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Effect of Body Condition Score and Lactation Number on Selected Reproductive Parameters in Lactating Dairy Cows

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Abstract: This study was conducted to investigate the relationship between body condition score (BCS), lactation number and selected reproductive measures such as the days open and the number of services required per conception in Holstein dairy cows. The body condition was arranged in 2 scales, scale-A (≤3.5, 3.75 and ≥4) and scale-B (2.25 until 4.5). Two studies were conducted on these dairy cows. A total of 267 cows were involved in the final data analysis to through light on the effect of BCS (Study 1) and lactation number (Study 2) on the days open and number of services required per conception. Results showed that the cows with BCS of 3.75 (in scale-A) or 3.5 (in scale-B) have a significant ($P<0.05$) shortest days open (100.45±6.00 and 97.94±5.42). The cows with =4 BCS had the longest days open (123.00±8.30 and 132.15±11.73) for scale-A and –B, respectively. The lowest number of services required per conception recorded with the 3.75 and 3.5 BCS (1.79±0.14 and 1.98±0.12), when they were compared to the thinner or fatty cows. Moreover, fatty cows (≥4 BCS), with their longer days open and higher number of services per conception; accompanied with a significant ($P<0.05$) increase in the number of lactation season and days in milk. Non significant shorter days open (89.31±4.88 and 89.62±10.16) and lower number of services per conception (1.87±0.29 and 1.72±0.14) was accompanied in the first 2 lactation seasons, in comparison to the successive ones. Subsequently, the cows with moderate BCS showed shorter days open and lower number of services required per conception than thinner and fatty cows. Likewise, cows at early lactation seasons showed shorter days open and lower services per conception than the later seasons. *In conclusion*, the relationship between BCS, lactation number and reproductive measures (days open and services/conception) was strong. Thus, BCS could be used as a management and selection tool to improve the reproductive performance in dairy cows.

Key words: BCS · Conception · Days Open · Reproductive Performance · Services

INTRODUCTION

The challenges associated with achieving pregnancy in modern, high producing dairy cows have received considerable attention from scientists, veterinarians and farmers in recent years. Today, dairy cows tend to have lower conception rate, grater days open and greater likelihood of culling due to infertility than their counterparts from 2 or 3 decades ago [1]. Extremes of body condition, <1.5 or >4, will almost invariably reduce reproductive performance although changes in condition are more important than actual condition at any time point [2].

Evaluation of body condition score is a useful management tool to assess body fat reserves in dairy cows. Low body after calving has been associated with increased incidence of anoestrus and anovulatory cycles and reduced conception rates. A very consistent method to assess BCS was designed [3]. Utilization of this method has indicated that cows with low BCS at 70 days postpartum are more likely to have anovulatory cycles. Moreover, cows that do not experience a luteal phase before the first postpartum insemination have reduced fertility [4,5]. Furthermore, cows with low BCS at breeding time have reduced oestrous detection after a luteolytic dose of prostaglandins-F2α [6] and reduced fertility when enrolled in timed artificial insemination protocols [7]. Therefore, minimizing a loss of BCS during the first weeks postpartum is critical fore adequate reproductive performance. This can be achieved by minimizing the incidence of postpartum problems and optimizing nutrient intake during the first 4 to 8 weeks in lactation. Excessive BCS prior to calving due to excessive energy intake or prolonged dry period has been recognized as a risk

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factor. It is often associated with metabolic problems [8]. Moreover, over conditioning during early lactation or at the time of calving results in health problems e.g. retained placenta, metritis, ketosis, displaced abomasums and cystic ovaries [9]. The higher incidence of infections or the cows may exhibit poor uterine muscular tone, fatigue during the calving procedures, difficult births as well as high susceptibility to infection [10].

In this respect, a trial was made to investigate the relationship between BCS and lactation number and some selected reproductive parameters such as days open and number of services required per conception.

MATERIALS ANS METHODS

Housing and management of cows: This study was carried out on a commercial private dairy farm belonging to Sharkia Province. A total of 267 dairy cows with certain BCS were involved in the final data analysis. The cows were kept in a stall barn, milked three times daily and the average milk yield/cow was 34±0.9 kg/day. The cows housing and management system is computerized. The cows were fed total mixed ration (TMR) *ad libitum* 6 times a day at 7.00 am. and then every 4 hrs regular intervals using a mixer wagon with 5-10% excess in the amount of mixed ration. The TMR (concentrates, silage, wheat straw, vitamins and minerals) was constituted according to [11] as illustrated in Table 1. The herd veterinarian recorded all the diseases and culling reasons in the farm.

Measuring of the body condition score: The BCS was measured visually by trained persons. Animals were grouped according to the BCS as well as milk production. The body condition was carried monthly to adjust the feeding requirements. Moreover, BCS was also carried at close up cows and after delivery. The cows were scored based on 2 types of scales. The scale-A based on a five-point scales with quarter point divisions, where score 1 was given to emaciated, score 3 to moderate and score 5 to obese cows. BCS was assessed based on the appearance of tissue cover over the bony prominences in the back and pelvic regions via palpation and visual inspection [12]. The scale-B based on increasing 0.25 point in the body score onward (from 2.25 up to 4.5) as described [13].

Some selected reproductive events such as days open, number of services required for conception and lactation number were recorded. However, the effect of BCS and the number of lactation seasons on these reproductive measures was performed in 2 studies.

Table 1: Composition of the total mixed ration (TMR) for the Holstein lactating dairy cow according to NRC [11]

Ration components	(TMR) kg/day	Ration components	(TMR) Kg/day
Corn silage	63.65	Salts	0.15
Wheat straw	1.03	Limestone	0.64
Soya meal	12.47	Bone meal	0.59
Corn grain	9.94	Niacine	0.00
Rice grain	4.05	Potassium carbonate	0.39
Rice bran	5.09	Magnesium oxide	0.10
Molasses (Sugarcane)	1.19	ME (Mcal/kg DM)	2.34
Multivita minerals	0.05	MEI (Mcal/kg DM)	1.47
Multivita vitamins	0.05	Meg (Mcal/kg DM)	1.21
Sodium bicarbonate	0.61	DCAD (mEQ/kg)	425.00

Nutrient Requirements of Dairy Cattle. According to 7th Rev. ed. National Academy Press, Washington, DC, USA

Study 1: A total of 267 cows were divided into three groups (scale-A) based on their BCS into thin (≤3.5; n=171), moderate (3.75; n=55) and fat (≥4; n=41), according to previous study [12]. This study documented the incidence of different BCS in the herd. The relationship between the BCS and some reproductive related measures, such as days open and number of services required per conception, was investigated.

The same cows (n=266) were divided into ten groups (Scale-B) based on their BCS into 2.25, 2.5, 2.75, 3.0, 3.25, 3.5, 3.75, 4.0, 4.25 and 4.5 scales [13]. In this study, it was tried to examine the effect of BCS on days open and the number of inseminations required per conception. In addition, the incidence of cows with different BCS was documented.

Study 2: In this study, a total of 266 cows were classified into 6 groups according to the number of lactation season (from 1st season to 6th one). This study illustrated the influence of lactation season on the days open as well as the number of services required per conception in dairy cows with different BCS.

The days in milk of all the cows were also documented and related to the BCS, days open and number of services required per conception.

The days open was calculated as the days after insemination subtracted from the days in milk

Statistical Analysis: Analysis of the data was performed using SAS analysis system package [14]. Significant differences between the means were evaluated utilizing Duncan's Multiple Rang Test (DMRT) [15].

RESULTS

The relationship between the BCS and selected reproductive measures (days open and services/ conception) were illustrated in Tables 2 and 3. Results revealed that BCS ≤3.5 was the highest among the other scores (in scale-A), as it recorded for 171/267 (64.04%) of cows (Table 2). The total means showed 107.69±3.22 and 2.01±0.05 for days open and number of services required per conception, respectively. The cows with BCS 3.75 had a significant ($P<0.05$) shortest period of days open (100.45±6.00), while the cows with score ≥4 had the longest (123.00±8.30) one. Regarding the number of services required per conception, the cows with body condition ≤3.5 and 3.75 showed the lowest (1.96±0.07 and 1.98±0.12) compared to the cows with ≥4 score

Table 2: The relationship between BCS and some selected reproductive parameters in a herd of Holstein Friesian cows

	BCS (scale-A)			
Parameter	≤3.5	3.75	≥4	Total means
No. of cows	171	55	41	267
% of cows	64.04	20.30	15.36	100
Milk yield	33±0.7	34±0.9	35±1.1	34±0.9
Days open	106.35±4.17^{ab}	100.45±6.00^{b}	123.00±8.30^{a}	107.69±3.22
S/C	1.96±0.07^{a}	1.98±0.12^{a}	2.26±0.15^{a}	2.01±0.05
DIM	226.60±5.04^{b}	231.47±9.20^{b}	265.85±0.11^{a}	233.63±4.19
Lactation No.	2.24±0.10^{b}	2.23±0.20^{b}	2.85±0.20^{a}	2.33±0.08

Means with different superscripts in each raw are different at level ($P<0.05$).
S/C: Services per Conception; DIM: Day In Milk.

Table 3: The relationship between body condition score and some selected reproductive parameters in a herd of Holstein Friesian cows

		Reproductive related parameters			
BCS	Cows				
scale-B	n(%)	Days open	S/C	DIM	LN
2.25	4(1.50)	109.88±9.97^{a}	2.00±0.40^{a}	181.25±6.52^{b}	2.25±0.20^{bcd}
2.50	6(2.26)	113.61±13.36^{a}	2.00±0.16^{a}	192.83±30.33^{b}	2.69±0.28^{bcd}
2.75	21(7.89)	111.30±6.98^{a}	2.03±0.12^{a}	223.61±13.15^{ab}	2.71±0.33^{bcd}
3.0	39(14.66)	98.43±6.99^{a}	2.00±0.12^{a}	212.10±9.27^{ab}	1.76±0.12^{d}
3.25	34(12.78)	103.25±12.45^{a}	1.83±0.30^{a}	226.98±8.16^{ab}	2.47±0.24^{bcd}
3.50	67(25.19)	97.94±5.42^{a}	1.87±0.39^{a}	226.26±13.58^{a}	2.18±0.17^{cd}
3.75	55(20.68)	87.83±13.15^{a}	1.79±0.14^{a}	234.79±11.21^{ab}	3.12±0.29^{abc}
4.0	26(9.77)	107.62±11.65^{a}	2.14±0.19^{a}	235.54±8.59^{ab}	3.00±0.77^{abcd}
4.25	6(2.26)	113.50±16.23^{a}	2.16±0.30^{a}	237.16±16.73^{ab}	3.50±0.42^{ab}
4.50	8(3.02)	132.15±11.73^{a}	2.50±0.20^{a}	266.25±18.37^{a}	4.00±0.70^{a}
Total	266	108.00±3.15	2.03±0.19	231.48±3.98	2.37±0.63

Means with different superscripts in each raw are different at level ($P<0.05$).
S/C: Services per Conception; DIM: Day In Milk; LN: Lactation Number

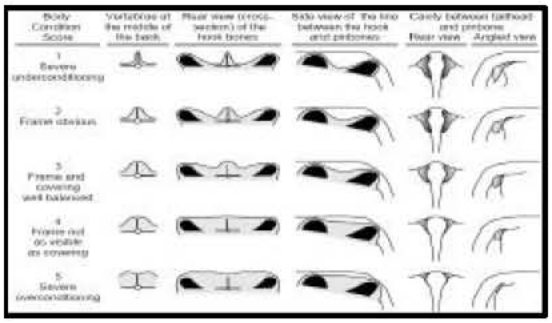

Fig. 1: A body condition scoring chart for Holstein dairy cows, according to Edmondson, *et al.* [12]. J. Dairy Sci., 72: 68-78.

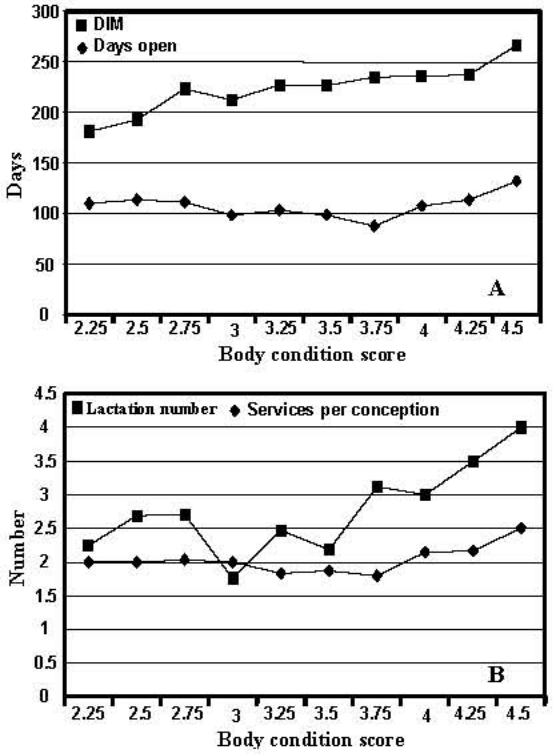

Fig. 2: The effect of body condition score on the days open (A); and number of services per conception (B) in lactating dairy cows. The figure also illustrates the relation between days in milk and days open (B); the relation between lactation number and number of services per conception (B).

(2.26±0.15). However, the fatty cows (≥4 BCS), with their longest period of days open and the highest number of services per conception; accompanied with a significant ($P<0.05$) increase in lactation seasons and days in milk compared to the other body scores (≤3.5 and 3.75).

Table 4: The relationship between lactation number and some selected reproductive parameters in a herd of Holstein Friesian cows

	Cows	Reproductive related parameters			
LN	n(%)	Days open	S/C	DIM	BCS
1st	94(35.34)	89.31±4.88[a]	1.87±0.29[a]	238.92±7.35[a]	3.38±0.03[a]
2nd	80(30.08)	89.62±10.16[a]	1.72±0.14[a]	219.97±6.54[a]	3.44±0.04[a]
3rd	45(16.92)	110.95±5.41[a]	2.0±0.10[a]	234.17±8.60[a]	3.30±0.16[a]
4th	22(8.27)	107.68±6.0[a]	2.07±0.11[a]	213.95±8.98[a]	3.51±0.15[a]
5th	17(6.38)	113.95±8.44[a]	2.08±0.13[a]	243.70±20.20[a]	3.55±0.06[a]
6th	8(3.01)	123.58±15.66[a]	2.11±0.22[a]	189.62±10.16[b]	3.56±0.13[a]
Total	266	108.00±3.15	2.03±0.19	231.48±3.98	2.37±0.63

Means with different superscripts in each raw are different at level (P<0.05). S/C: Services per Conception; DIM: Day In Milk; BCS: Body Condition Score

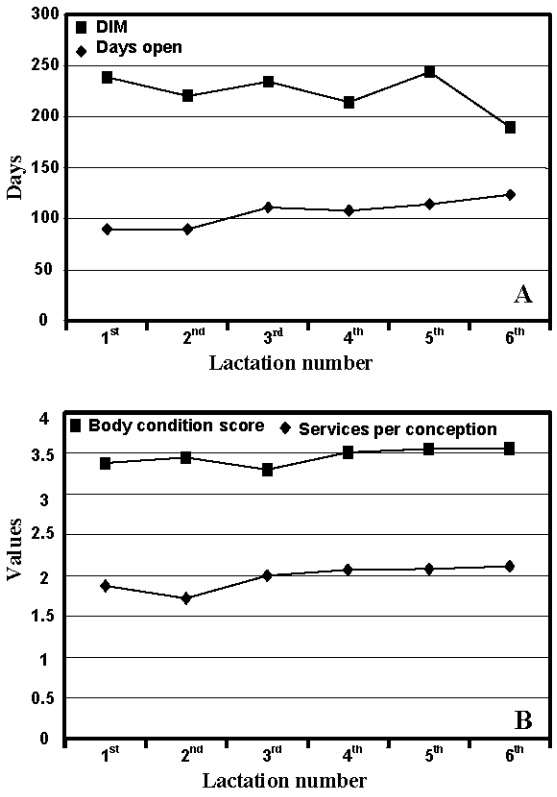

Fig. 3: The effect of lactation number on the days opens (A); and on the number of services per conception (B) in lactating dairy cows. The figure also illustrates the relation between the days in milk and days open (A); and between the body condition score and services per conception (B).

When the body condition was scaled on the basis of increasing 0.25 point beginning from 2.25 until 4.50 scale (scale-B), similar results were obtained (Table 3 and Fig. 2). The intermediate body conditions (3.5 and 3.75) revealed a non significant shortest period of days open (97.94±5.42 and 87.83±13.15) and the lowest number of services required per conception (1.87±0.39 and 1.79±0.14), when they were compared to the thinner or fatty cows. The previous results accompanied with a significant (P<0.05) increase in number of lactation seasons and days in milk for fatty cows (highest BCS) and a significant decrease for thinner cows (lowest BCS).

Regarding to the relationship between lactation number and the selected reproductive measures (Table 4 and Fig. 3), results revealed that most of cows are in their first and second lactation season. A non significant shorter period of days open (89.31±4.88 and 89.62±10.16) and lower number of services required per conception (1.87±0.29 and 1.72±0.14) were accompanied with the first and second lactation seasons, when they were compared to the successive one.

DISCUSSION

In recent years, high producing dairy cows have received considerable attention from scientists and farmers. Today's dairy cows tend to have lower conception rate, greater days open and greater likelihood of culling due to infertility than their counterparts from 2 to 3 decades ago [16]. In this study, cows with 3.75 BCS had a significant shortest period of days open than cows with score ≥4.0. The number of services required per conception in the cows with ≤3.5 and 3.75 BCSs were lower compared to cows with ≥4.0 score. However, fatty cows (≥4 BCS), with their longest period of days open and the highest number of services per conception; accompanied with a significant increase in lactation seasons and days in milk compared to the other body scores (≤3.5 and 3.75). It is been known for some time that cows with low BCS have a greater likelihood of being anovular [17], of 18 cows that had a BCS of less than 2.5, 15 were found to be anovular. These cows generally have small follicles. However, the majority of cows that are anovular are cows with good BCSs of more than 2.75. Even more than 20% of cows with 3.25 BCS were found to be anovular. These cows generally have follicles that are larger than ovulatory size (17 mm) and usually larger than 20 mm. The intriguing thing about these data is that although clearly cows with low BCS are likely to be anovular, most of these anovular cows in dairy herd do not have low BCS.

Selection for high milk yield has led to thinner cows that lose BCS in early lactation. Results from a previous study [18] showed that selected cows for high

production have poorer reproductive performance, in that the first heat is delayed, conception rates were poorer and consequently calving intervals were longer. A strong relationship was found between BCS and reproductive performance. Therefore, to control reproductive performance, managing cattle to predetermined levels of BCS and BCS loss is more important in high than low genetic merit cows. One tempting hypothesis is that BCS changing may be more important as an indicator of reproductive performance than BCS, as it indicates a potential selection criterion for fertility. The present study showed a non significant shorter period of days open and lower number of services required per conception accompanied with the first and second lactation seasons, when they were compared to the successive ones. Negative Energy balance during the 1st month of lactation is detrimental for the recovery of ovarian function in 1st lactation Holstein dairy cows [19]. It is assumed that manual BC scoring might be not sensitive enough to reveal changes in energy balance. However, another author [20] found in primiparous cows a reduction in 6 open days for each additional unit of body condition at calving. In a meta-analysis that BCS at parturition was associated with the relative risk for conception only in cows showing a low BCS at parturition and BCS change during the early lactation period was not associated with the relative risk for conception [21]: cows in good BCS at calving had significantly reduced days open. In contrast, [22] found that fat cows were less likely to conceive at first service than were cows in normal condition. This conclusion is in accordance with the results of our study, cows with high BCS did not conceive from the first service and this led to higher number of services per conception in this group compared to the other groups. Several studies had pointed out that cows losing one unit or more BCS during early lactation are at greatest risk for low fertility with conception rates 17-38% has also referred to it by [23]. According to [24] the long-term effects of NEB might impair the health of preovulatory oocytes and follicles and reduce progesterone concentrations after ovulation. Thus, high BCS of the fat cows group near calving and subsequent BCS loss more than one unit might be a risk factor for impaired conception in this group. Other fertility parameters like interval from calving to first service, service period and days open did not differ significantly among the three groups investigated.

Increased milk yield at 120 day of lactation was associated with an increased likelihood of conception and decreased body condition during the 1st month of lactation was associated with a decreased likelihood of conception [25]. However, the changes in BCS during the 1st month of lactation was included in the logistic regression model because the correlation between changes in BCS during the 1st month of lactation and changes in BCS between parturition on and first postpartum AI was 0.72 ($P<0.05$). Negative energy balance is most severe during the first 2 weeks of lactation and may influence physiological functions during the time that are important to conception [26]. The likelihood of the conception from first service may be determined by the loss of BCS during the 1st month of lactation. However, then higher yielding cows were more likely to conceive than were lower yielding cows. There may be an antagonistic relationship between milk yield and reproductive performance. Additionally, [27] suggested that high yielding cows are reproductively sound because they are healthier than are lower yielding cows.

Changes in body condition during early lactation follow changes in energy balance [28]. The energy requirement of a dairy cow is met through a combination of dietary intake and mobilization of body reserves. The mobilization of body reserves leads to a decrease in BW and BC. Therefore, BC scoring, although subjective, can be a useful tool for relating suboptimal reproductive performance to inadequate nutrition in early lactation [8,29]. According to [28,30,31]; high producing cows experience a severe weight loss during the first 3 to 5 wk after calving. The adverse effect of this weight loss on developing follicles can be detrimental and lead to defective follicles and low levels of P4 that are associated with low fertility [29]. Otherwise, cows that consume sufficient dry matter during this period apparently have healthy follicles and maintain high fertility [32].

A decrease in BCS of more than 1.0 point during the first 5 week after calving leads to lower fertility at first service [29]. Body condition and body weight increased linearly with prepartum high energy diets. Moreover, over consumption of energy prepartum did not impair milk production when high energy total mixed rations were fed postpartum [28]. However, over conditioning of the dairy cows during the late prepartum period lead to an increased number of days from parturition to conception due to a higher incidence of embryonic mortality. According to [33] the loss of BC in multiparous cows contributed to the failure of conception at first AI service. There was a positive correlation between higher total milk yield at 120 d of lactation and conception at first AI service. Energy balance during the dry period and early lactation, as monitored by BCS scores, was more

important to conception at first AI service than were health disorders or other risk factors. Cows that are at risk for failure to conceive at first AI can be identified by monitoring BCS at dry-off, parturition and during early lactation. BCS at calving appears to have little influence on milk yield. However, changes in BCS, which are related to BCS at calving, have influenced milk yield [25]. The rate of increase in milk yield in early lactation was important to total yield and may more accurately reflect the dynamic biological changes experienced by the cow. The rate of increase in milk yield may be associated with BCS or changes in BCS. An increase in BCS during the dry period was related to an increase in milk yield and milk yield acceleration and a higher BCS at dry-off was associated with a decrease in milk yield and milk yield acceleration than a low BCS. A dry period length that is <58 d or >58 d was negatively associated with milk yield and acceleration after parturition [33].

The initiation of a follicular wave, including recruitment and dominant follicle selection, occurs regardless of the typical early postpartum negative energy balance [34]. Cows that were on a high energy diet had an increase in the number of follicles larger than 15 mm. Their results showed that although the mean daily EB did not appear to have a significant role in follicular function, the day of EB nadir was positively correlated with the day of first ovulation. The improvement of EB from its most negative value also enhanced follicular competence, since first wave dominant follicles that emerged after the EB nadir exhibited greater apparent steroidogenic output and ovulation rate than dominant follicles that emerged before the EB nadir. Cows on a low-energy diet seem to have a higher concentration of NEFA and a lower concentration of insulin like growth factor (IGF-I) than cows on a high energy diet. Plasma concentrations of NEFA are good indicators of adipose tissue mobilization for energy and the increase of NEFA in cows on a low energy diet reflect the dietary induction of a negative EB. The daily growth rate and total growth of the dominant follicle were affected by the fluctuation in energy intake; both the rate and total growth were higher for cows on a high energy diet compared to cows on a low energy diet. A decrease in energy levels caused a reduction in the IGF-I concentration, possibly the reason for a decrease in growth rate of the developing follicle. Lactation status seems to have an influence on ovarian follicular responses. Dry cows (non-pregnant) tended to have smaller dominant follicles during the first follicular wave [35] and a lower frequency of larger follicles (>15 mm) through out their estrous cycles.

In conclusion, BCS is easy to measure and could be used for management and breeding programs as indirect selection criteria for fertility as changes in BCS can be used to identify cows at risk for failure to conceive. Subsequently, the relationship between BCS, lactation number and reproductive measures (days open and services/conception) was strong.

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