with low birth weight which would result in calves with low birth weight [17, 18].

Most Ongole crossbred cattle in rural areas of Indonesia were owned by rural households and farmers. Often, the marketing of animals was based on visual assesment, while drugs were administrated mostly by estimation. Regularly, the right use of live weight criteria in feeding, marketing and drug administration required sophisticated facilities such as weighing scales (monitor digital electrical scale), which was expensive and not readily affordable by many rural households [19]. Beef cattle production of local household farmers was difficult to be practically predicted due to limited availability of animal weighing scale machine on the field [20]. The objective of this study was to estimate calf birth weight (CBW) using all linear body measurements of heifers mated by artificial insemination method in North Sulawesi province of Indonesia.

2. Material and methods

2.1. Location of Study

Ongole Grade heifers with unknown composition of Ongole breed and Local Indonesian beef cattle in North Sulawesi province were used in this research. All animals were unpregnant heifers at one to two weeks after parturition process, at the ages ranging from two to three and half years old. Heifer breeding strategy of household farmers were mated with the artificial insemination technique by the inseminator using bull sperms collected from Ongole Bull Sperm Bank Institution, located in Singosari, East Java Province, Indonesia. Heifer household farmers were located in three villages of Tumaratas, West Tumaratas and Tonsewer, Minahasa Regency of North Sulawesi Province. This regency is categorized as agricultural areas with altitude of 600-700 m above sea level. It is characterized by cool and humid climate of 25-28^{o}C and 70-80 percent, respectively.

2.2. Experimental Animals

The number of 126 grass-fed Ongole Grade heifers were randomly chosen in this study. Age was primarily determined by dentition with the indication as follows: cows showed unchanged milk teeth, indicating the age of less than one year old; cows showed two changed milk teeth, indicating the age of one and half to two and half years old; cows showed four changed milk teeth, indicating the age of two and half to three and half years old; cows showed six changed milk teeth, indicating the age of three and half to four and half years old; and cows showed eight changed milk teeth, indicating the age of above five years old. Dentition indicators were verified with household farmer information and records by the inseminators. The unhealthy and pregnant cows were excluded in this study.

2.3. Measured Traits

Measurements of heifer body dimensions were taken form February to March 2022 on each Ongole Grade population including heifer body length (HBL), measured using a tape measure from distance between the site of pins (*tuber ischii*) to tail drop (*tuberositas humeri*), heifer chest girth (HCG), measured with a tape measure as body circumference of the chest just behind the foreleg [21]. Heifers were also weighed directly using the monitor digital electrical scale equipment tool with the maximum capacity of 2000 kg of the equipment tool. This equipment tool was eligibly used due to the maximum animal weight of below 2000 kg. The accurate weight value in kilogram and gram digital unit of animal weighed was directly read on the monitor of electrical weighing monitor connecting with the floor cable of animal scale equipment tool, where the heifer was standing on.

2.4. Statistical Analysis

The data collected on each animal were analysed using the Insert Function Procedure of the related statistical category in datasheet of Microsofl Office Excel (2007) within the animal age groups. The interrelationship of body weights and body measurements were estimated by simple correlation and regression [22]. The best estimation equations for body

weight from other traits (chest girth, body length, heifer body weight) as independent variables were determined. Descriptive statistics and regression analysis of body weight on each of the independent variable were performed using the Insert Function Procedure of the related statistical category in datasheet of Microsoft Office Excel (2007) referring to multiple regression model described by [23].

Correlation coefficients were also obtained from parameters. Linear regression effects of independent variables on live weight were included in the following model:

$$Y_i = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + ei$$

Where Y_i is dependent variable of either calf durable parturition or calf birth weight of an *i-th* animal; b_0 is the intercept; b_1, b_2 and b_3 are the regression coefficients; X_1, X_2, and X_3, are independent variables of body dimensions of heifer chest girth, heifer body length, heifer live weight, and e_1 is the residual error term.

3. Results

Observation result of calf parturition durability (CPD) started by the existence of swell and mucus vulva of dam until fetus delivery from animal vulva in the limit time of less than 60 minutes without human assistance (n=43 heifers) were categorized as normal parturition. The heifers with CPD between 60 to 100 minutes (n=58 heifers) showing the restless sleeping, beat around the bush, and high frequent defecation without human assistance during parturition were categorized as slight calving difficulty. The total of animals (n=25 heifers) indicated by higher frequencies of the animal's beat around the bush, and higher frequent defecation during more than 100 minutes of CPD with human assistance to pull head and foreland of the fetus were categorized as high calving difficulty. This last CPD without human assistance carrying dam disability might cause death of both calf and its dam. In this study, the average and standard deviation of CPD were 69.14 minutes and 27.138 minutes, respectively (Table 1). The coefficient of variation of CPD was 39.25 percent, indicating high variability of CPD among heifers in the population. This high variability of CPD revealed that heifer parturition needs the intensive observation of breeder and solutions for alleviation of the factors affecting this variable, including heifer and calf body measurements.

Correlation coefficients among variables of calf parturition durability (CPD), heifer chest girth (HCG), heifer body length (HBL) and heifer live weight (HLW) were presented in Table 2. High positive correlation coefficients of the variables were indicated between calf birth weight (CBW) and CPD of 0.937, and between HCG and HLW of 0.973. However, both variables of CBW and CPD were negatively correlated with both variables of HCG and HLW of -0.85 (Table 2). These correlation values revealed that the larger and the heavier the heifer bodies, the shorter the calf parturition durability, indicated also by lighter calf birth weight. Variable of HBL was lowly correlated with variables of CBW, CPD and HCG. At the adult age of animals, linear dimensions of body size had reached the constant point reflecting body skeleton dimensions to be heritable into the body size dimensions of the next generation [24]. In this study, the observed body conditions of heifers were all under normal and consistent animal ages.

Table 1 Variables measured in heifers and calves related with reproduction process

Variables	Animals (n)	Average	Standard deviation	Coefficient of variation (%)
Calf durable parturition (minute)	126	69.14	27.138	39.25
Calf birth weight (kg)	126	25.85	1.517	5.87
Heifer live weight (kg)	126	368.55	29.615	8.03
Heifer body length (cm)	126	139.27	5.178	3.72
Heifer chest girth (cm)	126	174.47	13.166	7.55

Simple linear regression model using single independent variable of calf birth weight (CBW) to predict calf parturition durability (CPD) showed that the determinant coefficient (R^2) was 0.91, indicating the accurate model. In this model, 91 percent of the changes of CPD (minute) were due to changes of the CBW (kg). Determinant coefficient (R^2) of single independent variables of heifer chest girth (HCG), heifer body length (HBL), and heifer live weight (HLW) to predict CPD were 0.74, 0.18 and 0.75, respectively (Table 3), indicating less accurate simple linear regression models. Multiple linear regression model using two independent variables of calf birth weight (CBW) combined with either heifer body

length (HBL) or heifer chest girth (HCG) to predict calf parturition durability (CPD) showed high determinant coefficient (R^2) of 0.91, indicating also the accurate multiple regression models. Multiple linear regression model using heifer's two independent variables of HCG and HBL to predict CPD showed moderate determinant coefficient of 0.75, indicating less accurate multiple regression model (Table 3).

Table 2 Correlation coefficients among variables of Ongole grade dams and their calves

Number of heifers	Variable	CPD	HCG	HBL	HLW
126	CBW	0.937	-0.844	-0.410	-0.846
126	CPD		-0.850	-0.427	-0.851
126	HCG			0.468	0.973
126	HBL				0.464

CPD = Calf Parturition Durability (minute); HCG = heifer chest girth (cm); HBL = Heifer body length (cm); HLW = Heifer live Weight (kg); CBW = Calf Birth Weight (kg).

Table 3 Regression equation models for predicting calf birth weight using calf parturition durability and Ongole grade heifer body measurements

Dependent variables (Y)	Independent variables (X)	Regression equation models	R^2
CPD	CBW	-385.167 + 17.416 X	0.91
	HCG	675.223 – 3.428 X	0.74
	HBL	453.168 – 2.706 X	0.18
	HLW	415.129 – 0.911 X	0.75
	HCG (X_1), HBL (X_2)	688.723 – 3.376 X_1 – 0.147 X_2	0.74
	CBW (X_1), HLW (X_2)	-257.072 + 14.905 X_1 – 0.153 X_2	0.91
	CBW (X_1), HCG (X_2)	-209.802 + 14.911 X_1 – 0.611 X_2	0.91
	HLW (X_1), HCG (X_2), HBL (X_3)	246.270 – 1.569 X_1 + 2.503 X_2 – 0.189 X_3	0.75
	CBW (X_1), HCG (X_2), HBL (X_3)	–199.345 – 14.901 X_1 – 0.575 X_2 – 0.104 X_3	0.91
CBW	HLW (X_1), HCG (X_2), CPD (X_3)	16.569 – 0.024 X_1 + 0.103 X_2 – 0.032 X_3	0.91
	HBL (X_1), HCG (X_2), CPD (X_3)	26.871 + 0.0033 X_1 – 0.0255 X_2 + 0.032 X_3	0.91

CPD = Calf Parturition Durability (*minute*); *HCG* = heifer chest girth (*cm*); *HBL* = Heifer body length (*cm*); *HLW* = Heifer live Weight (*kg*); *CBW* = Calf Birth Weight (*kg*).

4. Discussion

In this study, the averages of heifer live weight (HLW), heifer body length (HBL) and heifer chest girth (HCG) were 368.55 kg, 139.27 cm and 174.47 cm, respectively (Table 1). The standard deviations of those variables were 29.615 kg, 5.178 cm and 13.166 cm, respectively. Furthermore, the coefficients of variation of HLW, HBL and HCG were 8.03 percent, 3.72 percent, and 7.55 percent, respectively. These coefficient values indicated the moderate variability of HLW and HCG, and the low variability of HBL among heifers in the population. Measurements of calf birth weight (CBW) showed the average of 25.85 kg with standard deviation of 1.517 kg. The coefficient of variation of this variable was 5.87 percent indicating the moderate variability (Table 1). This moderate variability of heifer body measurements and high variability of calf parturition durability revealed validity of further statistical analysis using the accurate and practicable multiple regression models for independent factors related to prediction of calf birth weight as the dependent variable.

Three independent variables of heifer body measurements (HLW, HBL, and HCG) included in the multiple regression model to predict calf parturition durability (CPD) showed moderate determinant coefficient of 0.75, indicating less accurate multiple regression model. However, two independent variables of heifer body measurements (HBL, HCG) combined with calf birth weight (CBW) in the multiple regression models to predict calf parturition durability (CPD)

showed high determinant coefficient (R^2) of 0.91, indicating the accurate multiple regression models (Table 3). All those regression equation models with high determinant coefficients of 0.91 could be categorized into the accurate models for CPD estimation [25], but these models were categorized into less practicable models in rural areas due to limited availability of animal weighing scale machine on the field for calf and heifer weighing. Therefore, the most accurate and applicable multiple regression models were including the most easily measured independent variables of heifers to predict calf birth weight.

Three independent variables of heifer body measurements (HLW, HBL, and HCG) were included in the multiple regression models to predict calf birth weight (CBW), showing high determinant coefficient of 0.91 and indicating high accurate multiple regression model. The same model including two independent variables of heifer body measurements (HBL, HCG) combined with CPD to predict CBW showed also high determinant coefficient of 0.91, indicating high accurate multiple regression model (Table3) with the model as follows:

$$CBW = 26.871 + 0.0033\ X_1 - 0.0255\ X_2 + 0.032\ X_3$$

Where, X_1 = heifer body length (HBL), X_2 = heifer chest girth (HCG) and X_3 = calf parturition durability (CPD). This high determination coefficient of 0.91 indicated that 91 percent of the changes of calf birth weight (kg) were due to changes of the HCG (cm), HBL (cm) and CPD (minute) following the equation model with the *intercept* of 26.871; HBL coefficient b_1 of 0.0033; HCG coefficient b_2 of – 0.0255; and CPD coefficient b_3 of 0.032; while the rest of 9 percent of calf birth weight changes were due to another unknown factor.

5. Conclusion

Measurements of Ongole grade heifers' chest girth, body length and calf parturition durability as independent variables could be applied in the multiple regression equation model to predict calf birth weight as follows: Calf birth weight (*Y in kg*) = 26.871 + 0.0033 heifer body length (X_1 *in cm*) – 00.0255 heifer chest girth (X_2 *in cm*) + 0.032 calf parturition durability (X_3 *in minute*) with determination coefficient (R^2) of 0.91. Determination coefficient of 0.91 indicated that 91 percent of the changes of calf birth weight (kg) were due to changes of the heifer chest girth (cm), heifer body length (cm) and calf parturition durability (minute) following the equation model with the *intercept* of 26.871; heifer body length coefficient b_1 of + 0.0033; heifer chest girth coefficient b_2 of – 00.0255; and calf parturition durability coefficient b_3 of 0.032; while the rest of 9 percent of calf birth weight changes were due to other unknown factors.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declared no conflict of interest.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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