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The Relationship between Frame Score, Calving Interval, and Body Mass Index in Indonesian Beef Cattle

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Abstract: This research was conducted to describe the relationship between cow's frame scores and calving interval and the body mass index of cows and calves, to evaluate the reproductive performance of cows. We aimed to prove that cows in an energy balance state will have a high reproductive capacity. The parameters recorded were body weight, withers height, body length, hip height, and heart girth of 731 cows, and a calving interval of 2,117 birth records of calves from four breeds of cattle, namely, Bali, Madura, PO, and PO Kebumen, were analyzed. In addition, descriptive analysis, analysis of variance, and correlation were performed to differentiate the breed. The results of the frame score classification of Bali, Madura, PO, and PO Kebumen cattle were minimal with a value of 0 to 1, very small to moderate with a value of 0 to 4, small to large with a value of 3 to 9 and small to very large with a value of 2 to 11, respectively. The mean calving interval values of Bali, Madura, PO, and PO Kebumen cattle were 1.18 ± 0.03, 1.20 ± 0.02, 1.22 ± 0.01, and 1.22 ± 0.01 years, respectively. The relationship between cow's frame score and calving interval was a positive and non-significant correlation. However, the relationship between calving interval and cow's body mass index was a significant negative correlation. This relationship indicates that the calving interval will remain optimal based on the cow's frame score. However, if the energy balance in the body is increased, marked by an increase in the body mass index, it will support better reproductive performance with a smaller calving interval. The relationship between the calf's heart girth and cow's body mass index was a negative and highly significant correlation. However, the relationship between the calf's body mass index and calf's heart girth was a positive, non-significant correlation, which can provide information that the calf's heart circumference is a limitation in the calving ease. We suggest that measuring the body mass index is the most appropriate system for estimating the optimum reproductive capacity of Indonesian beef cattle. Since such a study has never been conducted before, our findings are expected to be consideration on the evaluation of livestock reproductive performance in Indonesia.

Keywords: body mass index, calving interval, frame score.

印度尼西亚肉牛框架评分、产犊间隔和体重指数的关系

摘要：本研究旨在描述奶牛的框架评分与产犊间隔与奶牛和犊牛体重指数之间的关系，以评估奶牛的繁殖性能。我们旨在证明处于能量平衡状态的奶牛具有较高的繁殖能力。记录的参数是：731 头奶牛的体重、肩高、体长、臀高和心围，分析了巴厘岛、马杜拉、采购订单和宝可布门四个品种牛犊的 2117 头犊牛的产犊间隔.此外，还进行了描述性分析、方差分析和相关性分析以区分品种。巴厘岛、马杜拉、采购订单、宝可布门牛的框架评分分类结果最小，值为 0~1，极小至中等，值为 0~4，小至大，值为 3~9 和小到非常大的值分别为 2 到 11。巴厘岛、马杜拉、采购订单和宝可布门牛的平均产犊间隔值分别为 1.18 ± 0.03、1.20 ± 0.02、1.22 ± 0.01 和 1.22 ± 0.01 年。奶牛框架评分与产犊间隔呈正相关且不显着。但产犊

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间隔与母牛体重指数呈显着负相关。这种关系表明产犊间隔将根据奶牛的框架分数保持最佳。然而，如果身体中的能量平衡增加，以体重指数增加为标志，它将以更短的产犊间隔支持更好的繁殖性能。犊牛心围与母牛体质量指数呈负相关且极显着。然而，小腿的体重指数与小腿的心周长呈正相关关系是不显着的，这可以提供信息，小腿的心围是产犊容易的限制之一。我们建议测量体重指数是估计印度尼西亚肉牛最佳繁殖能力的最合适的系统。由于以前从未进行过此类研究，因此我们的研究结果有望作为评估印度尼西亚牲畜繁殖性能的考虑因素。

关键词：体重指数，产犊间隔，框架分数.

1. Introduction

Hip height is correlated with growth [1], it can be used to predict maturity and potential growth curves [2], as the most accessible alternative in controlling body size [3] and facilitating evaluation in linear body measurements and the use of this system can be used to identify the suitability of the frame score with the carrying capacity of the environment [4].

Bigger cattle grow faster [5] but show lower fertility than smaller cattle [6]. Changes in body weight are the easiest way to estimate reproductive performance [7]. The relationship between infertility in cows and a balance of energy status (body weight) [8] and energy needs to meet various maintenance needs [9], a measure of energy status using the body mass index [10].

Reproductive traits are economically crucial for sustainable production, and reproductive capacity is the time interval between two calf births [11]. In cattle, the calving interval is expected to be one year, so one cow produces one calf per year [12]. Therefore, this study aimed to determine the relationship between the frame score, calving interval, and body mass index in cows and calves in Indonesia beef cattle.

2. Research Methods

This study was conducted from July 2019 to February 2020. We analyzed the data recorded from the Beef Cattle Research Station (BCATRES) and the PO Kebumen Cattle Breeding Association (PERPOKEB). A total of 731 data for cows with 2117 data for calf births belonging to four cattle breeds in Indonesia were used in this study. Details of the number of animals per breed were as follows: 46 heads of Bali cows with 110 calf births, 201 heads of Madura cows with 201 calf births, 193 heads of Peranakan Ongole (PO) cows with 729 calf births, and 421 heads of PO Kebumen cows with 1,077 calf births. The Bali, Madura, and PO cows and calves located in Pasuruan at the BCATRES were appropriately housed. The PO Kebumen cows and calves were located in Kebumen at The PERPOKEB and were appropriately housed too. Body Weight (BW) was measured using a digital scale with a weight scale of 1,000 kg and an error of 0.5 kg. Body measurements were identified using a calibrated ruler, measuring tape, and caliper in centimeters (cm). Four characteristics were measured, i.e., Withers Height (WH), Body Length (BL), Hip Height (HH), and Heart Girth (HG). The cows were in a parallelogram standing position when measured. The measurement points for each individual are illustrated in Fig. 1.

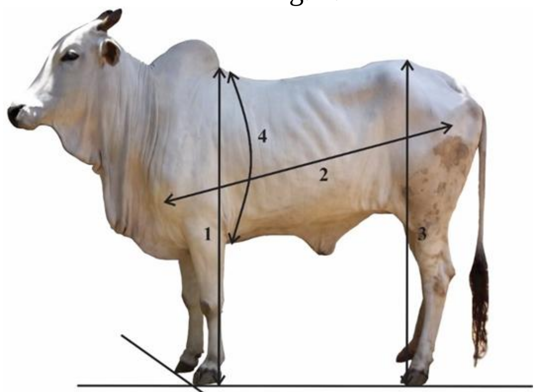

Fig. 1 The measurement points of cattle: 1 - withers height (WH); 2 - body length (BL); 3 - hip height (HH); 4 - heart girth (HG)

Calf birth data were needed for calculating the calving interval (CI) in years. CI data comes from the cows with at least two (2) consecutive birth records of calves, and if there were more than two (2) records, the average value was used.

The data of BW, WH, BL, HH, and HG were standardized to an adult age of five (5) years with a multiplication factor [13], as shown in Table 1.

Table 1 Correction factors for data standardization based on the age of the cows

Age (Years)	Multiplication Factor
2	1.020
3	1.015
4	1.010
5-10	1,000

Calf BW data were obtained by weighing the calf after birth for 24 hours [14]. BW of female calves was standardized to BW of male calves with a multiplication factor value of 1.07.

Table 2 Correction factor for calf standardization based on the age of cow

Age (Years)	Multiplication Factor
2	1.15
3	1.10
4	1.05
5-10	1.00

In addition, data on BW, WH, BL, HH, and HG were standardized based on the age of five (5) year old cows with a multiplication factor [13], as shown in Table 2.

Frame score and body size classification based on HH using Table 3, a modification of the BIF method [2].

Table 3 Frame score and body size classification, based on the age of five (5) year old cows

Frame Score	Hip Height (cm)	Body Size
0	$x \le 113.28$	Very small
1	$113.28 < x \le 118.11$	Very small
2	$118.11 < x \le 122.43$	Small
3	$122.43 < x \le 127.00$	Small
4	$127.00 < x \le 132.08$	Moderate
5	$132.08 < x \le 136.91$	Moderate
6	$136.91 < x \le 141.73$	Moderate
7	$141.73 < x \le 146.05$	Large
8	$146.05 < x \le 150.88$	Large
9	$150.88 < x \le 155.45$	Large
10	$155.45 < x \le 160.02$	Very large
11	$x \ge 160.02$	Very large

Body Mass Index (BMI) values of cows and calves are calculated by the following equation [15]:

$$BMI = (BW/WH/BL)/10 \quad (1)$$

where:
BMI - body mass index ($kg.m^{-2}$);
BW - body weight (kg);
WH - withers height (m);
BL - body length (m).

Descriptive statistics (mean and standard error), analysis of variance, and Correlation were used to examine differences between cattle breeds. All the statistical analyses were performed using the SPSS Statistics software.

3. Results and Discussion

The performance of each breed of cattle in Table 4 shows the data description of Bali, Madura, PO, and PO Kebumen cattle. Table 4 shows the highest frame scores for PO Kebumen cattle with ten classes, followed by PO cattle with seven categories, Madura cattle with five classes, and Bali cattle with two classes. In the modified classification based on the BIF method [2], Bali cattle were included in the tiny body size category (values 0 to 1). Madura cattle were included in the minimal to medium body size category (values 0 to 4), and the PO cattle were included in the small to medium body size category. Large (scores 3 to 9), PO Kebumen cattle were in the type of small to huge body size (scores 2 to 11).

Based on Table 4, Figures 2-8 show the visualization of the variable relationship between the Bali, Madura, PO, and PO Kebumen cattle.

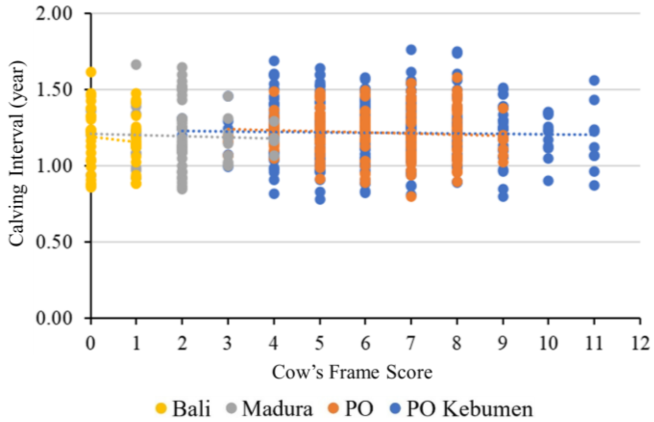

Fig. 2 Scatter plot showing the associations between cow's frame score and calving interval

Figure 2 shows no difference in the average CI value for each cattle breed. The CI values range from 1.15 to 1.25 years, which is quite an optimal value even though it does not reach the one (1) year CI value. This CI is a classic parameter for cattle reproductive efficiency, although a shorter CI is not the goal of reproductive programs [16].

Figure 3 shows that the average BMI value for the frame score of the Bali cow was higher than that of the Madura, PO Kebumen, and PO cow. However, this value was still in the range of 16 kgm^{-2} to 25 kgm^{-2}, which was an average value indicating the balance of sufficient energy [17].

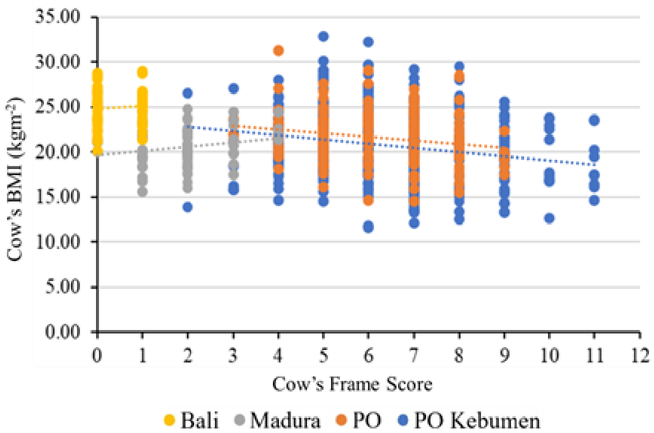

Fig. 3 Scatter plot showing associations between cow's frame score and cow's BMI from the cows under study

Table 4 Parameter values for cows and calves of cattle breeds studied

Cattle Breed	Cow's Parameters						Calf's Parameters			
	Frame Score	n (head)	Mean ± Standard Error				n (head)	Mean ± Standard Error		
			CI (year)	BMI ($kg.m^{-2}$)	BW (kg)	HG (cm)		BMI ($kg.m^{-2}$)	BW (kg)	HG (cm)
Bali	0	26	$1.19^{a} \pm 0.04$	$24.85^{a} \pm 0.44$	$277.96^{a} \pm 6.65$	$158.70^{a} \pm 1.30$	65	$4.43^{a} \pm 0.08$	$13.99^{a} \pm 0.27$	$60.80^{a} \pm 0.61$
	1	20	$1.16^{a} \pm 0.04$	$25.14^{a} \pm 0.45$	$299.84^{a} \pm 7.82$	$163.96^{b} \pm 1.74$	45	$4.41^{a} \pm 0.09$	$14.07^{a} \pm 0.27$	$61.80^{a} \pm 0.47$
Madura	0	3	$1.17^{a} \pm 0.12$	$20.79^{b} \pm 0.40$	$252.55^{a} \pm 3.49$	$150.93^{c} \pm 1.66$	9	$4.33^{a} \pm 0.14$	$17.36^{b} \pm 0.28$	$63.25^{b} \pm 1.08$

Continuation of Table 4

	1	17	$1.20^{a} \pm 0.04$	$20.23^{b} \pm 0.61$	$253.42^{a} \pm 8.96$	$151.14^{c} \pm 1.63$	50	$4.11^{a} \pm 0.14$	$17.00^{b} \pm 0.60$	$64.95^{b} \pm 0.66$
	2	38	$1.21^{a} \pm 0.04$	$20.35^{b} \pm 0.32$	$267.01^{a} \pm 4.75$	$153.70^{c} \pm 0.82$	106	$4.00^{a} \pm 0.06$	$16.99^{b} \pm 0.24$	$65.88^{b} \pm 0.51$
	3	9	$1.16^{a} \pm 0.05$	$21.04^{b} \pm 0.77$	$291.78^{a} \pm 12.10$	$157.93^{a} \pm 2.70$	25	$4.16^{a} \pm 0.14$	$17.57^{b} \pm 0.67$	$65.25^{b} \pm 1.08$
	4	4	$1.18^{a} \pm 0.05$	$22.65^{a} \pm 0.66$	$333.46^{b} \pm 16.18$	$168.03^{d} \pm 1.72$	11	$4.28^{a} \pm 0.44$	$18.14^{b} \pm 1.57$	$63.67^{b} \pm 1.03$
PO	3	4	$1.15^{a} \pm 0.03$	$22.28^{a} \pm 0.51$	$317.68^{a} \pm 8.57$	$161.47^{b} \pm 2.93$	16	$5.95^{b} \pm 0.17$	$24.87^{c} \pm 1.01$	$67.36^{b} \pm 1.30$
	4	19	$1.23^{a} \pm 0.02$	$22.69^{c} \pm 0.68$	$340.57^{a} \pm 7.97$	$161.38^{b} \pm 2.74$	82	$5.65^{b} \pm 0.07$	$25.50^{c} \pm 0.50$	$67.66^{b} \pm 0.64$
	5	44	$1.23^{a} \pm 0.02$	$21.79^{c} \pm 0.36$	$346.21^{b} \pm 6.47$	$166.23^{b} \pm 1.14$	179	$5.83^{b} \pm 0.07$	$26.43^{c} \pm 0.28$	$68.98^{b} \pm 0.47$
	6	39	$1.22^{a} \pm 0.02$	$22.26^{c} \pm 0.44$	$378.60^{c} \pm 10.15$	$170.79^{d} \pm 1.85$	160	$5.72^{b} \pm 0.07$	$26.82^{c} \pm 0.32$	$70.25^{c} \pm 0.43$
	7	41	$1.20^{a} \pm 0.03$	$21.66^{c} \pm 0.45$	$385.73^{c} \pm 9.57$	$174.15^{e} \pm 1.32$	152	$5.69^{b} \pm 0.07$	$27.50^{c} \pm 0.34$	$71.26^{c} \pm 0.61$
	8	38	$1.21^{a} \pm 0.03$	$20.80^{b} \pm 0.49$	$379.71^{c} \pm 10.89$	$176.64^{e} \pm 1.68$	125	$5.39^{b} \pm 0.08$	$26.96^{c} \pm 0.42$	$72.51^{c} \pm 0.82$
	9	7	$1.16^{a} \pm 0.04$	$19.50^{b} \pm 0.57$	$354.04^{c} \pm 13.43$	$175.38^{e} \pm 3.48$	15	$5.55^{b} \pm 0.21$	$27.61^{c} \pm 0.97$	$73.78^{c} \pm 2.08$
PO Kebumen	2	3	$1.25^{a} \pm 0.03$	$20.11^{b} \pm 3.66$	$265.07^{a} \pm 41.01$	$151.70^{c} \pm 4.60$	7	$7.57^{c} \pm 0.22$	$32.20^{d} \pm 1.76$	$67.59^{b} \pm 4.86$
	3	5	$1.21^{a} \pm 0.08$	$18.70^{b} \pm 2.15$	$299.02^{a} \pm 26.17$	$153.60^{c} \pm 5.15$	15	$6.83^{c} \pm 0.26$	$31.10^{d} \pm 0.35$	$70.90^{b} \pm 0.87$
	4	45	$1.24^{a} \pm 0.03$	$21.37^{c} \pm 0.43$	$348.03^{b} \pm 8.24$	$162.51^{b} \pm 1.41$	108	$7.31^{c} \pm 0.11$	$31.53^{d} \pm 0.33$	$68.14^{b} \pm 1.03$
	5	83	$1.20^{a} \pm 0.02$	$22.27^{c} \pm 0.38$	$374.50^{c} \pm 5.82$	$168.18^{d} \pm 0.91$	211	$7.19^{c} \pm 0.11$	$32.14^{d} \pm 0.36$	$69.37^{b} \pm 0.84$
	6	102	$1.23^{a} \pm 0.02$	$21.55^{c} \pm 0.37$	$384.54^{c} \pm 6.56$	$169.43^{d} \pm 0.96$	265	$7.17^{c} \pm 0.10$	$31.82^{d} \pm 0.28$	$69.83^{b} \pm 0.69$
	7	94	$1.21^{a} \pm 0.02$	$19.85^{b} \pm 0.37$	$375.94^{c} \pm 6.83$	$170.81^{d} \pm 1.20$	238	$7.07^{c} \pm 0.09$	$32.16^{d} \pm 0.40$	$70.48^{b} \pm 0.81$
	8	43	$1.23^{a} \pm 0.03$	$20.01^{b} \pm 0.68$	$397.71^{c} \pm 12.46$	$177.86^{e} \pm 1.54$	112	$7.07^{c} \pm 0.13$	$32.51^{d} \pm 0.41$	$71.55^{c} \pm 1.31$
	9	27	$1.22^{a} \pm 0.04$	$19.26^{b} \pm 0.69$	$412.86^{c} \pm 15.69$	$182.95^{f} \pm 2.25$	68	$6.88^{c} \pm 0.19$	$32.96^{d} \pm 0.75$	$73.48^{c} \pm 1.41$
	10	11	$1.19^{a} \pm 0.04$	$19.38^{b} \pm 1.11$	$410.68^{d} \pm 20.65$	$184.85^{f} \pm 3.29$	30	$6.96^{c} \pm 0.17$	$32.53^{d} \pm 0.88$	$72.72^{c} \pm 1.46$
	11	9	$1.17^{a} \pm 0.07$	$18.78^{b} \pm 1.06$	$460.17^{d} \pm 26.44$	$195.39^{g} \pm 3.76$	25	$6.86^{c} \pm 0.22$	$33.15^{d} \pm 0.79$	$74.66^{c} \pm 1.30$

Notes: Mean ± Standard Error means with different superscript letters in each column were significantly different ($p < 0.05$); CI - calving interval, BMI - body mass index, BW - body weight, HG - heart girth

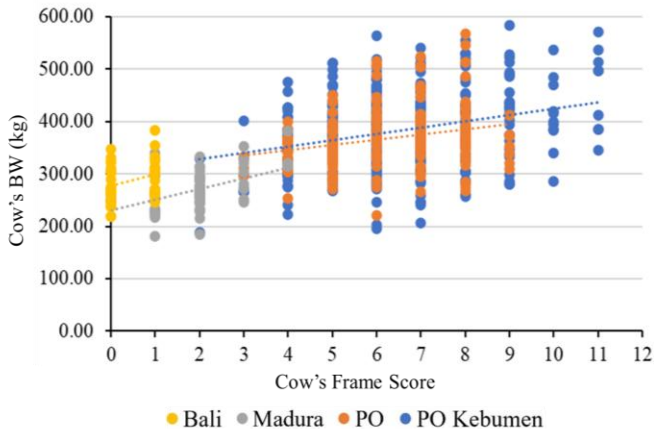

Fig. 4 Scatter plot showing associations between cow's frame score and cow's BW from the cows under study

Figure 4 shows the cow's BW in line with the cow's frame score value. Matching cow size to the environment requires an assessment of the environmental conditions and the needed nutrient requirements; changing cow size can use selection over generations or crossbreeding smaller frame-size cattle breeds with larger frame-size cattle breeds [18].

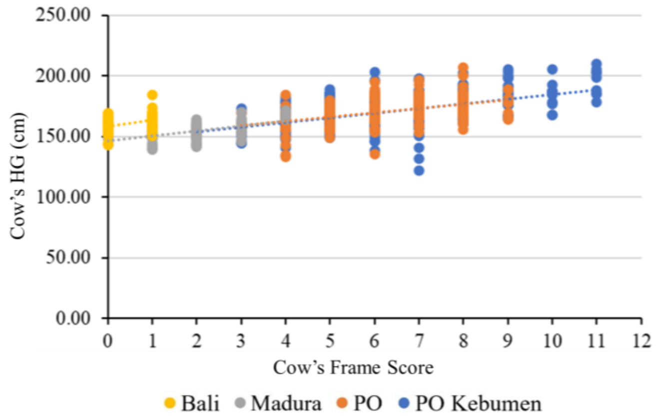

Fig. 5 Scatter plot showing associations between the cow's frame score and HG

Figure 5 shows the HG value of the Madura cow based on the cow's frame score value, which has the smallest value, followed by the Bali, PO, and PO Kebumen cows, respectively. The HG is related to BW and indicates the ability of feed intake [19].

Figure 6 shows the BMI value for calves based on the cow's frame score value, including three groups, BMI value for the Bali and Madura calves with the smallest values, BMI value for the PO calves, and BMI value for the PO Kebumen calves. Figures 7 and 8 show that the BW value for the Bali calves is the lowest, followed by the Madura, PO, and PO Kebumen calves, and the HG value for calves. BMI at birth is related to the calf's viability. Based on the field research, the mortality rate for the Bali cattle ranges from 13.76% - 28.48% [20], although this mortality rate can be reduced by maintenance management interventions and supplementary feeding [21]. The Madura calf mortality rate ranges from 2.23% - 3.43% [22; 23], the PO calf mortality rate was 1.92% [24], the PO Kebumen calf mortality rate was 0.29% [25].

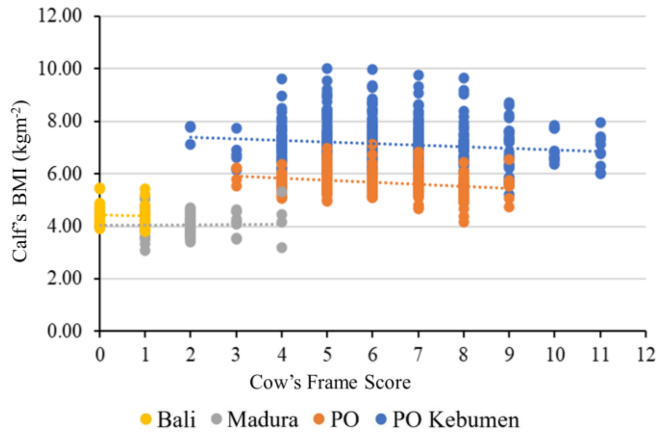

Fig. 6 Scatter plot showing cow's frame score with calf's BMI in the Bali, Madura, PO, and PO Kebumen cattle

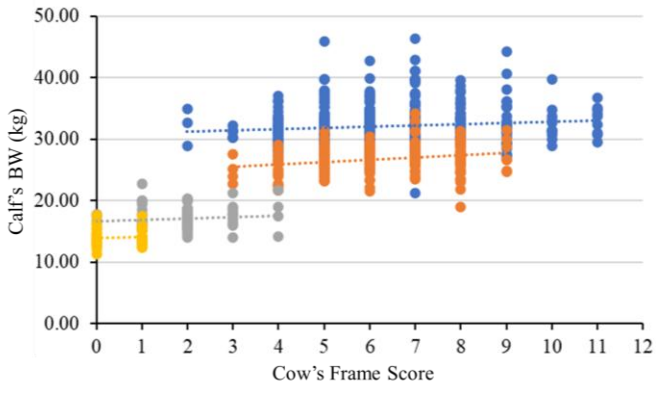

Fig. 7 Scatter plot showing the cow's frame score with the calf's BW in the Bali, Madura, PO, and PO Kebumen cattle

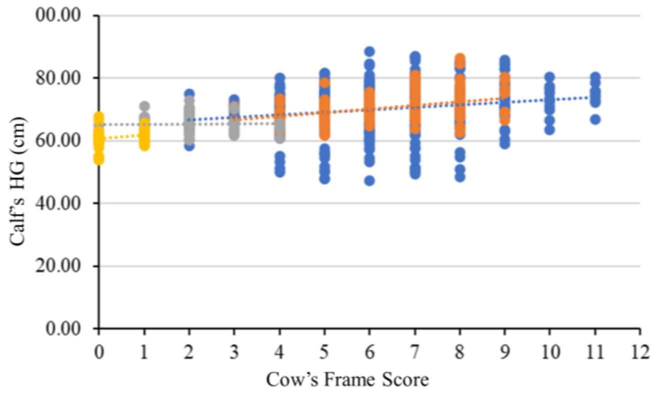

Fig. 8 Scatter plot showing the cow's frame score with the calf's HG in the Bali, Madura, PO, and PO Kebumen cattle

Table 5 The correlation matrix of cow's frame score with the calving interval, body mass index, body weight, heart girth

	CFS	**CI**	**CBMI**	**CBW**	**CHG**	**CfBMI**	**CfBW**	**CfHG**
CFS	1							
CI	0.040	1						
CBMI	-0.230**	-0.082*	1					
CBW	0.494**	-0.039	0.581**	1				
CHG	0.439**	-0.027	0.331**	0.809**	1			
CfBMI	0.774**	0.075*	-0.076*	0.381**	0.268**	1		
CfBW	0.871**	0.065	-0.125**	0.502**	0.411**	0.777**	1	
CfHG	0.343**	0.085*	-0.148**	0.208**	0.253**	0.015	0.493**	1

Notes: ** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed); CFS - cow's frame score, CI - calving interval, CBMI - cow's body mass index, CBW - cow's body weight, CHG - cow's withers height, CfBMI - calf's body mass index, calf's body weight -, CfHG - calf's withers height

Table 5 shows twenty-one (21) variables that have a positive correlation (a highly significant – sixteen (16) variables, with significant values – two (2) variables, a non-significant – three (3)) and seven (7) variables have a negative correlation (highly significant – three (3) variables, significant – two (2) variables, non-significant – two (2)).

The relationship between the cow's frame score and calving interval was a positive non-significant correlation, meaning that as long as feed needs are met, and reproductive function is normal, it will not affect reproductive performance [26]. The relationship between the cow's frame score and the cow's BMI was a negative and highly significant correlation; this condition indicates that the higher the cow's frame score, to maintain body condition requires more feed [6] if there is a lack of feed, it causes lower body weight so that in the calculation of the cow's BMI, the value will be smaller. A positive and highly significant coefficient correlation was the relationship between cow's frame score and cow's BW, cow's HG, calf's BMI, calf's BW, and calf's HG. The higher the cow's frame score can be an indicator of the higher body weight and body size of the cow and calf [1].

The relationship between CI and cow's BMI was significantly negative; a higher BMI can be used as an indicator of better energy status, supporting better reproductive performance [27]. The relationship between CI and cow's BW and cow's HG was a negative non-significant correlation; it could mean that cow's BW and HG were not used as indicators of reproductive performance. The relationship between calf's HG and calf's CI and calf's BMI was a significant positive correlation, while the relationship between CI and calf's BW was a positive non-significant correlation; the CI can be associated with the opportunity to improve the condition of the cow's body after calving and the development of the calf during lactation is more optimal, then the readiness of the cow's body condition for initiating pregnancy [28].

The relationship between cow's BMI and cow's BW and cow's HG was a positive, highly significant correlation; this is illustrated by calculating BMI; cow's BW becomes a factor that is divided so that the higher the cow's BW, the higher the cow's BMI, while HG can be used as an indicator of the size of BW [29]. Therefore, the higher the cow's HG, the higher the cow's BMI. However, the relationship between cow's BMI and calf's BMI was a significant negative correlation; the relationship between cow's BMI and calf's BW and calf's HG was a negative, highly significant correlation. Cow's BL is a dividing factor, so a higher cow's BMI can also indicate that the smaller the body size, which limits the development of the calf in the uterus; this can explain the relationship between a cow's BMI and calf's BMI, calf's BW and calf's HG that had a negative correlation.

The relationship between cow's BW and cow's HG, calf's BMI, calf's BW, and calf's HG was a positive, highly significant correlation; the relationship between cow's HG and calf's BMI, calf's BW, and calf's HG was a positive highly significant correlation. Cow's BW is closely related to cow's HG because it can be used as an indicator for estimating cow's BW; the larger the cow's HG can provide information that the cow's BW is also getting bigger, cow's BW and cow's HG can be used as indicators in the calf development process because they are related to the volume of the cow's abdominal cavity where the uterine organ will be able to support optimal calf development, so calf that produced is getting bigger [30].

The relationship between the calf's BMI and the calf's BW was a positive, very significant coefficient correlation, as in the calculation of BMI, the calf's BW becomes a factor that is divided so that the higher the calf's BW, the higher the calf's BMI. The relationship between calf's BMI and calf's HG was a positive non-significant correlation; this can provide information that there is a limit on calf's HG associated with the cow's pelvic in the ease of the calving process [31]. The relationship between calf's BW and calf's HG was a positive, very significant correlation; calf's HG can be used as an indicator for calf's BW; the larger the calf's HG, the larger the calf's BW.

4. Conclusion

The frame score categories for the Bali, Madura, PO, and PO Kebumen cattle were tiny with a value of 0 to 1, very small to moderate with a value of 0 to 4, small to large with a value of 3 to 9, and small to very large with a value of 2 to 11, respectively. The mean CI of Bali, Madura, PO, and PO Kebumen cattle were 1.18 ± 0.03, 1.20 ± 0.02, 1.22 ± 0.01, and 1.22 ± 0.01 years, respectively. The relationship between a cow's frame score and CI was a positive non-significant correlation, but the relationship between CI and the cow's BMI was significantly negative. This relationship indicates that the CI will remain optimal based on the cow's frame score. However, if the energy balance in the body is increased, marked by an increase in the BMI, it will support better reproductive performance with a smaller CI. The relationship between the calf's HG and the cow's BMI was a negative, highly significant correlation. However, the relationship between calf's BMI and calf's HG-positive was a non-significant coefficient of correlation, which can provide information that calf's HG is a limitation in the calving ease. BMI is the most appropriate system for estimating the optimal reproductive capacity of Indonesian beef cattle, however, the index requires three parameters (BW, WH, BL), which may be the only limitation.

Ethical Statement

No ethical statements were required for this study. All animal procedures related to livestock measurement are non-invasive and conducted by trained technicians, so they are free from pain, injury, and disease.

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