

Body Condition,  
Energy And Health  
In High-Producing  
Dairy Cows

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# Body Condition, Energy And Health In High-Producing Dairy Cows

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Adipose tissue, or body fat, is an animal's means of storing energy during times of nutritional excess for later use when food energy is insufficient for the animal's needs. This is as true for dairy cows as for other animals. In the past, the balance of fat deposition versus fat mobilization was used in dairy management schemes as a simple means of improving production with the concept that cows could be fed to gain weight at one time so they could "milk off their backs" at a later time when the production needs exceeded feed energy supply. During the 1970s, research and clinical evidence demonstrated substantial health problems associated with energy over-feeding that resulted in fat cows. A considerable amount of research has been conducted since then expanding our knowledge of dairy cow nutritional physiology and to the interactions between health productivity and energy supply and demand.

Body condition scoring (BCS) systems have been developed and validated as an accurate means of evaluating dairy cow fat and energy reserves. These systems have been promoted as useful in management of high-producing cows, and many dairymen and dairy consultants have begun to incorporate body condition scoring into their monitoring schemes. For many reasons, there is no single universal accepted estimate of optimal BCS. Well conducted research focuses on one or several very specific questions, so different trials conducted under different circumstances often show results that seem to conflict. Some research findings seem to contradict knowledge or convictions people have formulated by personal experience. As a result, the use of body condition scoring may seem limited or confusing, or simply opinion-based.

The purpose of this presentation is to discuss some of the interactions between energy utilization, productivity and health of high-producing dairy cows and how they relate to body condition score. An appreciation of these factors should allow the dairy producer to use body condition scoring wisely and to tailor it to individual needs.

## **Fat metabolism**

As ruminants, dairy cattle ferment feedstuffs in their large forestomach. This single fact directly impacts virtually all aspects of their energy metabolism. As part of the fermentative process, rumen bacteria break down the overwhelming majority of carbohydrates that enter the rumen. These carbohydrates include the simple sugars, cellulose and starches that are the major energy and structural components of plants. The end products of this fermentation are small fats known as volatile fatty acids (VFA). These VFAs are absorbed through the gut wall and utilized as the primary energy source for the ruminant animal. One result is that almost no glucose is available to the ruminant by absorption from the gut. Instead, ruminant metabolism relies almost exclusively on fat in one form or another.

The VFAs derived from digestion can be directly used by the animal or converted to longer chain fats for storage if they are produced in excess of the cow's immediate energy needs. Besides the cow's needs for basic body maintenance, the largest single energy demand in the

high-producing lactating dairy cow is for milk production. While many tissues can derive their energy directly from fat, the mammary gland has an absolute requirement for glucose in order to produce milk. Since the cow does not absorb glucose from the digestive tract, almost all glucose for milk production must be manufactured in the liver. The VFAs are directly utilized by the liver for this purpose. For a dairy cow producing between 90 and 120 pounds of milk a day, this amounts to a complete turnover of the glucose in her blood approximately every four to six minutes, a truly remarkable metabolic feat. Because of this direct link between VFA production, conversion to glucose and utilization for milk production, it may not be surprising that the feeding factor with the highest direct correlation to milk production is the total dry matter intake (DMI). The VFAs can also be used to produce milkfat.

If the VFAs are not directly used for tissue metabolism or milk production, they can be combined in the liver into longer-chain fats that are transported to the adipose tissue for storage. When the supply of VFAs is too low to support the animal's needs, this fat is then mobilized and transported via the blood back again to the liver for conversion to a more usable form. The fat can be used for energy, converted to glucose, or used to produce milkfat. The various pathways through which fat is utilized are influenced and regulated by a complex of enzymes and hormones. Not all metabolic pathways can be optimally or maximally used at all times.

### **Fat versus health**

Over the last 20 years some strong associations have been seen between body condition or fat mobilization and poor health in dairy cows. Some of the health problems are profound life-threatening problems, while others are more insidious and result in poor performance but little overt disease. Thus some problems directly call attention to the problem of over-conditioning, while others require a more careful monitoring system to detect.

The most dramatic disease of over-conditioned dairy cows is a problem that has been known as "fat cow syndrome." This problem occurs in the immediate periparturient period. It involves a severe metabolic derangement and multiple organ system failure. The typical affected cow will show signs of milk fever, usually with recumbency. It is difficult to ever get these cows to rise again and prolonged recumbency leads to severe muscle damage. Also seen in most cases are retained fetal membranes and the cow appears to have impaired ability to control infectious disease. Instead of showing localized uterine infection, the cow rapidly develops signs of septicemia with widespread infection, to which she does not respond appropriately. Mastitis is also frequently seen in addition to the uterine disease. Affected cows are usually severely ketotic and anorectic. The prognosis for affected animals is very poor. Fortunately, this condition is usually seen in individual animals but when such a case occurs, may reflect poor overall nutritional management with over-feeding of the late gestation cows in the herd.

More insidious is the fatty liver syndrome in dairy cows. Cows with this problem are usually not obese at the time they show signs of disease. Instead they are usually cows that have lost excessive amounts of body condition since freshening. Signs appear three to eight weeks post partum, when cows have been in chronic negative energy balance for a period of time. The signs include decreased milk production and chronic ketosis that does not respond appropriately to therapy. With chronic negative energy balance, affected animals mobilize excessive amounts of fat from their peripheral fat stores. As described above, this fat circulates to the liver where it should be used for a variety of different metabolic end purposes. If the fat mobilization is excessive, however, not all of the fat is appropriately channeled through the different metabolic pathways. Some of the fat is stored in the liver, leading to the change for

which the disease was named. Some of the fat is partially metabolized but inadequate functioning of the metabolic pathway leads to accumulation of partially oxidized fats known as ketones. This excessive ketone body production, known as ketosis, can produce further anorexia and exacerbate the problem. Ketosis can develop whenever lactating cows go off feed, so this problem is commonly seen in association with other diseases. In fatty liver disease, the primary problem is the metabolic imbalance of inappropriate utilization of the excessively mobilized body fat stores. If affected animals are identified promptly, they can respond to aggressive treatment very favorably. On the other hand, if the problem continues over a prolonged period, the cow will cease to be productive and may develop severe enough problems that she dies. The existence of fatty liver disease cows in a herd suggests a problem of insufficient energy feeding to early and peak lactation cows.

The most insidious disease problems associated with fat metabolism in dairy cows are those that do not show overt signs of disease. Numerous studies have shown that cows losing excessive amounts of body condition in early lactation develop high amounts of fat infiltration in the liver. Not all of these cows will show fatty liver disease with its associated severe ketosis and decreased milk production. In fact, many of the highest-producing cows in the herd will typically develop severely increased liver fat but still not show clinical ketosis. It appears that liver function per se is not adversely affected except in a minority of these weight-losing cattle. They are, however, still experiencing abnormal fat metabolism, which can be demonstrated with a variety of different analytical methods in research settings. The exact mechanisms by which this abnormal fat metabolism affects other aspects of animal health has not been clearly defined. What is clear is that these animals show a higher rate of reproductive inefficiencies, prolonged days to conception and prolonged calving intervals, and increased incidences of metabolic and infectious diseases.

### **Body condition**

Research data as well as personal opinions vary concerning the optimal body condition score for cows at freshening. Many recommendations are complicated because of variations in feeding practices from farm to farm. In general, there is good agreement that excessive body condition is detrimental to performance. Where recommendations vary is on whether cows should be on the thinner or the heavier side of a mid range body condition score. There is substantial agreement of research information on the interaction between body condition score and a variety of other parameters important to dairy cow performance. An understanding of some of these will provide a perspective on decisions concerning BCS in cows in individual herds.

As mentioned earlier, total dry matter intake has a very strong correlation with total milk production. In the last week prepartum, most cows decrease their dry matter intake both before and after calving. Several studies have shown that fatter cows decrease DMI more substantially than thinner cows. These trials have also shown that cows with lower BCS, because they tend to consume more dry matter, will also have a decreased time of negative energy balance post partum and will produce the same or more milk than fat cows while mobilizing less fat from their peripheral tissues. As a result, leaner cows will tend to lose less weight postpartum and therefore will tend to suffer fewer disease episodes and be more efficient at breeding back.

Much of the positive effect of calving cows in leaner body condition seems to result directly from the increased dry matter intake these cows are able to sustain. A recent study showed that by force-feeding cows for increased dry matter intake, the high DMI cows developed

less liver fat postpartum and showed increased production. Relating to the discussion above about dairy cow fat metabolism, it is also more biologically efficient for cows to produce milk directly from feed energy than by converting the feed energy to fat and then fat to milk. The biological efficiency of converting feed to milk energy or to body fat is approximately the same at about 60%, while conversion of fat energy to milk energy is a higher efficiency, at about 80%. The two steps involved in converting feed first to fat and then to milk energy decreases the efficiency to around 50%. On the same note, this effect is even more severe if the body fat stores are laid down during the dry period. Cows are more efficient at gaining weight while in the late lactation period and, if the fat is deposited during the dry period, the biological efficiency is decreased to somewhere between 30 and 45%. Therefore, aside from any considerations of the health effects of overconditioning cows, it is simply more cost-effective to attain as much milk production as possible directly from feed intake.

With these thoughts in mind, the ideal situation would be to maintain a thin cow who can consume enough feed to maintain optimal milk production while neither gaining nor losing weight. Unfortunately, this goal is as yet unattainable. It is clear, however, that to obtain optimum milk production and cow health, both BCS and nutrition should be critically monitored to obtain maximum dry matter intake postpartum and avoid excessive condition loss during the first several months postpartum. The BCS loss is more detrimental to the cow than is excess condition itself but excess condition will in turn lead to a greater tendency toward condition loss.

A BCS monitoring program can be relatively easily implemented. Using such a system will allow cows to be grouped both for milk production and BCS. The BCS should be viewed critically to observe for changes associated with suboptimal feeding and for discrepancies between feeding recommendations and feed intake. Target goals can be established for cows in each lactation group and feeding patterns adjusted to attain that goal if large numbers of cows fall outside the target range. Individual cows falling outside the target range can be moved to other feeding groups to help correct for those problems. In a well managed system, less than 10% of the cows in a group should fall outside of the target range.

General rules of thumb that seem to be agreed upon by a wide variety of trial results suggests that the mean condition scores of the dry cows and the peak lactation cows should not vary by more than one-half BCS unit. While cows will lose some condition in the early lactation period, this should probably not exceed one condition score. Body condition should improve in the middle and late stages of lactation so cows can dry off in the condition in which it is desired that they calve. If cows do dry off overconditioned, they should be maintained at the current weight or reduced only slightly. Drastic weight loss feed regimens in the dry period are probably more detrimental than weight loss in early lactation.

Recommendations for optimum body condition score at the various lactation stages will be argued by some but my recommendations would be as follows: on a condition score system of one to five, with one being a very thin cow and five an obese cow, animals at drying off and parturition should be between 3.0 and 3.5. Condition loss should be maximal at one to two months after calving and at the pre-breeding examination, BCS should be about 2.5 or a little greater. Body condition should stabilize and then begin to improve after about 90 to 100 days in milk, so BCS at the pregnancy examination should be stable or a little bit improved. An additional BCS measurement at about 100 days before drying off should show the cow improving condition back toward the levels desired at dry off. This is a good time to adjust the feeding regimen to obtain optimal BCS at the dry period.

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