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# Body Condition Scoring of Dairy Cattle: A Review

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## Review Article

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**ABSTRACT**

The body condition scoring (BCS) is a subjective estimate of the energy reserves in adipose tissues of a dairy cow and acts as an important tool for dairy cow management. The various methods to assess the body condition are post slaughter techniques, estimation of weight, laboratory techniques such as respiration calorimeter, estimating fat cells diameter, ultrasonography for back fat thickness (BFT) and body condition scoring (BCS). Out of these methods, the most primary, non-invasive, quick and inexpensive method is BCS, which involves the visual and manual assessment of thickness of fat cover at different skeletal check points. On the basis of BCS, the dairy cows can be classified into different categories viz. under condition, average or over condition cows, which affects the performance of animal. During dry period and at the time of calving, there should be no under / over conditioning. The targeted BCS should be at 3.25 to 3.5 (1-5 point scale). Generally, BCS shows the decreasing trend during early lactation due to homeorhetic response caused by negative energy balance and partitioning of energy reserves to support milk production. Excessive loss of energy during this period, generally in cows with higher / lower BCS at calving, results in productive, reproductive, metabolic disorders in dairy cows. Once, the cow recovers from negative energy balance, it starts gaining BCS during mid and late lactation. Environmental factors, i.e., inclement weather such as high or low temperature also affects the BCS. Since, the patterns of BCS change are under the genetic influences (e.g. by DGAT 1 gene in Holstein cows), thus increase / decrease of BCS is not same for all the cows. The on-going research in automation of BCS might provide a more accurate, practical and less time consuming means of estimating energy content of dairy cattle.

## INTRODUCTION

The body condition scoring (BCS) is a subjective estimate of the energy reserves in adipose tissues of a dairy cow. It is an acceptive, noninvasive, quick and inexpensive method to estimate degree of fatness. It is a means of accurately determining body condition of dairy cows, independent of body weight and frame size [1]. It is evinced that the profile of lactating cows in milch barn is different e.g. some may be in early lactation and the others may either be in mid or late lactation. The observations on body condition status of animal will help the manager to adopt corrective management measures, thus enabling to improve the production profile of an animal. Hence, body condition scoring may be used as an efficient tool in this regard. Although many may consider this as a nutritional management practice, but changing BCS have implications on milk yield, health, reproduction, longevity and overall profitability of an animal.

Dairy cows like other mammals possess the tendency to nurture her new born from tissue stores, i.e., up to one-third of the total milk solids produced in early lactation is produced from the body tissue reserves [2]. Dairy cow has its own body energy

reserves in the form of adipose tissues to meet the energy demand of an animal. The metabolism of adipose tissues, by hormone sensitive lipase causes the breakdown of triacylglycerols present in adipose tissues to release free fatty acids, thus releasing the energy [3,4]. For maintaining the energy level, there should be perfect balance between the process of lipolysis and lipogenesis, but, the process of lipogenesis is slow during period of early lactation and increases during the latter part of lactation, whereas, the rate of lipolysis is higher during early lactation and frequently lowers with progressing lactation [3,5,6]. In high yielding dairy cows, during the period of early lactation (mainly 2-4 months following calving), the rising trend of milk yield followed by low dry matter intake, makes the animal in a status of negative energy balance [4]. During this stage, there is excessive depletion of body reserves, which gets replenished during mid and late lactation as the animal returns to the positive energy balance. These fluctuations in energy balance lead to changes in the body condition, production and reproduction performance [7,8].

Therefore, if fluctuation in energy balance is within the limit, the production and reproduction performance of animal will be better. The energy reserve is directly associated with body condition score [7], the difference of energy reserve in each stage of lactation can be better adjusted by recording the BCS during those respective stages of lactation. As the management strategy varies with production profile of an animal, therefore, it is difficult to provide adequate management input to all animals or to keep all the animals in the same profile. Keeping this feature in mind it would, therefore, be better to develop a system which could give an idea about the status of animal at any given time. Therefore, the BCS has been reviewed under following sub heads:

1. Assessment of energy reserves by various methods including BCS
2. Status of animal and BCS
3. BCS during dry period and at calving
4. BCS during lactation
5. BCS in relation to health and reproduction
6. Effect of weather and climate
7. Genetics of BCS

**Assessment of energy reserves by various methods including BCS**

The most ideal method to assess the body condition is by the post slaughter chemical evaluation of animal carcass along with its different components after removal of gastrointestinal food and urinary tract [9].

The changes in fat content of an animal during varying stages is well documented, thus there is clear need to measures these energy reserves of an animal. Until 1970's, there was no simple measures to assess the energy reserves of an animal [10,11]. Since, the decrease in body condition also reduces the body weight of an animal, thus, the most obvious solution would be to measure the body weight. However, body weight alone is not a good indicator as it is affected by many factors such as age, parity, changes in body fat, internal protein and water, feeding management, gastrointestinal content, changes in weight of different organs, stage of lactation, frame size, gestation and breed [10,12-14]. The energy stores may vary up to 40% in animals of similar body weights [15,16]. Thus, separate methodology needs to be adapted. In conditions where the budget and laboratory facilities are very well available, metabolic and hormonal factors, respiration calorimeter, body water by dilution with deuterium oxide, estimating fat cells diameter, etc. may be done. These methods provides much accurate results, but they are costly, time consuming and inapplicable for field conditions [9,14,17]. The fat content of the ninth through eleventh rib is highly correlated with the entire fat content of the carcass [18]. Thus, the back fat thickness (BFT), a measure of the layer of subcutaneous fat, lies between the skin and the deep fascia, in the area located above the gluteal and longissimus dorsi muscules, can be measured by using real time ultrasound is also one of the approach to estimate the energy / fat reserves of a dairy cow [19-21] **(Figure 1 and Table 1),** but still it requires the ultrasound machines and well equipped technicians, thus the primary method used by the dairy farmers, veterinarians, field workers is a subjective analysis of the amount of body condition of a cow, termed as body condition score (BCS), which involves the visual and manual assessment of thickness of fat cover and prominence of the bone of tail and head region. The BCS being non-invasive, quick and inexpensive is accepted universally to estimate the degree of fatness [8,21-23]**.**

**Table 1.** Assessment of body condition by description, BCS, back fat thickness (BFT), and total body fat content (TBF).

| Description | BCS | BFT, mm | TBF, kg |
|---|---|---|---|
| Emaciated | 1.0 | < 5 | < 50 |
| Very poor | 1.5 | 5 | 50 |
| Poor | 2.0 | 10 | 76 |
| Moderate | 2.5 | 15 | 98 |
| Good | 3.0 | 20 | 122 |
| Very good | 3.5 | 25 | 146 |
| Fat | 4.0 | 30 | 170 |
| Adipose | 4.5 | 35 | 194 |
| Obese | 5.0 | > 35 | > 194 |

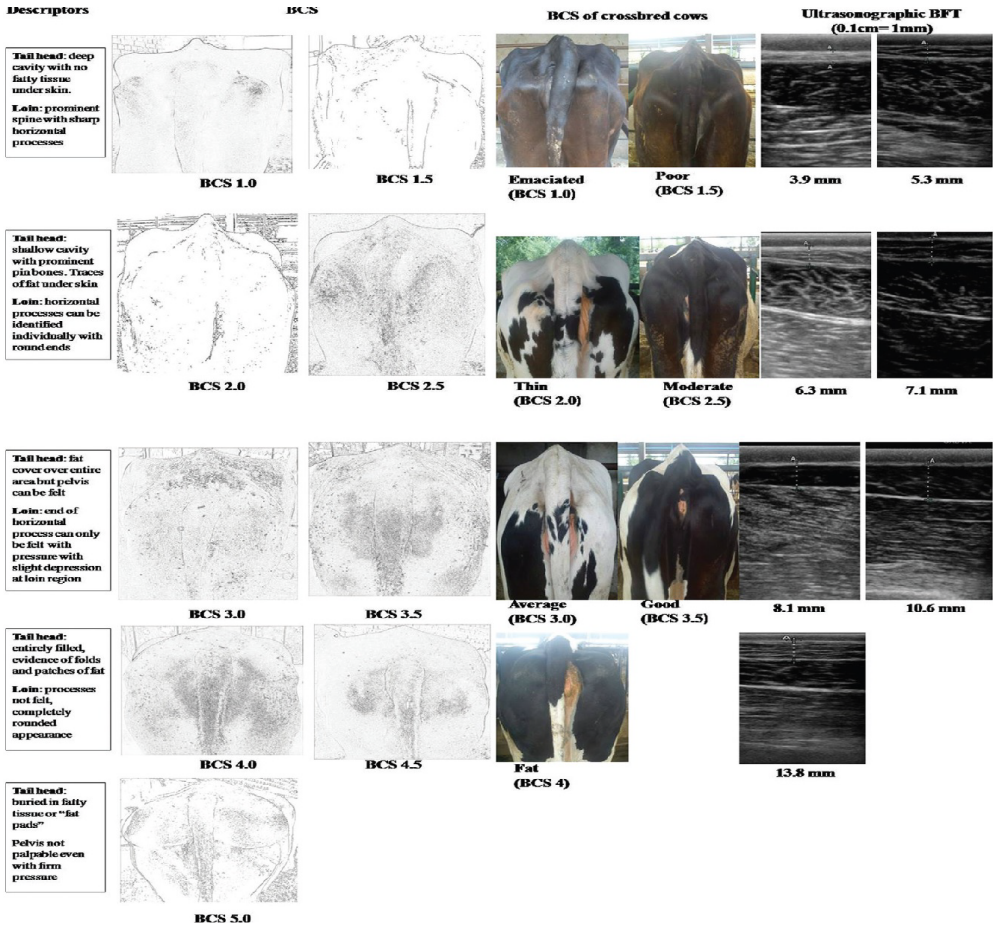


**Figure 1.** Classification of BCS by back fat thickness (BFT) using ultrasonography.

### The scoring system of body condition score (BCS)

The system suggested as by [24] and [25] were used owing to its consistency between the score of 2.5 to 4 as well as its frequent use to examine BCS of other breeds. As per this system of scoring, following 7 body check points were examined:

(a) Loin (short ribs)

(1) Spinous process and (2) Transverse process

(b) Pin bone

(c) Hook bone

(d) Thurl (Rump)

(e) Tail head ligament

(f) Sacral ligament

### Status of animal and BCS

The cows can be categorized in three categories viz. average or good condition, under condition and over condition cows. Those cows scored between 3- and 3+ considered as average or good condition, cows scored ≤ 2+ and ≥ 4- considered as under conditioned and over conditioned, respectively [26]. While, [7] categorized animals in ideal, too thin and too fat range, which were 2.5 to 3.5, < 2.5 and > 3.5, respectively for lactating cows. For dry and pregnant cows were 3 to 3.5, < 3 and > 3.5, respectively for ideal, too thin and too fat range. However, [21] had classified animals on 1-5 score scale with an increments of 0.5 score which indicates emaciated, poor, thin, moderate, average , good and fatty animal. Variation in status of dairy animals could be attributed to varied levels of milk production in lactation. It has been reported that not all cows reduce their BCS equally. The dairy cattle with high genetic merit have a higher predisposition for mobilization of body fat reserves to cover milk production demands [27,28]. The cows selected for higher milk yield had lower BCS during lactation and their body score changes after calving were relatively higher in cows as compared to lower genetic merit cows. Thus, mobilization of body fat reserves and milk production are closely related [9,28,29], as higher and more prolonged BCS loss in cows is associated with higher milk yield [30].

### Body condition score during dry period and at calving

The ensuing lactation performance of any milch cow depends on body reserve recouped during dry period. The dry cow

need sufficient body reserves to support early lactation milk production, when she is in negative energy balance. It is evident that over body reserves and under body reserves have an adverse effect on production, reproduction and health performance of the animal. According to the hepatic oxidation theory, uptake and oxidation of fat in the liver suppresses feed intake decreasing energy intake and extending the length of time in negative energy balance. Thus, fatty / obese cows have prolonged negative energy balance due to less dry matter intake [1,26,31], poor production performance such as lower peak yield, peak feed intake and poor persistency [32,33], greater reproductive ailments like retention of placenta, difficult calving and other post parturient difficulties [14,34] along with higher susceptibility to metabolic, infectious and digestive disorders viz. mastitis, metritis, milk fever, ketosis, displaced abomasums, etc. [14,35,36]. Whereas, the cows with lower body condition score at parturition mobilized less body fat resulting in reduced milk fat without having significant effect on milk yield, protein, SNF, DM intake or nutrient utilization [37]. The reduced milk yield of the under conditioned cows was due to insufficient energy and protein reserves of the animal's body [38].

The optimal body condition score for dry period of a cow is 3.0-3.25. The cows that were conditioned at BCS-3 had higher feed intake and are more close to peak milk yield. Moderate increase in condition score at calving (BCS 2 to 3) will lead to significant improvement in milk yield, but score above 3.5 at parturition was detrimental to milk production [39,40]. Similarly, [7] had suggested optimal body condition score of dry cow should be above 3 and below 3.75 (i.e., 3.25 to 3.50). He further opined that the risk of post parturient problems may be avoided when the dry cows scored between 3.25 and 3.50. However, [41] did not find any effect of condition score at calving on peak and 305 days milk yield.

**Changes in body condition score during dry period**

The animal should not lose their body condition score during dry period as it impacts negative effect on health, calving and fat per cent in ensuing lactation. Such a decreasing trend off BCS is associated with increased risk of dystocia and culling [42]. Similarly, [32] had observed milk fat depression in ensuing lactation by 20 per cent reduction in body condition score during dry period. However, gained condition during dry period yielded more milk (545.5 kg extra milk per point increase in BCS between dry off and parturition) in first 120 days of lactation and accelerated rate of increase in milk yield [38]. Generally, the improved body conditions at calving have a positive effect on milk fat percentage, particularly in early lactation besides reducing the anestrous interval after calving [43].

**Body condition score during lactation**

The ideal body condition score during each stages of lactation is that which optimizes milk production, minimizes reproductive and health disorder as well as maximizes economic return [26,44]. As per [7], the "ideal body condition is range and is a function of stage of lactation". Many researchers reported association between mean BCS during lactation with production traits [45-47]. The cows of greatest efficiency of milk production showed no significant increase in body condition during lactation and cows that increased significantly body condition during lactation were less efficient producers and had higher body condition score at the end of lactation [1]. The cows that are genetically superior milk producers tend to have genetically lower BCS in late lactation [45-47]. A reduced BCS for high yielding cows is expected since many studies have shown a lower BCS in animals selected for high yield [28]. Therefore, feeding guidelines are very important to optimize the BCS. The major aspects of feeding management that can be adjusted to control body condition includes maximizing feed intake, adjusting energy concentration, adjusting crude and escape protein levels, providing adequate fiber to prevent off-feed problems or chronic intake fluctuations and checking macro mineral (Ca, P, Mg and K) levels and water availability which may proves to be beneficial [32].

**Body condition score during early lactation**

The depletion as well as replenishment of body fat reserves must not exceed certain limits [14]. In early lactation, maximum dry matter intake lags behind peak milk yield [48], so cows in early lactation utilize tissue reserves to support milk yield [49]. Energetically, use of body tissues accounts for about 30 per cent of milk production during 1st month of lactation [2,50]. This implies that, depending on milk yield, the dairy cow will drift into negative energy balance after calving but its duration and magnitude vary [51]. Duration of negative energy balance on an average endures about 8 weeks [38,52-54] and varies from 5 weeks [55] to 14 weeks [30], while [32] advocated that maximum negative energy balance occurs within two to three weeks after calving.

Negative energy balance leads to a homeorhetic response [2], in which increased lipolysis in adipose tissue, increased gluconeogenesis and glycolysis in liver, protein mobilization in muscle tissue, mineral mobilization in bone and increasing capacity and activity of GI tract [14,56] had observed that a loss of 1 unit of BCS following calving is equivalent to about of 400 mcal cumulative energy. Moreover, [38] observed that changes in BCS during first month of lactation has a stronger influence on milk yield than those at parturition and thus loss of body condition has been associated with increased milk yield. [33] Found that 1 unit increase in body condition score, increases about 22.39 g fat and decreases 14.53 g of protein per kg of milk, thus shows a linear and inverse relationship between body condition score with fat and protein yield respectively. Considering these facts, it would be better to adjust the feeding regime so as to maximize feed intake during early lactation. The sooner a cow reaches high levels of feed intake, the sooner she moves out of negative energy balance. Consequently, reproductive performance improves and milk production is greater. Diets that contain adequate fiber help to prevent low intake, poor body condition scores along with erratic and low milk production. Diets should always be properly formulated to meet energy and protein requirements for high levels of milk production. Generally, when high energy diets are fed to fully meet the cow's requirements, both fat and thin cows

produce more milk compared to when energy is limiting. Adequate dietary energy should come from high quality forages, grains or supplemental fats. Diets formulated to contain proper levels of crude protein and escape protein promote highest milk yields and optimum condition scores. Overly fat cows in early lactation especially respond to proper escape protein levels [32].

Many researchers found that body condition loss during first month of calving is strongly related to reproductive performance, as the body condition loss increases the no. of days open, days to first oestrous and service per conception were significantly increased [40,57,58]. While, [41] found no significant difference for days to first observed oestrous, days to 1st breeding, days to conception or numbers of times bred for cows grouped by BCS at calving or by condition loss between calving and 1st breeding. [31] Had also reported excessive loss of body condition has been associated with lowered reproductive performance and reduced milk production as well. [7] suggested that in early lactation, the cow should lose BCS of less than '1' unit and thus cow in early lactation should be above 2.5 in condition. However, if cows remain in good condition (3 to 3.5), but do not peak very high then inadequacy of protein, macro minerals or water intake should be checked [32].

**Body condition score during mid-lactation**

Generally, the body condition replenishment begins when animals shift to positive energy balance [7]. Suggested that cow in 1st 100 to 120 days of lactation should score between 2.5 to 3.5 and body condition repletion should begin by 7 to 12 weeks at a modest rate of 0.2 body condition unit per 6 weeks. However, [41] observed the same at the rate of 0.13 units every 6 weeks. Therefore, in mid lactation the nutritional objective is to meet or slightly exceed energy requirements so body reserves can be built-up. If cows become over-conditioned during mid-lactation (3.5 to 4.0), energy intake should be reduced, and crude protein levels should be checked. If cows become under-conditioned (2 to 2.5 range), the ration is probably low in energy.

**Body condition score during late lactation**

The body condition score between 200 days of lactation and the date of dry off should be between 2.75 and 3.50. However, the cows should be dried between BCS of 3.25 to 3.50. For dairy cows, most of the increase in body condition must occur during late lactation [59]. In this period, the nutritional goals are to completely replenish body fat reserves, yet prevent over-conditioning. Reduce dietary energy concentration, if many cows reach the condition 4 range. If cows are in below BCS 3 range, then increase dietary energy to the mid-lactation group. Moreover, examine early lactation diets because conditioning problems in late lactation may begin during early as well as mid-lactation [32].

**Body condition score in relation to health and reproduction**

One potential mechanism underlying the reported effect of BCS mobilization on animal health is an alteration in lymphocyte function [60,61] had also reported lower secretions of Immunoglobulin M (IgM) and Interferon γ (IFN-γ) in peripheral blood mononuclear cells isolated from over conditioned cows at calving.

Researchers found that extreme energy deficiencies with excessive lipolysis has been related to health disorder such as fatty liver, ketosis, resulting in reduced milk yield [17]. Cows under conditioned or over conditioned at drying off were more prone to foot problems after calving and in condition of over conditioned at drying off were more likely to develop cystic ovarian disease and reproductive problems. There are more chances of metritis if cows over conditioned at 30 day postpartum [26].

The BCS at parturition (< 2.5) reduces pregnancy rate at 1st artificial insemination. And the no. of days open will be more if BCS decreased to more than one unit [62]. Increased loss of body condition in early lactation is related to poor reproductive performance [28].

**Effect of weather and housing**

Weather and the type of housing influenced the targeted condition scores, especially when animals are outside or maintained in loose housing. Slightly higher condition scores with respect to general ranges, given for specific production stages are often desirable, when prolonged periods of wet and / or cold weather is expected. This depends upon whether windbreaks are available, amount of mud, rain, or snow, hair / wool, and the diet available for the animals. Increased body condition score gives the animal increased insulation and energy reserves during periods of inclement weather. Further, body condition may be expected to fall if feed intake declines during periods of high heat and humidity [59]. The most significant body condition changes were detected during the summer months.

**Genetics of BCS**

It has been reported that not all cows reduce their BCS equally. The high genetic merit dairy cattle have a higher predisposition for mobilization of body fat reserves to cover milk production demands [27,28]. The cows selected for higher milk yield had lower BCS during lactation and that their body score changes after calving were higher than in cows with lower genetic merit [29]. The genetic studies have clearly demonstrated differences among sires for condition score curves [9]. The effects of polymorphism in the DGAT 1 gene on energy balance/body condition score and milk production traits in primiparous holstein cows during the first six months of lactation had also been observed [63].

## CONCLUSION

The body condition scoring (BCS) provides non-invasive, quick and inexpensive method of estimating of dairy cow energy reserves. The changes in BCS occurs according to the different stages of cow, i.e., during dry period, gestation, calving, early, mid and late lactation. Out of which, BCS at the time of calving is most influential since, it have impacts on early lactation, post parturient BCS loss, productive, reproductive and metabolic functionality of the animal. Thus, maintaining the optimal BCS as per the stage of animal is of utmost importance. The nutritional management along with proper housing is necessary to maintain the BCS profile of animals. The genetic studies among sires for condition score curves and the quantitative traits loci (QTL) responsible for such effect should also be evaluated. The dairy producers and consultants should consider inclusion of BCS monitoring within management schemes. Further research is required for development of automated monitoring techniques to provide more accurate, practical and less time consuming means of estimating energy content of dairy cattle.

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