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Importance of Body Condition Scoring in Reproductive Performance of Dairy Cows: A Review

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Abstract

Body condition score (BCS) is a subjective method of assessing the amount of metabolizable energy stored in fat and muscle (body reserves) on a live animal. Body condition scores provide an indication of the energy status of dairy cattle. It can be used on both heifers and cows, although primarily they are used on the lactating dairy herd. Adjusting the nutritional program to obtain desired body condition at different stages of production is necessary to enhance production efficiency. Females that are too thin or too fat can be an expensive investment. Nutritional management is the most crucial one and is a key factor for normal production and reproduction cycle. Thus, it could be used as a management and selection tool to improve reproductive performance in dairy cows.

Keywords

Reproduction, BCS, Fertility, Cows

1. Introduction

The challenges associated with achieving maximum reproduction potential in modern high producing dairy cows have received considerable attention in recent times. In such scenario, delayed puberty and anestrous are one of the major constraints for optimal reproductive performance of dairy cows. Such condition besides imposing a question mark on the management practices, also prove to have unfavorable outcomes leading to reduced economic value of an animal.

The management system of measuring body condition has been used as a simple, accurate and clinically applicable tool to predict fertility during postpartum period in cows. It is useful to quantify the extent, as to which the various

factors like nutrition, disease or other environmental causes, is significantly contributing towards determining the fertility status of the animal.

As time has passed, various methods of scoring body condition have evolved. Previously it was being done by conventional technique of measuring changes in weight or heart girth [1]. But due to the cumbersome and meagre interpretations, this system was soon outdated. Therefore, body condition scoring was originally developed for management in sheep during the 1960, before being adopted for use with cattle in the 1960s [2] [3] [4]. The scoring system was modified for beef cattle by Lowman *et al.* [5]. Later a criteria system created for BCS of dairy cattle [2] [6] [7]. During the last 25 years, various other BCS systems have been described and researched throughout the world [3].

With due course of time, some other subjective methods were standardized. These methods required expertise and were based on observation and palpation of certain parts of the animal body after which a score was given based on some standard numerical scale. Likely, there were some constraints in these methods too.

Palpation required animals to be under restraint while scoring was performed. For this reason, in many production systems, especially those with large herd sizes, the opportunity for this type of evaluation was limited. On the other hand, visual method is a preferred method when large numbers of freely moving cattle are involved. Body condition scoring performed in this way is a rapid and easy method of assessing the condition of cattle [8].

Similarly, like various methods to score an animal, the scale on which the score has to be decided varies with different conditions/individuals. A scale of 1 to 9 has been described for beef cattle and a scale of 1 to 5 is generally used for dairy cattle [9]. In both scales, score increases with the amount of fat deposits, mostly over the ribs, around the tail base, lumbar and pelvic areas, and gives a practical measurement of body reserves. Therefore, this system based on a fixed scale represents the state of the animal where the lower value represents extremely thin and the higher value signifies obese body condition.

BCS which gives a relative score to each cow for her level of body reserves in the form of muscle and fat is virtually very important as the BCS at key periods in lactation, as well as BCS changes over early lactation, could affect the resumption of estrous cycles and reproductive success [10].

Keeping in view the wide range which the scale represents, it should be realized that extremes of body condition, <1.5 or >4, will almost invariably reduce reproductive performance [10]. Low body after calving has been associated with increased incidence of anestrus and anovulatory cycles [11]. The cows with low BCS at breeding time have reduced estrus detection [12] and reduced fertility when enrolled in timed artificial insemination protocol [13].

Excessive BCS prior to calving has been recognized as a risk factor often associated with health problems and metabolic disorders e.g. retained placenta, metritis, ketosis, displaced abomasums and cystic ovaries [14] [15]. In wake of these

facts, it is best to breed cows in good body condition and then use strategic supplementation with nutrients to get the desired production and reproduction traits.

Body condition scoring proves to be a wonderful tool in management. Not only it tempts to classify the animals into different categories representing their reproduction potential but also assists in managing them during the different phases of production in order to augment the fertility. The purpose of this chapter is to review the relationship between BCS and importance of it on reproductive performance.

2. Evaluation of Body Condition Score

Body condition score (BCS) is a subjective method of assessing the amount of metabolizable energy stored in fat and muscle (body reserves) on a live animal. BCS system initially developed by [16] for ewes. The system involved palpating the backbone and lumbar processes, feeling for the sharpness and covering of the bones. Ewes were scored on a scale from 0 to 5, where 0 was on the point of death and 5 was very fat. Later, Lowman *et al.* [5] developed BCS system for beef cattle using a 0 to 5 scale, with intermediate values for animals whose condition falls between these numbers, functioning as an 11-point scale. This system also used palpation of the backbone and lumbar processes and included palpation of the tailhead region. Bullock *et al.* [17] suggested that for BCS to be considered as an indicator of body fat amount or percentage, it should be considered together with body weight (BW) and frame. However, Broster and Broster [18] suggested that BCS reflects largely adipose tissue stores and no protein reserves. For this reason, BCS together with body weight (BW) can be proposed to be good predictors for body fat [19] [20] [21]. Among others, Edmonson *et al.* [22] and Ferguson *et al.* [11] indicated that not only is BCS a good measure of total body fat but also the method is accurate and repeatable between assessors of body condition. In many countries, a system of charts, pictures and descriptions to define specific characteristics of each BCS [23] [24] has been developed.

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Some workers have defined a separate scale of 1 to 9 for beef cattle [25] and a scale of 1 to 5 is for dairy cattle [26]. Whereas some workers use the same measurement scale with similar results in both types [27]. In both scales, score increases with the amount of fat deposits and gives a practical measurement of body reserves. Others have further, aided their measurements by using calipers

[28]. Moreover, this technique requires expertise and because of the subjective nature of body condition scoring its perception varied among individuals. However, to make BCS more practical and for situations where it is not possible to palpate the animals, many workers [9] [22] proposed visual method which became a preferred method in large dairy farms.

In many countries, a system of charts, pictures and descriptions to define specific characteristics of each BCS [23] [24] has been developed. Body condition scoring performed in this way is a rapid and easy method of assessing the condition of cattle without the use of scales and is relatively unaffected by body size [8]. Critical times to monitor body condition score of the cowherd are 30 days prior to breeding, 90 days post-breeding, weaning, 100 days prior to calving and at calving.

Criteria of Score

The interpretation of the score remains constant all over the world. Too low or too high score was found to be detrimental to the fertility status of the animal. Thus, it is necessary for a cow to be in appropriate body condition for optimum reproductive function.

The evaluation of body scoring has been extensively studied and desirable scores have been recommended for cows [22] [24] [29] [30] and buffaloes [31]. Body condition score 1.0 indicates a very thin cow. A body condition of 2.0 is also too thin. Such cows may be in good production status but their reproduction may suffer from lack of body condition. Ideally, no cow in a herd should be less than 2.0. A body condition score of 3.0 indicates the ideal condition for cows in mid-lactation. These cows are supposed to have passed the stage of negative energy balance, have been gaining weight for several weeks and have begun to accumulate flesh covering the hooks, pins and vertebrae. If a cow is halfway between 2 and 3, then her body condition score is considered to be 2.5. Less than 10 percent of the herd should score 2.5 or below. A body condition score of 4.0 indicates a cow that is heavy at calving or is getting ready to go dry. Generally, cows should not score above 4.0 because then they are considered fat and it can interfere with reproduction as well as can depress their appetite. If a cow scores above 4.0, then she is considered very fat. If she scores 5.0, then she is deemed to be an obese cow which is at high risk for many metabolic problems, decreased fertility and is more prone to go off feed at the time of calving. Essentially, a cow with a 5.0 body condition score is round and covered with fat.

3. Relation of Dry Matter Intake Energy Balance and BCS in Reproductive Performance

Management of reproductive performance, including both fertility and calving, is an important issue to the dairy industry. The primary goal of commercialized dairy farming not only pertains to birth of a calf per year but also sustenance of a viable economics in terms of variable inputs and the consequential results. These

inputs incur heavy investment in terms of many factors like infrastructure, labour, feed, medicines, etc. Out of all these, nutritional management is the most crucial one and is a key factor for normal production and reproduction cycle. Its relationship with reproduction has been established [32].

The nutritional status or energy balance of an animal is evaluated through body condition score (BCS), as it reflects the body energy reserves available for metabolism, growth, lactation and activity [33]. It is an important managemental tool for maximizing milk production and reproductive efficiency while reducing the incidence of metabolic and other peripartum diseases. In addition, assessment of body condition scores (BCS) of dairy cattle can be an accurate way of evaluating the effectiveness of dairy feeding systems. Body condition score changes throughout the lactation cycle and gives an idea about the cow's energy balance and its feeding requirements [34]. The need for estimating the body condition score has amplified in the last few years, especially when the problem of decreased fertility due to nutrition was documented by several authors [35]. Loeffler *et al.* [36] established that negative energy balance, body condition loss and disease affect fertility.

Relation of Dry Matter Intake (MI) and BCS during Prepartum Period

Nutritional status in the prepartum period influences subsequent reproductive performance [33]. Dry matter intake and negative energy balance during the dry period have a crucial influence on herd health, productivity and reproductive efficiency. They affect endocrine parameters, metabolic hormones and key concentrations of metabolic factors. There is normal decline in DMI prepartum in cows, as the foetus grows, which is exacerbated in cows that subsequently develop metabolic or gynaecological problems at or after parturition [34]. Thus, excessive drop in DMI prepartum could serve as an early warning signal of the propensity of cows to develop problems at or after parturition as inadequate protein and energy intake during pregnancy results in low BCS at calving [37].

In cows, both, an excessive (≥4.0 points, scale 1 - 5) or insufficient (<2.0 points) BCS at calving reduces subsequent fertility rates. In addition, loss or gain of one BCS after calving significantly reduced fertility in cows with acceptable BCS before parturition [38] and affected the general health status of the animal [39]. Gearhart *et al.* [29] demonstrated that cows losing more body condition during the dry period were at a higher risk for dystocia. This, in turn, means these cows are more likely to be culled for infertility.

On the other hand, over-conditioned cows (BCS > 3.5) have reduced DMI post-calving, lose excess BCS post-calving, have lower fertility and increased risk of developing cystic follicles [40]. Thus, it becomes increasingly clear that massive increases in BCS followed by abrupt loss in the early postpartum period are not well tolerated by the cow [41].

Current strategies to minimize BCS loss involve keeping cows in BCS 2.75 -

3.00 at calving, shortening the dry period and maintenance of normal rumen function. Thus, minimizing BCS changes pre and post-calving, maintenance of optimal rumen function and prevention strategies to prevent metabolic disorders are key management targets, in association with improved cow comfort and reduced stress, to improve health, productivity and reproductive efficiency of high yielding dairy cows [40]. Furthermore, feeding high roughage diets at the start of the dry period to minimize BCS gain and maintaining change in BCS score of 0.5 of a unit are increasingly important goals to achieve for high conception rates and herd pregnancy rates [42].

4. Over Conditioned at Calving

In dairy herds, the BCS at calving is tightly related to milk yield [43] [44]. However, in beef herds, the prepartum BCS, the BCS change during pregnancy and the calving BCS do not generally affect milk yield or calf performance [45] [46] [47] [48]. The most consistent relationship among published studies has been the increased incidence of ketosis for cows with high BCS at calving [49]. Gillund *et al.* [50] described a cow with a score as high or higher than 3.5 was approximately 2.5 times more likely to become ketotic than cows with scores at calving as low or lower than 3.25. In addition, it was reported that ketotic cows had higher BCS at calving and during the first weeks postpartum than healthy cows and lost significantly more body condition over a prolonged period of time compared with non-diseased cows. Similarly, Gillund *et al.* [50] reported that cows calving with BCS 3.75 are at higher risk of developing ketosis with a subsequent lower likelihood of becoming pregnant at first breeding. For likelihood of retained placenta or metritis, Markusfeld *et al.* [51] calculated an odds ratio of 0.7 for each additional unit of BCS at calving, indicating that cows with higher BCS at calving were less likely to experience retained placentas.

5. Postparturient Transition Period and BCS

High yield in the early postpartum period forces the cow to mobilize mainly fat but also protein to meet the energy demands of milk production. During that period, a cow can lose up to 50 - 75 kg of body weight with no adverse effect [40]. The duration of this steep fall can be shortened and prevented by increasing DMI in the early postpartum period as not only this sharp body condition loss affects the production level of the animal but also makes it prone to many other grave conditions [52].

Optimal body condition of dry cows should be between scores 3.00 and 3.75. Risk of problems can be avoided when cows have scores from 3.25 to 3.50. In early lactation, cows loose body condition. Body condition lost during this period can be maximum 1.00 unit of BCS.

Cows that are mobilizing tissue at a high rate have increased blood concentration of non-esterified fatty acids, β hydroxy butyrate, triacylglycerol but reduced concentrations of insulin, glucose and IGF-I [34]. This metabolic status increases

the risk of hypocalcaemia, acidosis, ketosis, fatty liver, metritis and displaced abomasums [42] [53] [54]. Butler and Smith [55] reported significantly higher incidence of metritis in cows losing 0.5 to 1.0 BCS units (22%) or > 1.0 BCS units (47%) when compared with cows losing <0.5 BCS units (6%). In another study, cows with BCS at calving <3.0 were more likely to have metritis than cows with a higher BCS at calving [56]. Waltner *et al.* [57] failed to identify a relationship between BCS and metritis.

Other studies show that delayed conception can be related to sub-clinical disease, stressful environmental, social conditions and nutritional stress [57]. Thus, it is clear that inadequate nutritional management of the cow in the dry period and after calving has a significant negative impact on subsequent conception rate, services per conception and interval from calving to conception.

After calving, dairy cows experience a slow increase in dry matter intake, a rapid increase in milk production and increased mobilization of fat tissue [58]. It is thus important for the dairy cows to maintain adequate body condition prior to calving as after calving, as cows increase in milk producing ability. It is usually 50 to 60 days after calving before they are in a positive energy balance.

6. Postpartum Anestrus and BCS

It is a worldwide recognized fact that, in the postpartum cow there is a normal anestrus period. Delayed recovery of ovarian activity is associated with poor body condition at calving. This situation appears when feed intakes in the last third of gestation are insufficient. Practically for multiparous is no real effect of BCS at calving on the cyclicity, but a significant effect of the postpartum state loss was determined [59]. According Freret *et al.* [60], cows that lost more than 1.5 points of their BCS between 0 and 60 days postpartum are characterized by nocyclicity or prolonged luteal phase. Pivko *et al.* [61] indicated that a poor body condition (mainly BCS 1) in cows may even result in the malfunction of ovarian activity in the form of cystic atresia of ovarian follicles. There is a close relationship between the cow body condition traits not only from the viewpoint of animal husbandry parameters, but also in the relationship to ovarian activity Bezdicek *et al.* [62]. However, this period is considered as abnormal when it extends beyond an average of 90 days [63]. Prolonged postpartum periods of anestrus (>150 days), due to its great incidence, is one of the main infertility problems [64]. Postpartum anestrus is more marked in beef cattle [65] and is a main factor limiting reproductive efficiency, because it prevents achievement of a 12-month calving interval.

Studies indicate that cows with lower body condition scores and loss of weight have lower conception rates and decreased efficiency of heat detection, compared to cows that are gaining weight and have higher body condition scores. Low BCS at calving leads to delay in onset of estrus, reduced fertility [66] and a longer inter-calving period in cows [37]. Wright *et al.* [67] indicated that each BCS is equivalent to 53 kg of body weight in cows and that postpartum anestrus

extended 43 days for each BCS lost at calving. The condition worsens when the cows have poor body condition because they suffer more from adverse effects of negative energy balance as they are not able to meet the energy requirements for growth, maintenance and milk production [68]. Gearhart *et al.* [29] determined that cows at dry off (≥4.0) had 2.5 times the risk of cystic ovaries in the next lactation than cows in good condition at dry off. In another study, cows with higher BCS were likely to have inactive ovaries than cows with lower BCS [51]. In the same studies, cows that lost more BCS during the dry period were 2.1 times more likely to have inactive ovaries for each additional BCS unit lost.

Though some authors [69] [70] have noticed a significant positive relationship between mean energy balance in the first weeks after calving and interval to first ovulation, still many others [71] [72] have found no relationship between mean negative energy balance and duration of postpartum anoestrus. Lucy *et al.* [73] reported that increasing energy balance is proportional to the number of large follicles in postpartum dairy cows. Prado *et al.* [74] found significant differences in follicular development related to body condition. Cows loosing ≥ 1-unit BCS after calving had a prolonged interval to commencement of luteal activity and were at greater risk of having delayed first ovulation. Sharestha *et al.* [75] stated poor postpartum nutritional status to be associated with delayed first ovulation postpartum. Butler *et al.* [69], Canfield *et al.* [76] and Canfield and Butler [77] found that first ovulation occurred approximately 10, 14 and 14 days after the maximum negative energy balance, respectively. Therefore, Fernando *et al.* [78] [79] shown that the nutritional status of the female animal affects growth and follicular diameter, follicle maturation and ovulation. In another study [80] suggested that the body condition and therefore nutrition and follicle size, had a specific effect on the proportion of cows that ovulate. It has been accepted that the nutrition acts at various levels of the system that monitored reproduction and that the main pathway by which nutrition affects follicular development is through the hypothalamic pituitary ovarian axis [81]. Rasby *et al.* [82] shown that the administration of a diet with low protein and energy content influence negatively the LH concentration, and therefore affect the growth, persistence and ovulation of the dominant follicle. Fernando *et al.* [78] found that body condition has no effect on beef cows on estrus traits, but there results agree to those observed in other cattle breeds, and also suggested that body condition affected follicle development and ovulation rate. Zurek *et al.* [83] further added that when ovulation occurred, energy balance was still negative but, in all cases, it was in a decreasing status.

Dubuc *et al.* [84] show in their study that the early ovulation or prolonged anovulation was associated with indicators of negative energy balance and uterine inflammation during the peripartum period. They also determined that ovulation by 21 DMI was associated with shorter time to pregnancy and prolonged anovulation was detrimental to subsequent reproductive performance and culling. However, the loss in BCS during the postpartum period appears to

have a strong relationship with first service conception rate, whereas the absolute BCS at calving does not [85]. Butler and Smith [55] found that cows which lost less than 0.5 units of BCS during the first 5 weeks postpartum had higher conception rates at the first service than cows that lost more than 0.5 BCS. Domecq *et al.* [44] concluded that multiparous cows that lost 0.40 and 0.80 points of BCS were respectively 0.85 and 0.47 times more likely to conceive at first service than cows that did not lose BCS. Suriyasathaporn *et al.* [86] concluded that cows with BCS 2 - 2.75 after 45 days interval milking (DIM) were more likely to conceive at first service than cows with BCS < 2 or BCS ≥ 3.0. Increased losses in BCS were associated with decreased risk of conception.

In another study [86] recorded that BCS at first insemination was not significant but the loss in BCS during the first 100 days of lactation was significant with cows losing more BCS being less likely to conceive. Ferguson and Otto [87] showed that first service conception rate progressively decreased from 55.9% for cows losing 0.51 to 1.0 unit of BCS to 28.6% for cows losing > 1.0 unit of BCS from calving to breeding. Further, cows with BCS 3.75 to 4.25 prepartum had higher conception rates than cows with BCS ≥ 3.5 [85]. Buckley *et al.* [88] demonstrated that cows with a low BCS had reduced conception rates compared with cows with moderate or high BCS. Roche *et al.* [89] demonstrated that cows with lower BCS at first service significantly affected pregnancy at first service. Patton *et al.* [90] showed that cows with lower BCS at first service had significantly lower conception rates. Garnsworthy and Topps [91] showed that cows calving at a medium BCS (3.25 to 3.75) had significantly fewer services per conception than cows with high or low BCS in trail. Hegazy *et al.* [92] determined that the number of services per conception was lower for cows scoring ≤ 1.5 or 2.0 at first service than for cows with BCS ≥ 2.5.

Braun *et al.* [93] observed days open to be significantly lower for cows with moderate BCS at calving (3.0 to 3.5), pre-breeding (2.5 to 3.0) and peak milk (3.0 to 3.5) as compared with cows with higher or lower BCS. Ruegg *et al.* [94] showed that cows with BCS < 3.5 at calving had fewer days open cows with BCS ≥ 3.5 at calving. In primiparous cows, [51] reported that the calving interval was 6.3 days shorter for each additional unit of BCS at calving.

Hegazy *et al.* [92] reported that days open decreased significantly for each BCS at service interval up to score 3.0. Fagan *et al.* [95] demonstrated that cows with a BCS < 2.5 had longer calving intervals than those with a BCS ≥ 2.5. Wathes *et al.* [96] noted that cows with a BCS ≥ 3.0 took 3 weeks longer to conceive than cows with a BCS of 2.75 to 3.5. In another study, lower BCS nadir significantly increased days open [90].

Thus, BCS is an effective management tool for evaluating the energy reserves of cows and the whole nutritional program throughout the year. Here, condition scoring of cattle allows the dairy keepers to determine if their cows are thriving in the system of management they are kept under and what steps need to be taken to strike a balance for good productive and reproductive results. Body

condition scores (BCS) allow producers, extension personnel and researchers to communicate more effectively regarding the herd's nutritional requirements.

7. Conclusion

In conclusion, impaired fertility is one of the main limiting factors affecting economy of dairy industry. Most studies have identified that BCS is a useful tool to aid in management of dairy cows as a proxy for estimating energy balance and risk factors for diseases. Those cows have over condition where at higher risk of developing metabolic diseases with subsequent lower likelihood of becoming pregnant at first breeding. Low BCS at calving leads to delay in onset of estrus, delayed follicular development, reduced fertility and longer inter calving period. The relationship of nutrition and management with fertility has been well recognized.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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