Correlation Between Body Condition Score with Reproductive Disorders, Reproductive Performance and Estrus Performance in Beef Cattle

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Abstract. The objective of this research is to determine the relationship between body condition score (BCS) and reproductive disorders, estrus performance, and reproductive performance in beef cattle. Sixty cattle with BCS scores 2, 3, 4, and 5 were used in this research. Minimum parity of one beef cattle used in this research. Correlation and simple linear regression were used to analyze the data. The results showed a moderate correlation coefficient and regression equation of BCS with post-partum estrus (0.51 and Y = 87,891-4,189X). The weak correlation coefficient and regression equation of BCS with vulva redness (0.26 and Y = 2.235 + 0.14X), intensity mucus (0.23 and Y = 2.343 + 0.12X), service per conception (0,35 and Y=2.266-0.201X) and days open (0.33 and Y = 107.35-3.56X). The very weak correlation coefficient and regression equation of BCS with the reproductive disorder (0.12 and Y = 4,964 - 0,57X), estrus behavior (0.15 and Y = 1.788 + 0.89X), and uterine erection (0.2 and Y = 1.352 + 0.1X). Conclusively, beef cattle with a minimum BCS of 4 is needed during mating.

Keywords: correlation, body condition score, reproductive performance and beef cattle

Abstrak. Penelitian ini bertujuan untuk mengetahui hubungan antara Body Condition Score (BCS) dengan munculnya gangguan reproduksi, tampilan reproduksi dan tampilan berahi pada induk sapi potong. Penelitian ini menggunakan 60 ekor induk sapi potong dengan skor BCS 2, 3, 4 dan 5. Induk sapi potong yang minimal partus 1 kali yang digunakan dalam penelitian ini. Data dianalisis menggunakan korelasi dan regresi linier sederhana. Hasil penelitian menunjukkan koefisien korelasi yang sedang dan persamaan regresi antara BCS dengan estrus post partum (0.51 dan Y = 87.891 − 4.189X). Koefisien korelasi yang lemah dan persamaan regresi antara BCS dengan kondisi vulva (0.26 dan Y = 2.235 + 0.14X), intensitas lendir (0.23 dan Y = 2.343 + 0.12X), service per conception (0.35 dan Y = 2.266 − 0.201X) dan days open (0.33 dan Y = 107.35 − 3.56X). Diperoleh koefisien korelasi sangat lemah dan persamaan regresi antara BCS dengan munculnya gangguan reproduksi (0.12 dan Y = 4.964 − 0.57X), tingkah laku berahi (0.15 dan Y = 1.788 + 0.89X) dan ereksi uterus (0.2 dan Y = 1.352 + 0.1X). Kesimpulan dari penelitian ini adalah dibutuhkan induk sapi potong dengan BCS minimal 4 saat proses perkawinan.

Kata kunci: korelasi, skor kondisi tubuh, performa reproduksi dan sapi potong

Introduction

Artificial insemination (AI) is one of the reproductive biotechnologies applied in Indonesia. AI can support the efficiency of male rearing in terms of genetic quality improvement and contribute in increasing beef cattle population. Unfortunately, the success rate of AI in Indonesia is still low. Raharja et al. (2018) reported that the service per conception (S/C) of cows in Samarinda is 3.26 to 3.78, and it takes 2 to 4 inseminations of cows to be pregnant. A study by Baliarti et al. (2017) on beef cattle in Yogyakarta also showed S/C higher than 2, and the estrus postpartum (EPP) reached 6 to 12 months.

The key success factors of AI include cow reproductive physiology, semen quality, and farmer's knowledge and inseminator's skill. Simple parameters of cow's reproductive physiology are body condition score (BCS) and estrus performance. Sodiq et al. (2017) stated that BCS correlates with nutrient sufficiency, animal health evaluation, and the success of AI application. Frozen semen produced by the Artificial Insemination Center with semen quality assurance has conformed to Indonesian national standards. Frozen semen handling will determine the semen quality so it needs to follow the standard operational procedure.

Human factor, including farmers and inseminators, are the most important success key for Artificial Insemination (Ardhani et al., 2020).

The low reproductive performance of cows is mainly due to poor feeding management. It has been reported that poor feeding management affect low (<3) or over BCS standard (>7) (Supriyanto, 2016; Dwitarizki et al., 2018). BCS has a relationship to the reproductive performance of cows; it measures fat deposits under the skin around the base of the tail, backbone, and hips (Budiawan et al., 2015). In addition, BCS also affects the secretion of hormones, especially for the supply of substrate hormone from fat and energy deposits. Body condition score has a moderate relationship with conception rate in beef cattle (Jamaludin et al., 2016). However, only a small number of research focused on the correlation of BCS with reproductive disorder, estrus performance, and reproductive performance. Therefore, this study aims at investigating and determining the relationship between BCS and reproductive disorders, estrus performance, and reproductive performance.

Materials and Methods

Research Location and Period

The research was conducted at the local farmers of Karangawen District, Demak Regency from August to October 2022.

Research Materials

This study used 60 cows with a minimum parity of 1, along with recording reproduction, rope, gloves, tissue paper, and 70-percent alcohol.

Research methods

Observational method was undertaken by collecting primary and secondary data. The primary data included body condition score (BCS), reproductive disorders (RD), and estrus performance (EP), while the secondary data were reproductive performance. Purposive sampling method with criteria minimum parity 1 were used to select from the cows.

Observed Parameters

The observed parameters in this research were body condition score, reproductive disorders, estrus performance, and reproductive performance of beef cow. Body condition score was observed from head to tail, hooks, rump, pins, ribs, back and shoulder palpation (score 1 to 9). Parish and Rhinehart (2016) stated nine categories of body condition score, namely BCS 1 (emaciated), BCS 2 (poor), BCS 3 (thin), BCS 4 (borderline), BCS 5 (moderate), BCS 6 (high moderate), BCS 7 (good), BCS 8 (fat) and BCS 9 (extremely fat). Reproductive disorders observation was done through rectal and ovary palpation (score 5=Normal reproductive; 4=One reproductive disorder; 3=Two reproductive disorders; 2=Three reproductive disorders; 1= four reproductive disorders and 0 = five reproductive disorders). Estrus performance was observed by checking of vulva alteration (1 to 3), behavior change (- or +), abundance of mucus (1 to 3) and uterus erection (- or +) at 8 hours intervals per day. Service per conception (S/C), days open (DO), conception rate (CR) and postpartum estrus (PPE) were the parameters of reproductive performance. Service per conception (S/C) is the number of mating up to pregnancy of beef cow (Puspitasari et al., 2018). The service per conception (S/C) was counted using the equation:

$$S/C = \frac{(Total\ mating\ to\ pregnant\ cattle)}{(Total\ number\ of\ pregnant\ cattle)}$$

Days open (DO) is the period between parturition and next pregnancy in beef cow (Puspitasari et al., 2018). Postpartum estrus (PPE) is the estrus or ovulation after parturition (Socheh et al., 2017).

Table 1. Number and Percentage of Reproductive Disorders of Beef Cow in Different BCS

BCS (head)	Reproductive Disorders											
	HO (head)	%	UO (head)	%	CO (head)	%	CLP (head)	%	An (head)	%	Σ (head)	%
2 (10)	1	10.0	0	0.0	0	0.0	3	20.0	2	20.0	6	60.0
3 (22)	0	0.0	0	0.0	0	0.0	3	13.6	0	0.0	3	13.7
4 (17)	1	5.8	0	0.0	0	0.0	2	11.8	0	0.0	3	17.6
5 (11)	0	0.0	0	0.0	1	9.1	1	9.1	0	0.0	2	18.2

Description: HO (Variants of Hypofunction), UO (Undeveloped Ovary), CO (Cystic Ovary), CLP (Corpus Luteum Persistent) and an (Anestrus).

Data analysis

Regression and correlation were used to analyze the data. Standard of coefficient correlation is 0-0.20 (very weak); 0,.21-0,40 (weak); 0.41-0.60 (moderate); 0.51-080 (strong) an 0.81-1.00 (very strong). The SPSS 26.0 statistical analysis program used to support the data analysis.

Results and Discussion

Relationship of body condition score and reproductive disorders in beef cow

The BCS score of beef cows in this research were 2, 3, 4 and 5. Table 1 shows the number and percentage of the reproductive disorders of beef cow with different BCS. The result showed that 14 beef cows (23.3%) experienced reproductive disorders. This figure is lower than 32.68% that was reported in East Ogan Komering Ulu, South Sumatra (Armelia et al., 2018). The highest reproductive disorders in this research are corpus luteum resistance or CLP (9 cows; 15%). CLP is the reproductive disorders caused by abnormal progesterone pattern (Lashari and Tasawar, 2012), and therefore can be addressed through fertility treatments, such as the administration of Prostaglandin (PGF2α). The consistent recording and reproductive physiological observation by the inseminator are crucial to reduce the occurrence of CLP. Table 1. showed that beef cow with BCS 2 has the highest reproductive disorder cases (6 cows; 60%). The highest reproductive disorders in cow with BCS 2 was affected by low level of body fat deposition, which correlates with steroid hormone such as estrogen and progesterone. Body fat deposition

indicate the nutritional status and related with reproductive physiology, including reproductive disorders (D'Occhio et al., 2019).

The regression and correlation statistical analysis showed the coefficient correlation of BCS and reproductive disorders is 0.12 and classified very weak correlation with the regression equation:

$$Y = 4.964-0,057$$

It means that increasing 1 score of BCS will decrease of 0.57 score of reproductive disorders. The coefficient of determination is 0.014, meaning that the effect of BCS on reproductive disorders is only 1.4%. The low coefficient determinant shows that beside BCS, many other factors contribute to the reproductive disorders.

Dwitarizki et al. (2018) states that the reproductive disorders are affected by three factors. The first factor is maintenance mis-management in areas such as artificial insemination, insufficient feed consumption, and mineral deficiencies. The second factor is cow physiology (including BCS) and the third is incidental factors. In this research, feed sufficiency is one of important rooms for improvement. Inadequate energy intake is one of the important aspects lead to the fertility disorders. Total digestible nutrient, protein, and lipid are needed to fulfill in ransom of beef cow. Feed sufficiency of this nutrient content will increase the BCS as reflected on the nutritional status of beef cows. The ideal BCS of beef cow would need 1 month after parturition to ensure a successful mating and to reduce the reproductive disorders (Hadush et al., 2013).

Sutiyono et al (2017) stated that a good BCS for beef cow is 4-7 to ensure the normal physiology reproduction. The concerns of feed sufficiency is not only on macronutrient but also micronutrient which includes mineral and vitamin. Vitamins and minerals play a significant role in fertility especially for hormone production. Vitamins A, D, E, and K, and also minerals calcium (Ca), magnesium (Mg), phosphorus (P), copper (Cu), selenium (Se) and zinc (Zn) play role as co-factor for enzyme and hormone synthesis related to reproduction (Pradhan and Nakagoshi, 2008).

Relationship of body condition score and estrus performance of beef cow

The estrus performance is important aspect to ensure the successful fertility. The number and percentage of the estrus performance in beef cow with different BCS showed in Table 2. The results of the research showed varied estrus performance of beef cows with different BCS. Relatively same number and percentages were observed on estrus performance of beef cows with different BCS. Rachmawati et al (2018) stated that beef cow in estrus will show redness of vulva, increased body temperature, abundant mucus cervix, and standing heat. Estrus performance of beef cow observed in this research included the redness of vulva, behavior change, mucus vagina intensity, and uterine erection.

The regression and correlation statistical analysis showed that the coefficient correlation of BCS and color of vulva of beef cow during estrus is 0.26 and classified weak correlation with the regression equation:

$$Y = 2.235 + 0.14X$$

It means that increasing 1 score of the BCS will increase of 0.14 score of color of vulva of beef cow during estrus. The coefficient of determination is 0.001, meaning that the effect of BCS on color of vulva of beef cow during estrus is only 0,1%. The low coefficient determinant showed that beside BCS, many other factors contributed to the color of vulva of beef cow during estrus.

One of the parameters for the estrus performance of beef cow is vulva redness. The escalation of estradiol during estrus will increase the adrenalin hormone. The increasing adrenalin hormone will affect the spurring of heart beat. Finally, increasing of the heart beat will increasing of the blood supply. The vulva redness is resulted from the increasing blood supply in vulva. The optimum redness of vulva will depend on the level of hormone and feed sufficiency for quality and quantity. The research of Anisa et al (2017) in Magelang regency showed that cows with BCS 5 showed the most optimum redness of beef cow's vulva during estrus compared to that of BCS 2, 3 and 4.

Table 2. Number and Percentage of Estrus Performance of Beef Cow in Different BCS

BCS (head)	Estrus Performance									
	Redness of Vulva (Percentage, %)			Behavior (Percentage, %)		Mucus Intensity (Percentage, %)			Uterine Erection (Percentage, %)	
	1	2	3	-	+	1	2	3	-	+
2 (10)	0 (0.0)	8 (80)	2 (20)	2 (20)	8 (80)	1 (10)	4 (40)	5 (50)	4 (40)	6 (60)
3 (22)	2 (9.1)	12 (54)	8 (36)	3 (13)	19 (86)	1 (4)	14 (63)	7 (31)	9 (40)	13 (59)
4 (17)	0 (0.0)	10 (58)	7 (41)	1 (5)	16 (94)	0 (0)	13 (76)	4 (23)	4 (23)	13 (76)
5 (11)	0 (0.0)	9 (81)	2 (18)	1 (9)	10 (90)	0 (0)	7 (63)	4 (36)	2 (18)	9 (81)

Description: Color of Vulva: 1 = pale; 2 = slight red; 3 = Red; Behavior: 1 = No behavior changing; 2 = behavior changing; Intensity of mucus: 1 = not mucus; 2 = slight abundant; 3 = abundant; Uterus erection: 1 = no uterine erection; 2 = uterine erect

The regression and correlation statistical analysis showed that the coefficient correlation of BCS and behavior change of beef cow during estrus is 0.15 and classified very weak correlation with the regression equation:

$$Y = 1.788 + 0.89X$$

which means that increasing 1 score of the BCS will increase of 0.89 score of behavior changing of beef cow during estrus. The coefficient of determination is 0.024 which means that the effect of BCS on behavior changing of beef cow during estrus is only 2.4%. The low of coefficient determinant showed that beside BCS, many other factors contribute to the behavior changing of beef cow during estrus.

During estrus, increasing of the adrenalin hormone will be followed by responses of beef cow to exhibits some behavior including loss of appetite, restless and standing heat. Each cattle showed different behavior change but they exhibit estrus behavior with the same intensity (Anisa et al., 2017). Present study showed that behavior change was apparent in a high percentage of beef cow (88.4%). The rest 11.6% of beef cow in this research did not show behavior change which may be due to deficiency of specific nutrient. Ma'ruf et al (2017) stated feed deficiencies in beef cow will affect the substrate of reproduction hormone. Low reproduction hormone makes estrus behavior less apparent. Anisa et al (2017) stated that the hormone used in maturation and exhibits is *Follicle Stimulating Hormone* and estrogen.

The regression and correlation statistical analysis showed that the coefficient correlation of BCS and mucus cervix intensity of beef cow during estrus is 0.23 and classified weak correlation with the regression equation:

$$Y = 1.788 + 0.12X$$

It means that increasing 1 score of the BCS will increase of 0.12 score of mucus cervix intensity of beef cow during estrus. The coefficient of determination is 0.0001 which means that the effect of BCS on mucus cervix intensity of beef cow during estrus is only 0,01%. The low of coefficient determinant shows that beside BCS, many other factors contribute to the mucus cervix intensity of beef cow during estrus.

Mucus cervix is produced after alteration of heart beat that affected the increasing tonic pressure in goblet cell. Increasing tonic pressure in goblet cell will allow diffusion of fluid cell to the cervix channel. The abundant mucus cervix depends on the level of estrogen and adrenalin hormone. The level of hormone is affected by supply of substrate hormone which come from fat and energy deposition. Ansori et al (2021) stated that ideal BCS of beef cow will ensure abundant secretion of cervical mucus. Ma'ruf et al (2017) stated that an ideal BCS of beef cows and feed sufficient will showed normal signs of estrus, including abundant cervical mucus.

The regression and correlation statistical analysis showed that the coefficient correlation of BCS and uterine erection of beef cow during estrus is 0.20 and classified very weak correlation with the regression equation:

$$Y = 1.352 + 0.1X$$

It means that increasing 1 score of the BCS will increase of 0.12 score of uterine erection of beef cow during estrus. The coefficient of determination is 0.039, meaning that the effect of BCS on uterine erection of beef cow during estrus is only 3.9%. The low coefficient determinant shows that beside BCS, many other factors contribute to the uterine erection of beef cow during estrus.

Uterine erection is an effect of altered estrogen level followed by the increasing prostaglandin. Prostaglandin is one of the hormones responsible for muscle tension, including in uterine. Uterine erection is the sign of beef cow is ready for mating (Ma'ruf et al., 2017). In this research, 69.1% of beef cow showed the uterine erection. Beef cows with BCS 4 and 5 show >70% uterine erection as estrus sign.

Table 3. Reproductive Performance of Beef Cow in Different BCS

BCS (head)	Reproductive Performance		
	Service/Conception (times)	Days Open (Days)	Estrus Post Partum (Days)
2 (10)	2.10	101.2	81.2
3 (22)	1.45	98.2	74.9
4 (17)	1.41	88.2	75.2
5 (11)	1.36	91.5	74.1

Relationship of body condition score and reproductive performance of beef cow

Reproductive performance is the most prevalent parameters of beef cow fertility. Service per conception, days open, and estrus post-partum are the parameters measured in this research. The measurement result of reproductive performance showed in Table 3. This research showed the optimum reproductive performance is observed from beef cow with BCS 4 & 5, >2 times of service per conception, 90 days open and >80 days. The low of BCS is affected to the reproductive performance. BCS is the parameters for the energy and fat deposition as the substrate hormone. The sufficiency of hormone is the key success of reproductive performance. Feed sufficiency will ensure the energy and fat deposition will be affected to the BCS and normal reproductive performance (Pradhan and Nakagoshi, 2008). Low BCS caused by poor nutrition management is related with longer estrus post-partum and days open. Feed sufficiency, including macronutrient and micronutrient, is vital for high reproductive performance.

The regression and correlation statistical analysis showed that the coefficient correlation of BCS and service per conception of beef cow is 0.35 and classified weak correlation with the regression equation:

$$Y = 2.266 - 0.201X$$

It means that increasing 1 score of the BCS will decrease 0.201 times of service per conception of beef cow. The coefficient of determination is 0.122 which means that the effect of BCS on service per conception of beef cow is only 12.2%. The low of coefficient determinant showed that beside BCS, many other factors contribute to the service per conception of beef cow.

The success of service per conception (S/C) depends on cow physiology including BCS, frozen semen quality, behavior of farmer and integrity of inseminator. This statement supported by Suryana and Yasin (2015) that state the factors influencing successfully of (S/C) is the semen quality, the estrus detection, body condition scores and the skills of the inseminators. Dwitarizki et al (2018) stated poor feeding management in community farmers is the causes of low reproductive efficiency in beef cow. Energy has a role in livestock to carry out metabolic activities, growth and reproduction. Dwitarizki et al (2018) stated that inadequate energy and other nutrients will result in decreasing BCS, estrus, and reproductive performance. Furthermore, energy and fat reserve indicated by BCS correlates with the success of mating (Sodiq and Hidayat, 2014).

The regression and correlation statistical analysis showed that the coefficient correlation of BCS and days open of beef cow is 0.33 and classified weak correlation with the equation:

$$Y = 107.35 - 3.56X$$

It means that increasing 1 score of the BCS will decrease of 3.56 days of days open of beef cow. The coefficient of determination is 0.11 which means that the effect of BCS on days open of beef cow is only 11%. The low of coefficient determinant showed that beside BCS, many other factors contribute to the days open of beef cow.

Days open is the period between parturition and next pregnancy. The days open will be longer when beef cow experiencing reproductive disorders, such as ovarian hypofunction, delayed Artificial Insemination, silent heat, repeated mating and nutritional deficiencies (Reswati et al., 2014). Najwan et al (2016) added that ensuring feed sufficiency in days open period will increase the success rate of fertility and reduce days open. Even though in this research the correlation is weak, the body condition score still contributing to the shorter days open.

The regression and correlation statistical analysis showed that the coefficient correlation of body condition score and estrus post-partum of beef cow is 0.51 and classified moderate correlation with the regression equation:

$$Y = 87.891 - 4.189X$$

it means that increasing 1 score of BCS will decrease 4.198 days of estrus post-partum of beef cow. The coefficient of determination is 0.258, meaning that the effect of body condition score on days open of beef cow is only 25.8%. Low coefficient determinant showed that beside body condition score, many other factors contribute to the estrus post-partum of beef cow.

Estrus post-partum (EPP) is the interval period between parturition to the first estrus. The EPP length is depend on the length of estrus, estrus detection, reproductive status and body condition score (Riyanto et al., 2015). One of the factors cause low reproductive performance of beef cow is delay in the estrus post-partum. body condition score as the indicator of energy and fat deposition will show the sufficiency of substrate hormone synthesis. Inadequate nutrient will disrupt the reproductive cycle, delaying post-partum estrus and reducing the reproductive performance. In addition, the lack of nutrients will also lead to ovarian hypofunction as one of reproductive disorders.

Conclusions

Beef cow with a minimum BCS of 4 is needed during mating. This standard will support the increasing estrus and reproductive performance while decreasing the reproductive disorders. Ensuring the feed sufficiency is important factor to increase reproductive performance.

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