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TRANSITION COW NUTRITION UPDATE

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The transition period, from 3 weeks before to 3 weeks after parturition, is one of the most stressful in the life of a dairy cow. Prevention of metabolic diseases has a large impact on the profitability of a dairy herd and the productive life and well being of a cow. Current nutritional recommendations for cows in transition will be discussed in this article. It is important to keep in mind that factors other than nutrition, such as cow comfort, feed bunk space, weather, access to water, cow monitoring and other management factors, can have an even greater impact on the success of the transition program. Transition cows must be able to rest in comfortable stalls, eat, drink, and move around freely without competition, in an area where there is ideal ventilation and minimal heat stress. Bunk space per cow should be a minimum of 2.5 feet and ample waterer space should also be available. On a free-stall operation the number of stalls should not be less than the number of cows, ideally 10-15% more stalls than cows.

During the transition period, the cow is going from the pregnant, non-lactating stage to the non-pregnant, early lactation stage. During the last weeks of pregnancy, feed intake decreases by about 30%, but at the same time, nutrient requirements are increasing. It is important to feed a nutrient dense diet to compensate for this lower intake. The rumen needs to be adapted to the higher grain lactation diet, and this should be done gradually. It is strongly recommended that herds have a close-up dry cow group (last 3 weeks of pregnancy) and a fresh cow group (up to 2 to 3 weeks after calving). Reasons are not only nutritional, but management related. Heifers can benefit from a longer close-up period of about 4-5 weeks and it is recommended to have close-up and fresh heifer groups separate from mature cow groups.

Transition program goals

Goff (2001) suggested the following in order to avoid disease during the periparturient period:

1. Meet the energy demands of lactation. That includes adapting the rumen to the high grain lactation ration and enhancing dry matter (energy) intakes.
2. Maintain normal blood calcium concentration.
3. Build and stimulate the immune system. Improving the energy and calcium status of the cow will also benefit the immune system.

Nutritional and Physiological Status of the Transition Cow

The National Research Council (NRC, 2001) publication summarizes research on the physiological status of the periparturient dairy cow on Chapter 9. Cows experience changes in endocrine status during the transition period to prepare them for parturition and lactation. Some of these hormonal changes are important in determining how cows should be managed and fed during this stressful period.

Changes include a decrease in plasma insulin and an increase in growth hormone concentrations. Plasma thyroxine concentrations increase during late gestation, decrease about 50% at parturition, and then begin to increase. Estrogen increases during late pregnancy but decreases immediately after calving. Progesterone concentrations decline rapidly approximately 2 days before parturition. Glucocorticoid and prolactin concentrations increase on the day of calving and return to prepartum concentrations the day after calving.

In late gestation cows start to mobilize fat from adipose tissue and glycogen from the liver. This causes an increase of two-fold or more in plasma nonsterified fatty acids (NEFA) between 2 to 3 weeks before calving and 2-3 days after calving. Authors suggest that part of the increase in plasma NEFA is caused by the reduction in dry matter intake that occurs in late pregnancy, and part of it is caused by the hormonal changes.

Cows should be fed a close-up ration during the last 3 weeks of gestation in order to transition more smoothly from the pregnant to the early lactation stage. Corbett (2001) summarized the records of more than 13,000 cows on 5 dairies to estimate the milk yield potential depending on the number of days in the close-up pen. The difference between cows that were on the close-up ration from 1-7 days and those on the close-up ration from 15-21 days was about 2,000 lbs in projected 305-d milk.

Energy

The recommended energy density for the diet of close-up cows is 0.73 Mcal/lb DM (NRC, 2001). This amount would not be sufficient to meet requirements during the final days prior to calving, because of the decrease in dry matter intake. A more energy dense diet, however, may mean an increased intake of rapidly fermentable carbohydrates that can adversely affect rumen fermentation and feed intake. Shaver (2001) recommends 0.7-0.72 Mcal/lb DM in order to allow for enough forage intake. The NRC (2001) recommends a minimum of 33% neutral detergent fiber (NDF) and a maximum of 43% non-fiber carbohydrates (NFC) in the diet of pre-fresh transition cows. In early lactation, even though cows will be fed a lactation diet with higher energy density, intake is still low and cows have to utilize body fat as source of energy. It is very important to maximize feed intake during the transition period in order to reduce periparturient disorders.

Most cows utilize body fat as source of energy in early lactation. There is a limit on how much fatty acid the liver can metabolize. Uptake of NEFA by liver is proportional to NEFA concentration in blood. These fatty acids can either be esterified or oxidized in the mitochondria or peroxisomes. Triglycerides accumulation in the liver can occur when body fat is mobilized in excess causing fatty liver. Some of the fatty acids are converted to ketones, primarily acetoacetate and beta-hydroxybutyrate. Ketone formation is also favored when blood glucose and insulin concentrations are low. The appearance of ketones in the blood, milk, and urine is diagnostic of ketosis. Accumulation of fatty acids in the liver reduces liver function. A major function of the liver in dairy cows is to produce glucose.

To reduce the severity and duration of negative energy balance in early lactation, fatty liver and ketosis need to be prevented. Critical time for prevention is about one week before calving to one week after calving. Dry matter intake needs to be maximized.

Body condition score at calving should be 3.25 to 3.75 (on a scale of 1 = thin; 5 = obese). Overconditioned cows have lower feed intakes. Cows should be dried off at the ideal condition score and keep it during gestation. Trying to reduce weight in the last three weeks of pregnancy will mobilize body fat and almost certainly cause fatty liver.

In Canada, a monensin controlled release capsule is now approved for use in dairy cattle as an aid in the prevention of subclinical ketosis when administered 2 to 4 weeks prior to expected calving. Ionophores, such as monensin, lead to higher propionate production in the rumen. Propionate is antiketogenic. Duffield et al. (2002) reported a significant reduction in the incidence of both clinical ketosis and abomasal displacement postcalving in cows fed a monensin controlled release capsule. There was also a numerical but nonsignificant decrease in the incidence of retained placenta. The mechanism for the reduction in the incidence of these periparturient diseases is probably improved energy metabolism. Another study by Vallimont et al. (2001) demonstrated a reduction in NEFA concentrations for cows fed 300 g monensin/day during the late dry period. Ionophores are not approved for use in the United States.

Feeding of a palatable calcium propionate product would also contribute to a reduction in subclinical ketosis by providing a glucose precursor to the cow and improving energy status.

Choline has been shown to increase the synthesis of very low density lipoproteins for export to tissues such as the udder, reducing fatty liver. Choline functions include lipid metabolism, membrane integrity, neurotransmission and methyl donor. Choline is extensively degraded in the rumen, but recently rumen-stable choline has become available. Studies have shown an increase in blood glucose and a reduction in ketones, and an increase in milk yield for cows supplemented with rumen-stable choline (Putnan, D. E., 2001). Goff (2001) suggests that more research is yet needed before use of choline in the transition ration can be widely recommended.

Feeding of 3 to 12 g of niacin/day may reduce blood ketones (NRC, 2001). It might be a good investment only if fed to overconditioned cows and chances of fatty liver development are high (Goff, 2001).

Another important aspect of meeting the energy demands of lactation is to adapt the rumen to the higher grain lactation diet. During the close-up period it is recommended that diets contain 35-38% non-fibrous carbohydrates (Goff, 2001). Shaver (2001) suggests concentrate feeding of up to 0.75% of BW. He warns that both excessive and minimal feeding of concentrates in the close-up diet may increase the risk of displaced abomasum. The rate he recommends should allow for adequate ruminal adaptation to a higher starch diet and provide enough energy intake to limit fat mobilization. Goff (2001) points out that adding more starch to the diet generally means a reduction in neutral detergent fiber (NDF) concentration of the ration and that could increase the incidence of DA. Therefore, it is important to find the right balance between starch and NDF content and also to feed a forage that supplies enough effective fiber (particles longer than 1.5 inches long that help form the rumen mat).

Protein requirements of the transition cow

The National Research Council (NRC, 2001) recommends that the pre-fresh dry cow diet contain 12% crude protein. Heifers may benefit from a 14-15% CP diet. Some studies showed positive results from feeding higher concentrations of CP by adding ruminally undegradable protein, but results have been inconsistent and sometimes negative. Feeding excess protein is also detrimental to the environment.

Cows loose significant amounts of muscle mass during early lactation. Fresh cow rations should have 17 to 18% CP in the diet with 10.5% of the total CP being rumen degradable protein (RDP) and the remaining rumen undegradable protein (RUP). Sources of RUP should be palatable in order to achieve high dry matter intake during this period.

Prevention of hypocalcemia

As mentioned in the other article by Endres, hypocalcemia can contribute to various periparturient disorders, such as displaced abomasum, ketosis, retained placenta and mastitis. Goff (2001) suggests that hypocalcemia occurs due to a mild alkalosis, primarily due to the high content of potassium of the forages used in close-up cow diets. A second cause is inadequate magnesium absorption during the close-up and fresh periods leading to hypomagnesemia. Therefore, some of the strategies he suggests are:

1. Feeding low potassium forages during the close-up period. Wet chemistry methods should be used to measure potassium concentration in forages. Mineral values determined by near infrared analysis are not accurate.
2. Magnesium content should be 0.4% of forage dry matter. In the close-up ration a combination of magnesium sulfate and magnesium oxide could be used. A blood sample can be taken within 12 hours after calving to determine magnesium adequacy (it should contain at least 2 mg of Mg/100 ml).
3. Phosphorus requirements are met by feeding 40-50 g of P/cow/day. Less than 25 g/cow/day may lead to hypophosphatemia and the downer cow syndrome. More than 80 g/cow/day may induce milk fever (NRC, 2001).
4. Potassium concentration in the close-up ration should be less than 1.6%.

These four steps should nearly eliminate milk fever in Holstein herds. It is also recommended that Ca concentration be 1-1.2%, sulfur between 0.22 and 0.4%, and sodium at 0.1 to 0.15%. Goff suggests that for second lactation or greater cows, anions could be added to the close-up diet to help acidify the cow's blood and urine before calving. His preference is hydrochloric acid rather than the traditional anionic salts such as ammonium chloride, calcium chloride or magnesium sulfate, because they cause a reduction in feed intake. Anion supplements based on hydrochloric acid are now available (such as Bio-Chlor™ and Soy-Chlor™). Liquid hydrochloric acid is unsafe to use in dairy farms.

The dietary cation-anion difference (DCAD) that one should start with would be zero mEq/kg. After 48 hours on that ration, urine pH of the close-up cows should be measured. Urine samples should be collected cleanly and at mid-stream. Urine pH of Holstein cows in the week before calving should be 6.2 to 6.8 and for Jersey cows urine pH should be 5.8 to 6.3. If the urine pH is below 5.8 cows are over acidified. Urine pH should always be measured when using anionic salts in the diet.

Moore et al. (2000) conducted a study to evaluate the effect of varying the DCAD - meq [(Na + K) – (Cl + S)]/100 g of dry matter - in prepartum diets on calcium, energy and endocrine status before and after calving. Dietary Ca concentration was increased with decreasing DCAD (using Ca carbonate). Cows fed the –15 DCAD diet had higher plasma Ca concentration than cows fed the +15 or 0 DCAD diets, but all heifers had normal concentrations of plasma Ca at calving. Authors reported a reduction in dry matter intake and an increase in the concentration of liver triglycerides for heifers but not cows fed the –15 DCAD diet. These results suggest that heifers should not be fed anionic salts before calving. Goff (2001) also suggests that heifers do not need anionic salts, especially the unpalatable salts. Housing ideally would allow for a separate heifer group. It has not only nutritional but also behavioral advantages.

Pehrson and al. (1999) investigated the safety of acidogenic diets and concluded that there were no adverse health effects with DCAD diets of –140 meq/kg of dry matter or more (using the [(Na + K) – (Cl + S)] equation). They measured the pH, carbon dioxide, standard bicarbonate and base excess of whole blood and the urine pH. As mentioned earlier, urine pH should be monitored when feeding anionic salts to avoid an uncompensated acidosis.

Feeding extremely low calcium diets (below 15-20 g of Ca per day) is a method that could be utilized to prevent milk fever. It is hard to achieve in practice. Two novel ways of achieving low Ca 'intakes' were reported in recent articles. Thilsing-Hansen and Jorgensen (2001) investigated the use of synthetic zeolite (sodium aluminum silicate, Degussa-Huls AG, Germany) fed 4 weeks before calving to prevent subclinical hypocalcemia and milk fever in Jersey cows. The hypothesis was that it is possible to reduce dietary calcium availability by adding a substance that can bind calcium, therefore resulting in low enough Ca absorption to stimulate Ca homeostatic mechanisms. Dry cows received either 1 kg of zeolite/d or none during those 4 weeks. At calving and day 1 and 2 after calving all cows received 250 g of calcium carbonate as a drench, and blood samples were taken. Thirty seven percent of control cows contracted milk fever, and 75% had calcium concentration below 2 mmol/L in one or more samples taken, whereas none of the zeolite-treated cows developed milk fever or experienced subclinical hypocalcemia. Using a similar strategy, but with a different dietary supplement that contained grain products, molasses, minerals and compounds that form poorly digestible complexes with calcium (Calcigard, Massey University, NZ), Wilson (2001) demonstrated a reduction in the incidence of clinical milk fever and subclinical hypocalcemia in seven commercial dairy herds.

Immune system

Another goal of the transition cow program is to maintain the best immune system possible in the fresh cow. To achieve this goal, negative energy balance needs to be minimized, protein concentration needs to be adequate, short-term deficiencies of vitamins and trace minerals need to be prevented (Goff, 2001).

Nutritional recommendations (besides energy and calcium recommendations discussed earlier):

- 2,000 IU vitamin E/day for 2-3 weeks before calving and the first 2 weeks after calving;
- 0.3 mg/kg of selenium per day;
- Sufficient vitamin A; NRC (2001) recommends a minimum of 50 IU *supplemental* vitamin A/lb BW;
- Adequate amounts of trace minerals such as copper, manganese, and zinc;
- Limit iron to less than 800 mg/kg in the diet or less than 1-2 mg/kg in the water.

Some studies demonstrated that feeding between 150,000 and 250,000 IU/day of vitamin A or feeding 300 to 600 mg of β-carotene/day reduced the incidence of intramammary gland infections and mastitis (NRC, 2001).

To access the adequacy of trace mineral status, liver samples could be collected on a routine basis when cows die due to trauma, lightning, etc., once or twice a year and these samples analyzed for trace mineral content. Blood is not a reliable indicator of the status of copper, zinc and manganese supplementation (Goff, 2001).

Grummer (2001) summarized the mineral and vitamin A, D, and E recommendations of the 1989 and 2001 NRC (Table 1 and Table 2, respectively). Vitamin recommendations in the 2001 NRC are for supplemental vitamin A, D, and E, whereas in the 1989 NRC recommendations were for total diet. For the example shown in Tables 1 and 2, a mature cow was used with a predicted dry matter intake of 13.7 kg/day. Major ration ingredients included corn silage, grass silage, corn, soybean meal, and beet pulp. Mineral sources were calcium carbonate, magnesium oxide, dicalcium phosphate, magnesium sulfate, and calcium chloride.

Table 1. A comparison of mineral recommendations published in the 1989 and 2001 NRC

Mineral (% of DM)	1989 NRC	2001 NRC w/o anionic salts	2001 NRC w/anionic salts
Ca	.39	.45	.60-1.5
P	.24	.30-.40	.30-.40
Mg	.16	.35-.40	.35-.40
Cl	.20	.15	.80-1.2
K	.65	.52	.52
Na	.10	.10	.10
S	.16	.20	.30-.40

Table 2. A comparison of vitamin recommendations published in the 1989 and 2001 NRC

Vitamin IU/lb BW	1989 NRC	2001 NRC
Vitamin A	35	50
Vitamin D	13.6	13.6
Vitamin e	.14	.73

Extended immunosupression in fresh cows contributes to retained placenta, metritis and mastitis. Kimura et al. (2002) recently reported that neutrophil function was reduced in cows with retained placenta (RP). They looked at the ability of neutrophils to recognize fetal cotyledon tissue using a chemotaxis assay. Blood samples were taken from 142 periparturient cows in two herds. About 14% of the cows developed retained placenta. Neutrophils from these cows had significantly lower neutrophil function before calving and for 1 to 2 weeks after calving. They also demonstrated that RP cows had lower plasma interleukin-8 concentrations and this could be a factor affecting neutrophil function in cows with RP.

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