Transition Cow Nutrition: Failure to Invest Now May be Costly Postpartum

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INTRODUCTION

The transition period usually refers to the final 2 to 3 weeks prior to calving. Traditionally, this time has been used to gradually adapt cows to high grain diets that are fed during early lactation. Without gradual adaptation to high grain diets, there is a risk of upsetting rumen fermentation and causing the cow to go off feed. While this is a very important aspect of managing the transition cow, there are several other reasons why close attention must be paid to feeding and managing the dairy cow during this period. The transition period coincides with a time when the dairy cow is going through hormonal and metabolic changes that are orchestrated to initiate calving and milk production. These changes cause stress to the dairy cow, which may predispose the cow to metabolic disorders that are independent of events taking place in the rumen. The focus of this review will be on managing the dairy cow to avoid metabolic stress and disorders that are associated with the onset of calving and milk production.

NUTRITIONAL AND METABOLIC STATUS OF THE TRANSITION COW

The latest dairy NRC (1989) lists only one set of nutrient requirements for the dry cow. This is probably an oversimplification. Nutrient requirements for the growing fetus increase dramatically during the last trimester of pregnancy. To make the situation worse, dairy cows tend to go off feed during the final 3 weeks prepartum, particularly during the final week prior to calving. The cow is placed in a precarious position because nutrient demands are increasing at a time when feed intake is decreasing. Consequently, many. cows will enter into a period of negative energy and protein balance prior to calving. To examine the nutritional status of transition cows, we alculated (using NRC requirements) the average energy and crude protein **(CP)** balances for 11 cows that were assigned to one of our research trials (Bertics et al., 1992; Figures 1 and 2). Cows averaged a 30% reduction in feed intake during the final 3 weeks of gestation. Forage to concentrate ratios were 100:0, 75:25, and 50:50 for the final 4 weeks prepartum, day 1 or 2 to day 5 postpartum, and days 6 to 28 postpartum, respectively. Energy content (Mcal NE_l/lb dry matter) and CP (%) of the diets were .68, 13.8; .73, 17.3; and .77, 20.8 for the three periods. Energy and protein content of the prepartum experimental diets

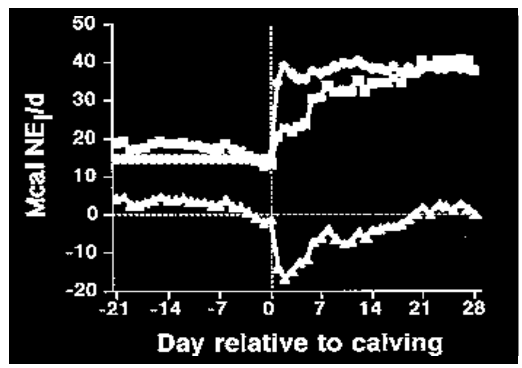


FIGURE 1: Energy requirement (circles), intake (squares), and balance (triangles) of transition cows (Bertics et al., 1992; NRC 1989).

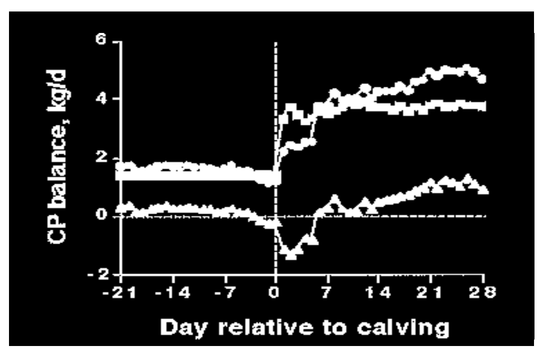
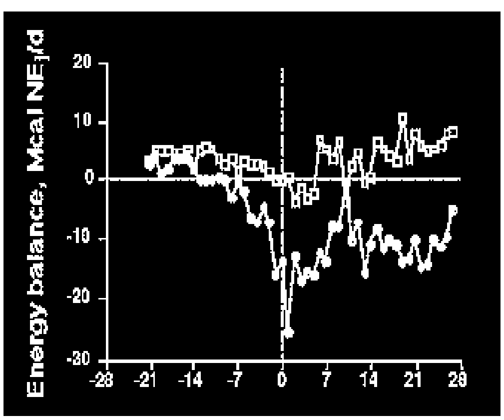


FIGURE 2: Crude protein requirement (squares), intake (circles), and balance (triangles) of transition cows (Bertics et al., 1992; NRC 1989).

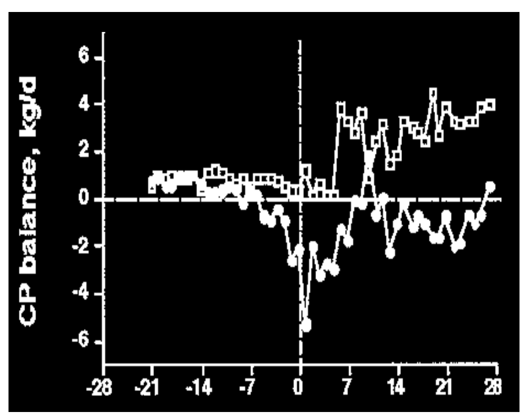
were higher than recommended by NRC (.57 Mcal NE_l/lb, 12% CP).

We repeated this exercise for the cow that experienced either the least or most severe depression in dry matter intake **(DMI)** between days 21 to 1 prepartum (Bertics, 1992) and results are shown in Figure 3. Dry matter intake of cow 723 decreased from 29 lb to 4.84 lb/day and DMI of cow 802 from 26 to 24 lb/day during that period. This data implies that cows which avoid severe DMI depression prior to calving have a favorable nutritional balance prior to and after calving, while those that go almost completely off feed experience an extended period of negative nutrient balance during the transition period.

The dairy cow undergoes metabolic upheaval during the final weeks prior to calving due to changes in feed intake and hormonal status that are associated with calving and the initiation of milk production. Most people think that the worst time for a cow is after calving when daily milk production is increasing more dramatically than feed intake. However, as the previous figures document, the period of greatest nutrient imbalances is over very shortly after calving. Likewise, most of the dramatic swings in hormone concentrations have taken place by a few days after calving (Grummer, 1995). Concentration of key nutrients in blood also go through the most radical changes at calving. For example, plasma fatty acid, glucose, and ketone concentrations increase dramatically at calving and stabilize during the early postpartum period. The increase in plasma fatty acids is due to mobilization of fat from adipose tissue and it occurs because of hormonal changes and the cow going off feed. During fat mobilization, fatty acids spill into blood and may ultimately be taken up by the liver. If this is excessive, the cow can develop fatty liver. A summary of data from 5 experiments (Skaar et al., 1989; Bertics et al., 1992; Studer, 1993; Studer et al., 1993; Vazquez-Anon, 1994) involving 78 cows indicated that DMI at 1 day prepartum, expressed as a percentage of body weight, was highly correlated to liver fat (r = -.45) and plasma fatty acids (r = -.44). Cows that eventually developed ketosis, displaced abomasum, or retained placenta postpartum had higher plasma fatty acid concentrations immediately prepartum than those that avoided postpartum complications (Dyk et al., 1995; Table 1). The increase in plasma glucose concentration at calving is probably due to the liver making more glucose in anticipation of lactation, but it is also due to mobilization of glucose from glycogen stores in the liver. Work from Iowa State University (Veenhuizen et al., 1991) indicates that fat:glycogen in the liver is positively related to the incidence of ketosis.



Day Relative to Calving



Day Relative to Calving

FIGURE 3: Estimated NE_l and CP balance of a transition cow which experienced severe DMI depression prepartum (circles) or a cow which experienced virtually no DMI depression prepartum (squares).

TABLE 1: **Plasma nonesterified fatty acid concentrations (µM) during the week prior to calving in dairy cows that did or did not develop postpartum disorders (Dyk et al., 1995).**

	Negative	Positive
Ketosis	452	574
Displaced abomasum	450	619
Retained fetal membrane	449	585

DRY MATTER INTAKE

Maximizing feed intake prior to calving appears critical for the prevention of metabolic disorders. We (Bertics et al., 1992) evaluated the effects of prepartum intake depression on the development of fatty liver. Eleven cows were fed ad libitum prepartum (control), and another 11 cows were maintained at the same level of DMI as recorded during days 21 to 17 prepartum by force feeding feed refusals via rumen cannulae. Feed intake of control cows declined 28% over the final 17 days prepartum. Liver triglyceride increased 227 and 75% for control and force-fed cows, respectively, between day 17 prepartum and day 1 postpartum (Figure 4). Cows that were force-fed prepartum produced milk with a higher fat content (4.22 vs. 3.88%), and tended to produce more 3.5% fat-corrected milk **(FCM)** over the first 28 days postpartum (101.5 vs. 91.9 lb/day).

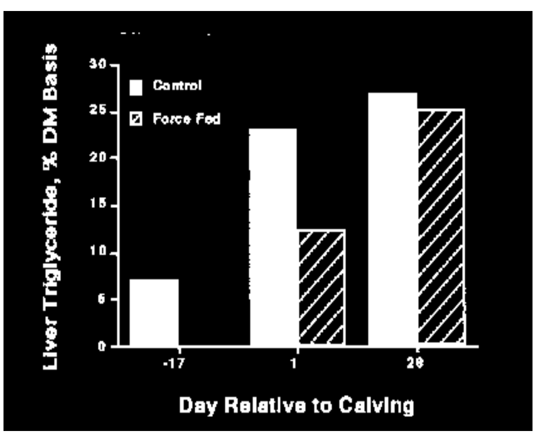


FIGURE 4: Effect of DMI on liver triglyceride.

Zamet et al. (1979) monitored 89 Holstein cows through the dry period and first 30 days of lactation and categorized cows as being normal or abnormal. Abnormal (n=45) cows were those that had one or more ipartum or early postpartum disorders diagnosed and treated. Feed intake during the final 27 days prepartum decreased from 1.8% to 1.2% of body weight for normal cows and from 1.8% to .9% of body weight for abnormal cows; DMI was significantly lower for abnormal cows from 3 days prepartum to 1 day postpartum. Differences in feed intake between the two groups increased postpartum and normal cows produced more milk. This data indicates that predisposition to disorders at and immediately following calving may be indicated by reduced DMI prepartum.

Numerous studies have indicated that overconditioned cows are more likely to have poor appetites postpartum (Garnsworthy and Jones, 1987; Holter et al., 1990). Postpartum feed intake is related to prepartum feed intake (Figure 5), therefore, one might hypothesize that overconditioned cows would also consume less feed prepartum. Emery (1993) summarized feed intake during the dry period for 20 multiparous cows. The 10 cows with the highest body condition score (> 3.6; 1 = lean, 5 = obese) consumed dry matter at approximately 1.5% of body weight and the 10 cows with the lowest body condition score (≤ 3.6) consumed dry matter at 2% of body weight. Overconditioned cows had a higher incidence of health problems within 75 days postpartum. We examined the relationship between body condition score at 17 days prepartum and DMI at 1 day prepartum or 21 days postpartum for 40 cows from 3 completed research trials (Bertics et al., 1992; Studer, 1993, Studer et al., 1993). The correlation coefficient between prepartum body condition score and DMI at 1d prepartum and 21 days postpartum was .25 and .45.

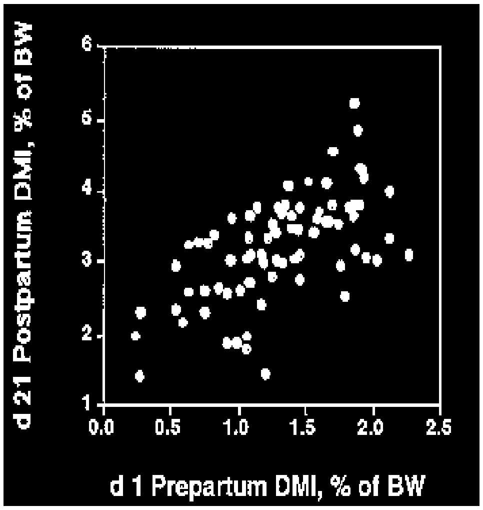


FIGURE 5: Relationship between DMI at 1 d prepartum and 21 d postpartum (Grummer, 1995; r = .54, P < .0001.)

DIETARY CARBOHYDRATE

One way to offset reduced energy intake associated with feed intake depression is to increase energy density of the diet. This can be achieved by decreasing fiber content of the diet, adding supplemental fat, or both. Similar to the lactating cow, proper carbohydrate nutrition is necessary to optimize rumen function and tissue metabolism of the transition cow. The importance of proper carbohydrate nutrition during the close up dry period and the first few days postpartum may be greater than during peak lactation because the transition cow is more susceptible to metabolic disorders which may influence total lactation performance.

Carbohydrates in ruminant diets are often referred to as fiber and nonfiber carbohydrate **(NFC)**. Fiber is usually measured as neutral detergent fiber **(NDF)** and is primarily composed of cellulose, hemicellulose, and lignin. Nonfiber carbohydrate is usually calculated as: 100 - % CP - % NDF - % ether extract (lipids) - % ash (mineral), and represents mainly starch, pectin, and simple sugars in ruminant feeds. Both NDF and NFC can be fermented by rumen microorganisms to volatile fatty acids, which are the primary energy source for ruminant tissues. However, in general, the rate of NDF degradation in the rumen is much slower than the rate of NFC degradation. Neutral detergent fiber and NFC content of feeds are negatively related, i.e., feeds that are high in NDF are typically low in NFC and visa versa. Cows need NDF to maintain proper *health* of the rumen. Excessive NDF in the diet may result in inadequate energy intake. Insufficient intake of NDF (or excessive intake of NFC) may result in acidosis and has been implicated in the etiology of displaced abomasum.

There is considerable logic for increasing the NFC and decreasing NDF of the close up dry cow diet. One reason talked about for years is to adapt the rumen microorganisms to the high grain (starch) diets that will be fed following calving. More recent research has indicated other, and perhaps more important, reasons for increasing NFC during the transition period. Dirksen et al. (1985) demonstrated that reduction of fiber percentage in the prepartum diet increases the development of rumen papillae and increases the capacity for volatile fatty acid absorption from the rumen. Development of the rumen papillae is essential to minimize ruminal volatile fatty acid accumulation, reduction in ruminal pH, and the likelihood of acidosis when high grain lactation diets are introduced postpartum. This aspect of lead feeding may be more important than that of adapting the rumen microflora to high starch diets. Because development of the rumen papillae takes 4 to 6 weeks (Dirksen et al., 1985) grain feeding must begin prior to parturition to benefit the cow postpartum.

Additionally, increasing grain feeding stimulates propionate formation in the rumen. Propionate is converted to glucose by the liver, and both propionate and glucose stimulate insulin secretion from the pancreas. Insulin is antilipolytic, which means it helps reduce fatty acid mobilization from fat stores. That can be important because fatty liver and ketosis is associated with excessive fat mobilization from adipose tissue. Increasing concentrate intake from .9 to 7.9 kg/d during the final 4 wk prepartum, while forage intake remained constant, resulted in 100 to 300% increases in serum insulin (P < .01; Holtenius et al., 1993). Serum insulin also was increased (P < .01) when energy intake was held constant during the transition period but concentrate was increased from 5 to 60% of ration DM.

Enhancing carbohydrate status and increasing plasma insulin does not need to be accomplished by feeding additional concentrate. Propylene glycol is converted by the liver to glucose, which increases the concentration of insulin in blood. Studer et al. (1993) evaluated the effects of prepartum propylene glycol **(PG)** administration on the development of fatty liver in 24 cows. Treated cows were drenched with 32 oz PG once daily starting 10 days prior to expected calving until parturition. Total liver triglycerides measured one day postpartum were 29.5 and 21.4% for control and PG treated cows. Prepartum plasma glucose concentrations were increased and fatty acid concentrations were decreased. Plasma ketones were significantly lower during PG administration and these benefits carried over beyond calving after treatment had been stopped. These results indicate that prepartum propylene glycol administration may have a role in the prevention of fatty liver. There were no significant differences between control and PG over the first 21 days postpartum for DMI, milk yield, or milk composition. Because 32 oz of PG is a large dose, we evaluated different doses of PG for ability to reduce plasma fatty acids in feed restricted heifers (Grummer et al., 1994). Ten ounces of PG was almost as effective as 30 oz for increasing plasma glucose and insulin and decreasing plasma fatty acids and ketones.

Drenching PG is labor intensive, therefore, we compared the efficacy of administering PG as an oral drench, mixed with a totally mixed ration **(TMR)**, or as a slug dose with grain (1 lb PG + 6 lb grain). Providing PG as an oral drench or with grain in a single offering separate from forage were similarly effective in increasing plasma insulin and reducing plasma fatty acids (Christensen, 1995). Feeding PG as part of a TMR was not as effective, probably because there wasn't sufficient PG consumed at any moment in time to trigger the metabolic changes required to reduce fat mobilization from adipose tissue. Previous research indicates that feed intake is not compromised if PG is limited to less than 5% of ration dry matter (Shaver, 1993).

Finally, there is limited evidence that increasing grain content of the diet may stimulate appetite prepartum. Therefore, energy intake may be increased due to greater DMI of a diet that is higher in energy density. Decreasing forage:concentrate ratio may increase energy intake and help reduce fatty acid mobilization from adipose tissue. Transition cows fed 20% concentrate from 28 to 4 days prepartum had higher DMI (~2.5 lb/day) until day 11 prepartum than did cows fed 5% concentrate during the same period (Hernandez-Urdaneta et al., 1976). By 4 days prior to calving until calving, DMIs were not different between the two treatment groups but cows consuming the diet containing 20% concentrate consumed more energy. Similar results were obtained by Johnson and Otterby (1981) for cows fed all alfalfa grass hay or corn silage-alfalfa silage based diets containing 12 or 47% high moisture corn beginning at 30 days prepartum. Increasing high moisture grain in the diet increased DMI from days 28 to 13 prepartum but not from day 12 prepartum to day 31 postpartum. Coppock et al. (1972) fed four diets varying from 75 to 30% forage during the final 28 d prior to calving. Although there were not statistically significant differences among groups, feed intake was highest for cows receiving the two diets with the most grain. However, percentage decrease in feed intake immediately prior to calving was greatest for cows consuming the diet with the most concentrate.

Michigan State workers observed a 30% increase in DMI when energy density of the diet was increased from .59 Mcal NE_l/lb dry matter to .7 Mcal NE_l/lb dry matter and CP was increased from 13 to 16% at about 3 weeks prior to calving (Emery, 1993). Dry matter intake began to decline at 5 days prior to calving but not below levels observed before the change in dietary energy density. Increasing energy density from .59 to .73 Mcal NE_l/lb and CP from 12.2 to 16.2 % during the final 26 d prepartum resulted in higher energy intake during the final 14 d prepartum (21 vs 15 Mcal NE_l/d), reduced plasma fatty acids (228 vs 346 μM), and reduced liver triglyceride (9 vs 15 mg/g wet tissue; VandeHaar et al., 1995). However, milk yield and body weight were not affected by treatments (Sharma et al., 1995). Results from these studies are confounded by protein content of the diet, therefore, one can not be certain whether these effects were due to energy or protein.

We (Minor et al., 1996) recently conducted a trial to examine the effects of dietary NFC during the transition period on feed intake, metabolic health, and lactation performance of dairy cows. Prepartum and early postpartum diet ingredient and nutrient composition are in table 2. The standard NFC diet (S) was predominantly alfalfa silage and straw. Straw was included to reduce forage quality so that the diet would be closer to NRC recommendations for NE_l in dry cow diets (S = .61, NRC = .57 Mcal NE_l/lb) . For the high NFC diet (H), forage,

TABLE 2: Ingredient and nutrient composition of standard and high NFC diets[1]

	Prepartum[2]		Early to mid lactation[3]	
	S	H	S	H
	(% of DM)			
Ingredient				
Alfalfa silage	54.0	27.0	32.4	26.9
Corn silage	8.0	4.0	16.4	13.2
Straw	25.0	12.5	. . .	. . .
Corn, cracked	5.4	39.1	26.8	. . .
Corn, finely ground	. . .	. . .	. . .	26.2
Starch	. . .	6.0	. . .	6.5
Corn gluten meal	6.4	. . .	. . .	. . .
Soybean meal	. . .	9.8	3.6	6.3
Cottonseeds	. . .	. . .	8.0	8.0
Roasted soybeans	. . .	. . .	10.0	10.0
Minerals and vitamins	1.2	1.6	2.9	3.0
Nutrient composition				
DM, % As-fed basis	53.7	67.0	59.1	63.1
OM	90.0	90.3	90.6	91.7
CP	14.4	13.2	17.0	17.1
Fat	3.2	3.8	5.7	6.3
NDF	48.9	29.5	26.2	21.8
NFC	23.5	43.8	41.7	46.5
NEL, Mcal/lb of DM	0.61	0.74	0.77	0.79

1 S = standard NFC diet; H = high NFC diet.
2 19 days before expected calving until parturition.
3 Calving until 30 weeks postpartum.

including straw, was reduced by 50%. To increase the fermentability of carbohydrate, NFC was increased by the addition of starch and corn was finely ground. Even though NFC of the H diet was quite high, the NE_l content was less than that in typical early lactation diets (.74 Mcal NE_l/lb). All cows (25 primiparous, 50 multiparous) were placed on diet S at 26 days prepartum and then assigned to S or H at 19 days prepartum.

Feed intake of cows during the prepartum period are in Figure 6. Cows fed H consumed more dry matter during the prepartum period than cows fed S (1.9 vs 1.5% of body weight) which indicates that diet composition can influence prepartum feed intake. On the day of calving, cows fed H had a more dramatic decrease in feed intake compared to those fed S, however, energy intake was greater for cows fed H due to the higher energy density of the diet. Previous research from our laboratory indicated that cows with high prepartum feed intake were less likely to have fatty liver or high blood ketones; therefore, we measured those parameters in this experiment. Except for the day after calving, cows fed H had lower plasma fatty acids (Figure 7). This means less fat was being mobilized from adipose tissue. Feeding H reduced plasma beta-hydroxy-butyrate (a ketone, Figure 7) and the effect was most prominent postpartum. We were surprised by the amount of triglyceride (i.e. fat, Figure 8) in the livers of cows on this experiment. Triglyceride content was much lower than we usually see in early postpartum cattle. This was partially due to the inclusion of heifers in this study which are less susceptible to fatty liver than mature cows. The low liver triglyceride might have precluded us from seeing more dramatic effects of treatment. However, there was a reduction in liver triglyceride due to feeding H and the effect was most noticeable at 28 d after calving. Cows fed H also had higher glycogen in the liver. Glucose can be stored in the liver as glycogen. Veenhuizen et al. (1991) indicated that liver triglyceride:glycogen ratio is a good predictor of a cow's susceptibility to ketosis. Cows fed H had lower triglyceride:glycogen

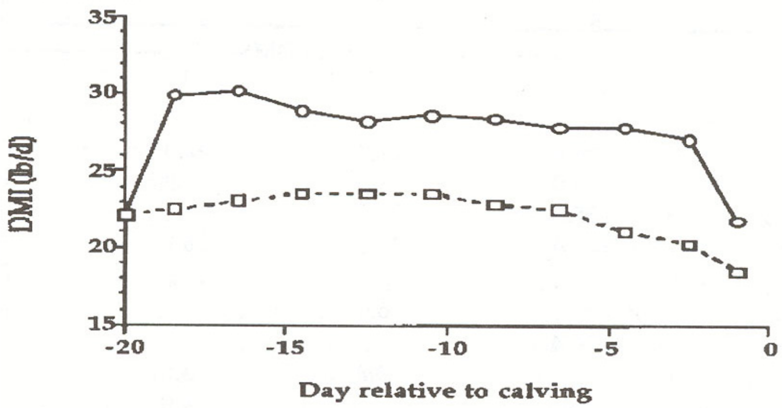


FIGURE 6: Dry matter intake (DMI) of cows fed standard (- - -) or high NFC (___) diets.

ratios (Figure 8). We measured milk production from these cows for 40 weeks postpartum. Cows fed H produced 5 more pounds of milk per day that was lower in milk fat (3.49 vs 3.69) and higher in milk protein (3.18 vs 3.01). The design of this trial did not allow us to determine if milk production differences were due to prepartum diet, postpartum diet, or a combination of both. Incidence of clinical metabolic disorders during this trial were extremely low and did not vary due to treatment. Nevertheless, this trial indicated that carbohydrate content of diets fed to transition cows may influence prepartum feed intake and metabolic status. Further research is needed to determine optimal dietary NDF and NFC for transition dairy cows.

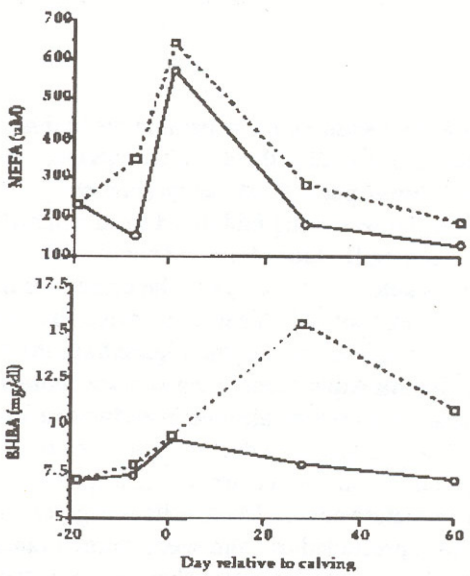


FIGURE 7: Plasma nonesterified fatty acid (NEFA) and beta-hydroxybutyrate concentrations in cows fed standard (- - -) or high NFC (___) diets.

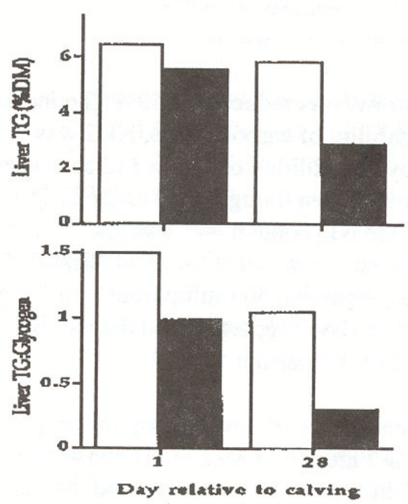


FIGURE 8: Triglyceride (TG, expressed as a percentage of liver dry matter [DM]) and triglyceride:glycogen ratio in liver of cows fed standard (□) or high NFC () diets.

DIETARY FAT

Fat supplementation is another strategy for increasing energy density of the prepartum diet. Kronfeld (1982) speculated feeding supplemental fat would reduce fatty acid mobilization from adipose tissue and potentially reduce the incidence of ketosis. This strategy assumes dietary fatty acids are incorporated into intestinally synthesized lipoproteins and are, in contrast to nonesterified fatty acids mobilized from adipose tissue, metabolized predominantly by tissues other than the liver. However, plasma nonesterified fatty acids concentrations almost always increase when supplemental fat is fed (Grummer and Carroll, 1991; Chilliard, 1993). This is probably the result of fatty acids *spilling* into blood as tissues metabolize the lipoprotein. These fatty acids can be utilized by the liver.

Feeding supplemental fat to cows from 17 days prepartum through 15 weeks postpartum did not reduce liver triglyceride or plasma beta-hydroxybutyrate during the transition period (Skaar et al., 1988). In fact, liver triglyceride tended to increase due to fat feeding. In contrast, Grum et al. (1996) increased energy density of diets fed to cows for the entire dry period by increasing concentrate:forage or by feeding supplemental fat. Feeding supplemental fat during the entire dry period reduced plasma nonesterified fatty acid concentrations and liver triglyceride at calving; increasing concentrate:forage had no effects. Rate of triglyceride formation was decreased and fatty acid oxidation was increased in liver tissue obtained at calving from the cows fed supplemental fat. Salfer and coworkers (1995) did not observe any improvement in lactation performance of cows that were introduced to dietary fat prepartum versus cows that received fat starting at parturition or 35 day postpartum. Currently, there is a lot of interest in feeding supplemental fat during the transition period. It represents an ideal time to acclimate cows to the presence of fat in the diet. More information is needed relative to the effects of fat supplementation on feed intake and metabolic health of the transition cow. However, in contrast to greater concentrate feeding, increasing energy density of the prepartum diet by feeding fat does not seem to increase DMI (Skaar et al., 1988, Grum et al., 1996).

DIETARY PROTEIN

Two theories have been forwarded to explain why improving amino acid status of the transition cow may impact performance. Firstly, improving the amino acid status of the prepartum cow may beneficially influence endocrine physiology and enhance lactation performance (Chew et al., 1984a). Secondly, protein requirements listed by NRC (1989) may be underestimated. As a result, underfeeding protein may cause maternal reserves to be depleted, leading to compromised lactation, health, and reproduction (Van Saun et al., 1993). Bell (1995) reported that amino acids serve as the nitrogen source for fetal growth and are also the major energy source for the fetus during late gestation. Uterine uptake of amino acids accounts for 72% of the maternal supply during late gestation. This rigorous demand for amino acids by the fetus occurs at a time when amino acid intake is usually decreasing.

Data from the large field trial by Curtis et al. (1985) indicated that feeding protein above NRC recommendations during the final 3 weeks prepartum decreased the risk of retained placenta and uncomplicated (primary) ketosis. Heifers fed 13% CP diets for the final 60 days of their gestation produced more milk during the first lactation than those fed 9% CP diets (Hook et al., 1989). Feeding rumen-protected lysine and methionine to dairy cows consuming diets containing 12.6% CP and high undegradable intake protein **(UIP)** during the final 3 weeks prepartum reduced the incidence of metabolic disorders at parturition (4/16 vs 5/11; Rode et al., 1994). Blood meal was used to increase CP from 12.4 to 15.3% in diets fed to heifers for the final 3 weeks of gestation (Van Saun et al., 1993). Undegradable intake protein was increased from 27 to 39% of CP. Heifers fed the high UIP diet maintained a higher body condition score (3.24 vs 3.03, scale = 1 to 5), produced milk with a higher protein percentage (3.18 vs 2.96%), and had fewer services per pregnancy (1.2 vs 2.1). In a follow up study (Van Saun, 1993) multiparous cows were fed diets near NRC specifications (approximately 12% CP, UIP = 32% of CP) or with elevated CP and UIP (approximately 13.5% CP, UIP = 42% of CP). Cows fed the high UIP diet had a lower incidence of ketosis (0 vs 16.7%) and had fewer days open (72 vs 90). Increasing dietary CP of all corn silage or predominantly corn silage diets from 8 to 15% by addition of soybean meal throughout the entire dry period increased the incidence of postpartum disease from 7.14 (2/27) to 69.2% (18/26; Julien et al., 1977).

Cows receiving the 15% CP diet suffered a variety of disorders, perhaps most striking was the large number (n = 8) of downer cows, including 6 that died. All cows on the trial were overconditioned. If liver fat was elevated, the liver's ability to detoxify ammonia resulting from ruminal soybean protein degradation may have been compromised. Chew et al. (1984b) fed 80% or 100% of NRC recommendations for CP during the entire dry period. Urea was used to increase CP of the corn silage and alfalfa grass hay diets. Cows consuming the 100% treatment consumed more dry matter (+.1% of body weight) prepartum and produced more milk (10,040 vs 12,081 lb) during the first 200 days of lactation.

Several recent studies, that have been published only in abstract form, indicated that protein content of the prepartum diet does not enhance postpartum performance of dairy cattle (Crawley and Kilmer, 1995; Wu et al., 1995, Putnam et al., 1996). Increasing UIP from 30 to 39% of CP by including blood meal or heated soybean products in diets containing 15% CP caused a decrease in milk production during the first 8 weeks postpartum (Crawley and Kilmer, 1995). Increasing UIP from 34 to 41% of CP (CP values were not reported) by inclusion of fish meal in prepartum diets did not affect lactation performance (Wu et al., 1995). However, postpartum response to rumen protected methionine and lysine only occurred in cattle that had been fed the fish meal diets prepartum. Increasing dietary CP from 10.5 to 14.5% by increasing UIP via expeller soybeans in diets of late gestation dairy cows did not improve lactation performance (Putnam et al., 1996).

FEED ADDITIVES

Niacin is a feed additive that has been used to prevent ketosis, presumably by reducing fat mobilization from adipose. A review of the literature (Grummer, 1993) indicated that feeding 6 to 12 g niacin/day has inconsistent effects on plasma fatty acids and glucose concentration, but in general, a beneficial influence on plasma ketone concentration. The likelihood of obtaining an antiketogenic response was increased if niacin was fed prepartum and(or) during early lactation. Feeding niacin prepartum through mid lactation did not decrease severity of fatty liver at 1 day postpartum or at 4 to 5 weeks postpartum (Skaar et al., 1989; Minor et al., 1996).

Although not approved for feeding to lactating dairy cows, ionophore supplementation may act in a similar matter as grain feeding or propylene glycol for reducing stress associated with early lactation. Monensin is an ionophore that enhances propionate production in the rumen. Sauer et al. (1989) fed monensin at approximately 0, 100, or 200 mg/day from 1 week prepartum until 3 weeks postpartum. Feeding the 200 mg/day from 1 week prepartum until 3 weeks postpartum reduced feed intake 2.6 lb/day and ketones from 7.2 to 3.9 mg/100 ml. Incidence of ketosis was 1 out of 12 for cows receiving the high dose of monensin as compared to 6 out of 12 for cows not receiving monensin. Similar results were obtained by Thomas et al. (1993) who fed 0, 150, 300, or 450 mg of monensin/day starting at 2 to 4 weeks prepartum through 84 days postpartum. Feed intake of cows fed monensin was not affected prepartum but was depressed 1.5 to 5.5 lb/day during the 84 day postpartum period; the difference was significant for cows receiving the lowest dose of monensin. Plasma fatty acids and ketones were reduced at all levels of monensin inclusion. Prepartum blood fatty acids, ketones, and glucose were reduced when cows at 50 days prior to expected calving were dosed with a capsule designed to release 300 mg monensin/day into the rumen for 100 days (Stephenson et al., 1994).

Depression in feed intake is often associated with suboptimal rumen fermentation. Consequently, yeast or other direct fed microbials have been postulated to be beneficial in diets fed to transition cows. However, it should be noted that depression of feed intake at calving is probably not related to rumen function but rather to physiological changes that are concurrent with lactogenesis, late gestation, and parturition. Addition of supplemental yeast to diets fed to cows between two weeks prepartum and 2 weeks postpartum did not reduce the depression in prepartum DMI, increase the rate of DMI postpartum, or enhance lactation performance (Robinson, 1996). Cows at Rutgers University (Wohlt et al., 1995) were fed 0 or 10 g of yeast per day from 30 days prepartum through 4 weeks postpartum and then cows in each group were divided to receive 0, 10, or 20g of yeast per day through week 18 of lactation. Supplementation of yeast during the transition period had no effect on feed intake through 4 weeks of lactation. Research is lacking for other direct fed microbial supplements.

Buffers are commonly used in diets fed to postpartum cows to enhance fiber digestion, reduce the incidence of acidosis, and promote feed intake in early lactation. However, because of their high content of cations, inclusion in prepartum diets could increase the incidence of milk fever.

Chromium is essential for maintenance of normal lipid and carbohydrate metabolism. Chromium deficiency can lead to insensitivity to insulin and impaired glucose utilization. Insulin is antilipolytic and may serve to modify fatty acid mobilization during the periparturient period. Subiyatno et al. (1996) reported that insulin sensitivity was lower prepratum in cows that were not fed supplemental chromium. Besong et al. (1996) fed 0 or 8 ppm chromium picolinate to dairy cows from 30 days prepartum to 60 days postpartum. Cows fed chromium picolinate had lower plasma beta-hydroxy-butyrate and liver triglyceride at 30 days postpartum and higher DMI and milk yield. To my knowledge, supplemental chromium has not been approved for dairy cows.

CONCLUSIONS

Transition period energy intake is a critical factor in determining the susceptibility of the early lactation dairy cow to metabolic disorders. Maximizing feed intake during the transition period must be a priority. Factors regulating transition period feed intake have not been defined. It would seem prudent to offer cows feeds that they like to eat. Provision of high quality forages may encourage feed consumption. Avoid sudden changes in diet ingredients, particularly when changes coincide with inclusion of less palatable feedstuffs such as some supplemental fats and rendered protein sources.

Introducing concentrate during the final 2 to 3 weeks prior to calving would benefit the cow by adapting the rumen to high starch diets and providing additional energy during a period when feed intake normally declines. Recommended diet specifications for the transition cow consuming 22-23 lb DM/day are 14-15% CP, 33-38%UIP (% of CP), .68-.72 Mcal NE_l/lb, a minimum of 32% NDF, and a maximum of 40% NFC. Feeding transition cows forage and concentrate as a TMR should be encouraged to insure forage to grain ratio remains constant.

If a TMR cannot be fed, cows should be individually fed. If cows are not individually fed, but have access to multiple feed ingredients, each cow will formulate their own unique diet based on preference of feed ingredients and/or social standing in their group. If forage is fed separate from grain and cows select against forage during feed intake depression, grain intake relative to forage may become excessive. This may result in acidosis, off feed problems, and displaced abomasums due to inadequate rumen fill. Preparation of a unique TMR for transition cows may not be an option for some producers. Blending a high group TMR with dry cow forage may produce an acceptable diet, however, calcium and buffer supplementation of the high group ration may cause the transition diet to be high in cations. Use of anionic salts to control milk fever may be warranted. Diluting a high group TMR by feeding dry cow forage separately is undesirable because cows will have a choice in what they eat. All forage diets are not adequate because they will not meet the diet specifications cited above.

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