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The Relationship between Body Condition Score and Milk Production, Udder Health and Reduced Negative Energy Balance during Initial Lactation Period: A Review

Review Article

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ABSTRACT

Achieving improved milk yield from a healthy udder, with a minimum weight loss especially during initial lactation, is the aim of every dairy farmer. Body condition score (BCS) of dairy cows has been found to be significantly associated with body weight, milk performance and udder health status of dairy cow during the pre and post- partum period. Under and over body condition of dairy cows should be avoided. Both conditions lead to weight loss, loss of milk, poor udder health and metabolic disease in dairy animals. Cows should have balanced body condition before and after calving. Better management practices during the dry period and at calving may optimize production, and udder health in subsequent lactation. This review aims to highlight livestock management strategies during the dry period which may help in optimizing BCS at calving and during the subsequent lactation period, thus improving milk performance and udder health, and reducing weight loss in early lactation.

KEY WORDS body condition score, improved milk yield, udder health, weight loss.

INTRODUCTION

High risk of poor milk yield, milk quality, udder health and increased chances of high negative energy balance forms a major part of the problems which occur during initial lactation of dairy cows (Singh *et al*. 2020a). However, optimum management conditions of dairy animals during its peripartum period leads to improved milk performance, udder health and reduced negative energy balance during initial lactation period. Body condition score (BCS) is non-invasive, quick, low cost and universally accepted method to estimate the degree of fatness (Bittante *et al*. 2004; Roche *et al*. 2009; Kirsten *et al*. 2014; Singh *et al*. 2015). BCS are intuitive, and evaluations are based on sight and sensation effect of the amount of hypodermic fat on a cow (Wildman *et al*. 1982; Edmonson *et al*. 1989). Change in energy status of animal body, in different stages of life, causes variation in the body condition, production and reproduction performance (Singh *et al*. 2015). It is used to estimate body condition of dairy cows independent of body weight and body frame (Wildman *et al*. 1982). It has been reported that energy status of animal's body is significantly associated with body condition score (Ferguson, 1996). BCS is found to be associated with body weight (Grainger *et al*. 1982), milk yield and milk composition (Ryan *et al*. 2003; Bayram *et al*. 2012), and udder health (Lacetera *et al*. 2005). Management to optimize BCS has influence on milk yield, animal health, reproductive performance and animal well-being, all of which contribute to farm profitability (Bewley and Schutz, 2008). Singh *et al*. (2020a) reported

that proper dry period management strategies may optimize BCS thereby raising body condition during dry period and at calving which may be beneficial in improving milk yield and health of dairy cows in ensuing lactation period.

Most of the reviews in literature deal with the effects of BCS on production, reproduction, and well-being of dairy cows but very less or scanty articles have been reviewed for the methods to optimize BCS and study its effect on production, and well-being of dairy cows. Therefore, this review focuses to study the methods for optimization of BCS and its effect on production, and well-being of dairy cows.

BCS in dry period

There is an extensive change in body condition of dairy cows during the dry period. Optimum body condition during this period affects directly or indirectly to the post- partum performance of dairy cows. Maintenance and pregnancy requirements of dairy cattle increases pre-partum but, it is noteworthy that feed intake gets reduced during this time (Ingvartsen *et al.* 1999). It is suggested that optimum body condition score of dry cow should be between 3 and 3.5 in a scale of 1 to 5. Moreover, risk of post parturition physiological disorders can be avoided in this BCS range (Ferguson, 1996). The cows calving with a BCS ≤ 2+ and ≥ 4+ were considered as under or over conditioned, respectively (Wildman *et al.* 1982). For Jersey crossbred cows, optimum BCS at calving was recommended somewhere in between 3.5 to 4.5 on a scale of 1 to 6 (Singh *et al.* 2020a). Change in BCS during the dry period or early lactation is corroborated with BCS at drying off, and BCS at calving (Singh *et al.* 2020a). Change in BCS during dry period and early lactation is found highly corroborated with BCS at drying period (Domecq *et al.* 1997). There is usually some body loss, but excessive loss of body condition should be avoided during dry period by meeting nutritional requirements for both maintenance and pregnancy (Kim and Suh, 2003). It has been seen that during dry period often the cows, which are overfed, become over-conditioned at calving and undergoes more severe negative energy balance during transition period (Grummer *et al.* 1995; Singh *et al.* 2020a). Cows generally go off feed when they are over fattened during the dry and early lactation periods. Over conditioned cows at this time were found to have a lower feed intake and higher cases of metabolic diseases (Treacher *et al.* 1986; Huyler *et al.* 1999). Singh *et al.* (2020a) found that reducing energy intake early in the dry period, and increasing towards calving significantly improved dry matter intake overall of dairy cows during dry period, thereby reducing negative energy balance (NEB) during early lactation. High body loss of cows make them more susceptible to abomasal displacement and reproductive problems like postpartum anoestrous (Overton and Waldron, 2004) and especially first calvers may be more prone to reproductive and other health problems such as delayed calving as first calvers are physiologically immature and needs proper nutrition for their body growth together with fetal growth. Therefore, high density concentrates or supplements may be reduced along with a provision of *ad libitum* good quality forages during far off period as compared to that in close up period where density of concentrates can be increased.

Apart from changes in amount of body fat, changes in body weight are affected with the fluctuation of body protein and water content, gastrointestinal content, fluctuating organ weights, fetal development, and also the frame size (Broster and Broster, 1998; Schroder and Staufenbiel, 2006). BCS and body weight were found to be corroborated with coefficients of correlation as 0.53, 0.34, and 0.57 in some Jersey, Friesian and their respective crosses (Otto *et al.* 1991). Slight loss of body weight during 30 days postpartum is commonly seen in high-yielders (Doepel *et al.* 2002). Many other research studies suggest that a change in one unit BCS can change 21 to 110 kg of body weight (Wright and Russel, 1984; Chilliard *et al.* 1991; Otto *et al.* 1991; Waltner *et al.* 1994; Enevoldsen and Kristensen, 1997; Komaragiri and Erdma, 1997; Komaragiri *et al.* 1998; Samarutel *et al.* 2001). More body loss and body condition loss leading to negative energy balance postpartum are known to reveal adverse effects in high milk yielders (Friggens and Badsberg, 2007; Cutullic, 2010). BCS reflects energy balance of dairy cows wherein NEB is reflected by a under BCS. In this condition, cow loses body reserves for maintaining milk yield but within very short period of time milk yield declines and body weight is considerably lost. In this NEB, immunity of udder and other systems are suppressed leading to increase in somatic cell count (SCC) and thereby reducing milk quality. On other hand, when a cow is over conditioned the satiety centers of hypothalamus is activated and the dry matter intake is reduced as a result of which body reserves are utilized to support milk production which may lower milk quality and quantity (Kuhla, 2020). That's why under and over BCS should be avoided (Singh *et al.* 2020a).

BCS, milk yield and milk composition

Genetic, nutritional, and environmental factors are associated with bovine milk yield and milk composition. However, the high genetic merit dairy cows are more susceptible for higher BCS loss than low producing cows. Milk yield and BCS are negatively correlated. However, moderate BCS supported higher milk production (Mushtaq *et al.* 2012). Change in BCS at drying period and dry period BCS is associated with change in subsequent lactation milk yield (Domecq *et al.* 1997). Singh *et al.* (2020a) found that Jersey

crossbred cows which had recommended BCS at calving between 3.5 and 4.5 produced significantly higher milk without significant change in milk composition. Waltner *et al.* (1993) reported that calving BCS and a unit change in BCS during lactation were related to the production of 3.5 % fat corrected milk (FCM) from cows 90 days in milk. Pre- partum BCS and milk yield were found to be significantly and negatively correlated (Bayram *et al*. 2012).

It is commonly noticed that lower yielder cows have a lower BCS cows at parturition and high producing cows mobilize more extent of BCS than that of comparatively lower yielding cows in early lactation period (Paul *et al.* 2018). This may be due to the reason that the cows in early lactation period have lower dry matter intake and to meet the milk production requirement, the higher producing cows mobilize more extent of BCS than lower yielding cows (Kuhla *et al.* 2015; Kuhla *et al.* 2016). To support this contention, an additional point in body condition score in the dry period resulted in an extra 545.5 kg more milk in the first 120 d of lactation and an earlier attainment of peak yield (Domecq *et al.* 1997). Berry *et al.* (2007) found a significant and non linear relationship between BCS at calving and lactation yield over 305 days. Furthermore, yields of milk, milk protein and milk lactose in the first 4 weeks of lactation were higher in cows having a BCS of 3 at calving compared to those having BCS 2.73, but fat yield was not changed significantly (Ryan *et al*. 2003). Singh *et al.* (2020a) reported that cows which had optimum BCS at calving, lost lower post partum BCS.

In earlier studies, it was suggested that increased body condition at parturition led to an increase in milk yield (Grainger *et al*. 1982). However, cows that are over-conditioned near calving are more prone to the risk of a lower yield and an increase reproductive and health problems (Singh *et al*. 2020a). Beever (2006) suggested that obtaining the correct BCS at calving may help in maximizing milk production and reducing body weight loss post-calving.

However, some researchers have also found that BCS at calving had a non- significant effect on milk yield and milk composition in dairy cows (Ruegg and Milton, 1995; Balakrishnan *et al.* 1997; Stockdale, 2000; Busato *et al.* 2002; Lake *et al.* 2006). Sordillo and Streicher (2002) found that a BCS of 3.5 and higher was negatively corroborated with milk yield, but on the other hand Oliver and Sordillo (1988) reported a non-significant effect of BCS on yields of milk, milk fat, milk protein, milk lactose and milk energy during 2 months of early lactation. In conclusion Paul *et al.* (2019) suggested that BCS at calving may be an effective aspect of management practice to choose higher milk producing cows

BCS and body weight during the dry period and early lactation

It is a common trend that dairy cow loses her body weight and body condition as she approaches to parturition. High BCS loss during dry period and initial lactation period is associated with body weight change. Body weight per unit difference in BCS was found highest at calving with a range from 44 kg to 62 kg in first and second parity animals. It was found that overall, 1 BCS unit change was equivalent to 31 kg body weight (Berry *et al*. 2006). Body condition loss during 1 to 4 weeks post-partum was marked most in high energy diet during dry period (Agenäs *et al*. 2003). An increase in a unit BCS at calving was found to be associated with increase in body weight (Fiems *et al*. 2006). Reduction in dry period was not found as a significant cause for the change in body weight of dairy animal at calving and during early lactation (Andersen *et al*. 2005) as mammary epithelial cells require considerable time to grow and prepare for next lactation period. Lake *et al*. (2006) found that cows having BCS 4 lost less body weight from 30 to 60 days as compared to cows having BCS 6 during early lactation. The diet in the early dry period was caused a significant difference in calving BCS, affecting DMI and metabolic status post-partum (Roche *et al.* 2013). Singh *et al*. (2020b), despite a non-significant relationship of body weight change with BCS, reported body weight loss following calving.

Severe restriction of energy intake shortly before calving increases the chances of ailments in early lactation and may also lessen milk yield (Roche *et al*. 2016). However, it was stated that feeding management immediately before calving is important. A slight restriction in ME intake for cows in optimum condition could be beneficial for metabolic and udder health (Roche *et al*. 2016).

BCS and udder health during early lactation

Udder health is a very important aspect of clean milk production and the well-being of dairy cows. During parturition, cows have a low immune response against metabolic problems, such as mastitis, because of the need to produce colostrum and the onset of lactation (Mansson *et al*. 2006). Elevated rates of udder problems were encountered in cows having high BCS during calving (Lacetera *et al*. 2005; De Feu *et al*. 2009). It is proposed that poor body conditioned cows in early lactation are more susceptible to mastitis (Lacetera *et al*. 2005). Ivemeyer *et al*. (2009) found that SCC is an important indicator of immune response and quality of milk. An increased BCS at calving has been seen associated with a reduced SCC in first- and second-parity cows, and a greater SCC in cows of third parity (Berry *et al*. 2007).

Udder health status, as measured by the SCC, was negatively correlated with BCS at calving (Singh *et al*. 2015). Cows in herds with a low-infection rate were found to have a significantly lower BCS a month pre- partum than cows in herds with a high-infection rate (Valde *et al*. 2007). However, inflammation-free udder with very low SCC may be associated to clinical mastitis cases (Suriyasathaporn *et al*. 2000). Achieving the optimum BCS at calving may prove to be important to avoid ensuing calving, lactation and metabolic disease losses (Mohammed *et al*. 2015). Kamboj *et al*. (2008) found that cows with a BCS lower or higher than 3.5, also had a higher SCC. Intra mammary infections in the early post-partum period were significantly corroborated with body condition score (BCS) in dry period and immediately after calving (Leelahapongsathon *et al*. 2016).

Dry period and blood metabolites

The blood metabolites like non-esterified fatty acids (NEFA) and beta-hydroxybutyrate (BHBA) are most commonly used to indicate negative energy balance in dairy animals. It is noteworthy that NEFA concentrations normally increase near calving period of cows (Ospina *et al*. 2010). Increased serum levels of NEFA post-partum were associated with milk loss (Chapinal *et al*. 2012). Raised levels of NEFA reflect poor management strategies to combat negative energy balance (Herdt, 2000). Management practice which lowers the blood NEFA in circulation may be effective to reduce the chances for health problems (Janovick *et al*. 2011). Duffield *et al*. (2009) remarked that high negative energy balance is found to be associated to milk yield. Common (55 days) dry period was found to have lower NEFA levels prepartum as compared to short dry period, but reduced (34 days) dry period was found to have lower NEFA levels during lactation than that of common dry period (Watters *et al*. 2008). Overfed cows in far-off period were found to have higher serum NEFA levels, and they lost more body weight during the close-up period and first 10 days in milk (DIM) (Dann *et al*. 2005). Lipid mobilization appears to be associated with health, and other metabolic as well as pathways are influenced as intake energy is directed toward production (Collard *et al*. 2000). Dry matter intake and serum NEFA concentrations normally have an inverse relationship (Overton and Waldron, 2004). However, there are some converse results which show that limited dry matter intake (DMI) during dry period reflected elevated NEFA prepartum (Murondoti *et al*. 2004; Dann *et al*. 2005; Drackley *et al*. 2005; Roche *et al*. 2005; Douglas *et al*. 2006; Roche *et al*. 2007). The suggested threshold value of NEFA ≥ 0.5 mEq/L for estimating a depression in milk yield was found same that related more chances of displaced abomasums (Chapinal *et al*. 2011).

Excessive blood NEFA is corroborated with complications near parturition and during lactation by depression in DMI, immune-suppression, increased peripartum complications and consequent infertility problems, decreased milk production (Drackley, 1999).

Reduced energy intake during dry period was associated with reduced plasma NEFA (Douglas *et al*. 2006), furthermore, restricted feeding also shown reduced NEFA concentration (Busato *et al*. 2002). Moreover, a higher energy density diet shown decreased NEFA compared to moderate energy density diet during dry period (Rabelo *et al*. 2005). But, some studies suggested that there is no effect of energy intake during prepartum on NEFA during dry period (Holtenius *et al*. 2003; Guo *et al*. 2007). It is advised to carefully monitor and test the fresh cows especially which are shifting towards lactation with a blood NEFA concentration ≥ 0.3 mEq/L or BCS higher than the average BCS of the herd (McArt *et al*. 2013). Singh *et al*. (2020a) showed significantly higher NEFA in over- fattened cows during dry period and post partum period than cows which has moderate BCS at calving, and lost more BCS postpartum (Zahrazadeh *et al*. 2018). Numerically higher concentrations of blood metabolites were investigated in the herd of high energy diets as compared to that of lower energy diets (Ryan *et al*. 2003; Singh *et al*. 2020a). Plasma glucose showed as decrease post partum period vs. prepartum (3.62 *vs*. 2.69 mmol/L respectively) (Winkelman *et al*. 2008). In an experiment it was found that blood glucose did not change in different groups with blood NEFA changes (Moorby *et al*. 2000).

BCS and udder health during dry period

Udder health during dry period is an essential aspect associated with production of high quality and quantity of milk. Intra-mammary infections during this period can deleteriously affect udder health leading to decreased milk production, changed milk composition during dry the period can be an important issue in udder health management (Klocke *et al*. 2007; Singh *et al*. 2020a).

BCS, length of dry period and udder health

Many studies are present in literature whish shows dry period lengths from 0 to 7o days (Bachman and Schairer, 2003). Cows having short dry period were found to have better postpartum BCS and DMI than long dry period without having significant difference in milk yield, and composition (Gulay *et al*. 2003). But contradictory results have also been reported that shortening of dry period depresses lactation performance (Coppock *et al*. 1974) also, short dry period has been found likely to increase milk protein percentage and improve udder health found in terms of decreased SCC during ensuing lactation (Watters *et al*. 2008).

Reduction in dry period length was found not correlated with milk fat percentage unless it is reduced to 20 days or lesser (Kuhn *et al*. 2006). Short dry periods were found beneficial for multiparous and over-conditioned cows in milk performance but not for primiparous cows (Pezeshki *et al*. 2007). This may be due to the fact that the mammary gland of primiparous cows is not fully grown and hence requires recommended 51 to 60 days of dry period to replenish the nutrients to prepare for ensuing lactation than for multiparous cows as suggested in a rigorous review on optimal dry period lengths by Bachman and Schairer (2003). Level of production should also be considered while planning dry period length as very high producing cows do not require a dry period and forcible drying may cause unnecessary stress However, low producing cows have lesser lactation length than high yielding cows and dry off early and do not require drying off (Friggens *et al*. 2004).

BCS, dry period energy level and udder health

Dry period energy level management offers a scope for decreased incidence of udder problems (Beever, 2006; Singh *et al*. 2020a) and improved milk production (Reis *et al*. 2012; Hills *et al*. 2015; Singh *et al*. 2020a) also, decreased body condition loss post calving (Drehmann, 2000; Butler, 2003; Singh *et al*. 2020a). Higher body conditioned cows near to calving had higher rates of udder infections at herd level (Valde *et al*. 2007). It has been suggested that low energy and high fiber diet may improve cow's health, production and fertility (Beever, 2006). Overfed cows showed higher lipid metabolization and ketone body production during lactation as compared to cows fed under controlled or restricted system and ultimately overfed cows may suffer from more metabolic disease (Janovick *et al*. 2011). But, feeding strategy during close up period should be changed. Greater energy density, quality of feed and similar ration of close up with milking ration have influence on close up period and improves cow's production in early lactation (McNamara *et al*. 2001). This may help in preparing rumen microflora for next lactation feed, increased dry matter intake, decreased body mobilization, milk protein synthesis, calcium mobilization and its absorption (Friggens *et al*. 2004).

It has been suggested that feeding management of cows should be planned to maintain the cow's proper body condition during dry period for better post partum period when there are greater chances of mastitis infection (Faye *et al*. 1998). However Singh *et al*. (2020a) in an experiment, in which energy intake was reduced in the early dry season, found a highly significant relationship between BCS and udder health. Cows with the recommended BCS at calving had better udder health and, in addition to this, significantly better quality milk with lower methylene blue reduction test (minutes) were also noticed.

CONCLUSION

It is evident that better feeding management strategies during the dry period may help in overcoming excessive blood NEFA concentration and transitional health problems. Both under and over- conditioning of dairy cows at calving and a short dry period should be avoided. Peripartum cows are more susceptible to a negative energy balance. Optimizing BCS at calving is an important aspect of dry period management for performance in lactation. Ensuring the optimum range of BCS during the peripartum period should be given priority in dairy herd management. High fiber and lower energy diet during the early dry period followed by a comparatively increased energy intake near to calving may help to obtain optimum condition of the cow during lactation, thereby improving milk yield, milk quality, udder health and reduced negative energy balance during early lactation.

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