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UNIVERSITY OF MINNESOTA

College of Veterinary Medicine

VETERINARY CONTINUING EDUCATION

ST. PAUL, MINNESOTA
UNITED STATES OF MINNESOTA

FEEDING THE EARLY LACTATION COW

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Early lactation usually refers to the first 3 to 4 weeks after parturition. During this time the cow is going through major hormonal and metabolic changes to sustain lactogenesis and initiate reproduction. Managing cows through this stress period is extremely important as what happens in this first 30 days determines the reproductive and productive success of the lactation. A good nutritional management program during this period can minimize stress, reduce or eliminate metabolic and health problems while providing nutrients to maximize milk production. This paper will provide some discussion on the feeding and management factors that can help improve performance of cows in early lactation.

DRY MATTER INTAKE (DMI)

The hormonal and metabolic changes in cows following parturition cause appetites to be depressed. Peak DMI's do not occur until 50 days into lactation for 1st lactation cows and closer to 100 days for cows in their 3rd or greater lactation (9). However, peak milk production usually precedes peak DMI by about one month. This lack of coinciding between peak nutrient output and peak nutrient intake results in the loss of body adipose tissue to sustain milk production. The extent and duration of this negative energy balance depends on feeding practices and the cow's body condition.

Dairy cows require specific amounts of nutrients for maintenance, production, growth and reproduction. Yet, most rations are balanced on nutrient concentrations based on an estimated DMI. If the DMI and concentration of nutrients (% Mcal/lb) are correct, the required quantities of nutrient will be consumed. However, most dairy nutrition advisors either estimate DMI based on the production of a group or herd of cows and often forget the early lactation cow can be 50% or more lower in DMI than the herd or group average. Several predication equations such as the one below from Ohio State (3) have a days in milk (DIM) factor in the equation to account for the lower intakes of early lactation cows.

$$\text{DMI (kg/day)} = .011\ \text{BW} + .03636\ \text{BW}^{.75} + .33636\ \text{FCM} - 3.056 + .0364\ \text{DIM} - .000070772\ \text{DIM}^2$$

(All values in kg; FCM = 4% fat milk)

An even more comprehensive set of equations for early lactation cows has been developed by Kertz and co-workers (9):

Week of lactation	Equation for multiparous cows
1	DMI (lb) = 28.78 + .1468 FCM - .003912 BW
2	DMI (lb) = 26.49 + .1951 FCM - .001136 BW
3	DMI (lb) = 23.96 + .2061 FCM + .002867 BW
4	DMI (lb) = 22.42 + .2365 FCM + .004073 BW
5	DMI (lb) = 20.50 + .3031 FCM + .003478 BW

FCM = 4% fat corrected milk
BW = Body weight in lb
Subtract 2.86 lb/day off each equation for 1st lactation animals

Stimulating feed intake of early lactation cows is a challenge as many factors affect feed intake. Roseler et al. (14) found DMI was affected 40 to 60% by cow factors, 20 to 30% by feed, 10 to 15% by environment, and 10 to 15% by management factors. Cow factors are probably the easiest to quantify and account for while feed, environment and management are much more difficult. Some things to evaluate in each of these areas when troubleshooting low DMI problems in early lactation are:

Cow factors

Body weight - Larger cows eat more than smaller cows and body weight is a major factor in equations predicting DMI.

Body condition - Fat cows (score 3.75+) eat less than properly or under conditioned cows.

Milk production - A major factor driving DMI; the higher the milk production, the greater the DMI.

Feed and ration factors lowering DMI

Specific nutrients are discussed later.

Feed characteristics - Molds, musty odors, dustiness and abrasive textures.

Volatile fatty acids - Excessively fermented silages or high "moisture" feeds high in lactic, butyric or acetic acids or high ammonia concentrations.

Restricted water intake.

Environment

DMI decline begins to occur at temperatures above 65°F with severe depressions at temperatures above 85°F. Ohio State developed the following equation to adjust DMI for temperature:

$$\text{DMI adjustment factor} = [1 - ((°F - 68) \times .00329)]$$

High humidities exacerbate temperature related decreases in DMI.

Management

Feed amounts - Approximately 5% of the amount fed should be weighed back as refusal each day.

Feed accessibility - Cows should have feed in mangers at least 20 hours per day. Cows in groups should have a minimum of 18 inches of bunk space.

Feeding several times per day of individual feeds or with a total mixed ration (TMR) encourages DMI.

Ad libitum feeding a TMR or forages when individual ingredients are fed allows cows to reach peak DMI as soon after calving as possible.

FIBER

Dairy rations need to contain a minimum amount of fiber to keep cows healthy. Insufficient amounts of fiber in a ration lead to depressed feed intakes, acidosis in the rumen, sore feet and low milk fat tests. In addition to an adequate quantity of fiber in the ration, the fiber needs to have sufficient physical form to promote rumination activity, saliva flow, maintain a rumen mat and prevent displaced abomasums (DA). When both the quantity and physical form requirements for fiber are met, an optimum rumen environment (pH 6.2 to 6.8) is maintained for the digestion of fiber and production of volatile fatty acids (VFA) for milk and milk component production (16,20).

Early lactation rations should contain (DM basis) at least 19% acid detergent fiber (ADF) and 28% neutral detergent fiber (NDF). Other fiber measures commonly used to assess fiber adequacy in rations are: 1) forage-NDF (the amount of NDF in the ration DM from forages only), and 2) effective NDF (the effectiveness of a nonforage NDF source to replace NDF from forage). Rations should contain a minimum of 19% NDF (DM basis) from forage with increasing amounts required as particle size of the forage(s) decrease (Table 1). Effective fiber requirements are not as well defined, but are similar to the forage-NDF guidelines or are considered to be about 75% of the total NDF in a ration.

Table 1. 'Forage-NDF recommendations with different particle size forages.

Theoretical length of chop (TLC)	% of particles > 1.5 inches	Forage-NDF in ration DM
Baled hay	100	19
3/8 inch	15 to 20	21
3/8 inch + whole cottonseed		19
14 inch	8 to 14	22[a]
3/16 inch	0 to 7	23[a]

[a] Suggest 25 to 50% of forage DM be fed as hay.
Reference (16)

ENERGY

Two sources of energy are available to the early lactation cow for maintenance and milk production -- adipose tissue and feed. Cows in early lactation generally do not consume adequate amounts of energy (DM) to meet production requirements until after the first month of lactation. During this period, cows must rely on the mobilization of adipose tissue to supplement the deficiency in dietary energy to meet requirements. The loss in body weight to help meet energy requirements is referred to as negative energy balance. Eastridge (3) found the period of greatest negative energy balance to immediately follow parturition and the return to energy balance (dietary energy = requirements with no weight change) was highly related to days in milk (DIM):

$$\text{Net Energy-Lactation Balance, Mcal/day} = -10.32 + 20 \times \text{DIM}$$

Villa-Godoy et al. (19) observed the differences in energy balance among cows in early lactation was not determined by differences in milk production but by differences in DMI.

Body condition scores (BCS) are a practical, easy way of monitoring energy balance in cows. Ferguson and Otto (4) recommended cows calve with a BCS of 3.5 to 3.75 (1=thin, 5=fat) and should lose about a .5 score in early lactation before reaching energy balance. Cows above a BCS of 4 at parturition should be avoided as they are more susceptible to metabolic disorders such as fatty liver and ketosis (2). More recent research (5,13) suggests a BCS closer to 3 at parturition is more desirable. Thinner cows (BCS 2.5 to 3) at parturition were found to eat more and reach maximum DMI sooner than cows with a BCS greater than 3.75 at parturition. Milk production appears to be unaffected by BCS between 2.5 and 4 at parturition (5).

Energy density of the diet can be increased through the addition of highly digestible carbohydrates and/or fat. Sufficient quantities of highly digestible starch and sugars (nonfiber carbohydrates, NFC) are needed both ruminally and postruminally. In the rumen, NFC supports bacterial growth, the production of propionate (a glucose precursor), and aids in the prevention of ketosis. Postruminally, undigested starch can be degraded and serve as a direct source of glucose. Nocek (11) has suggested the starch content of diets should have a total tract digestibility greater than 85% with 50 to 75% of the total being rumen degradable. However, feeding excess amounts of NFC (>40% of the dietary DM) can lead to acidosis and off-feed problems. Generally, these problems are not apparent during the first month of lactation unless large excesses of NFC are being fed. The more common signs of acidosis like laminitis and low milk fat percentage often do not appear until 1 to 2 months following the incidence. The optimum quantity of NFC or highly digestible carbohydrate in early lactation diets has not been determined and is probably quite variable with diets, but early lactation diets should not exceed 40% NFC, DM basis (16).

An alternative to high levels of starch or NFC in diets is highly digestible fiber (pectins and hemicellulose). Feeds like beet pulp, soyhulls, wheat midds and whole cottonseed are highly digestible fiber sources which may be beneficial in early lactation diets. Garnsworthy and Jones (5) compared feeding high fiber-low starch (HFLS) and low fiber-high starch (LFHS) concentrates containing fat (7%) to cows during the first 16 weeks of lactation. The HFLS concentrate contained 34% NDF and 16% starch compared to 18% NDF and 34% starch in the LFHS concentrate. Feeding HFLS concentrate enhanced DMI in thin cows (BCS of 2.5 to 3 at parturition), but caused greater adipose tissue mobilization in fat cows (BCS >4 at parturition) compared to feeding LFHS concentrates. Milk production was unaffected by concentrate type; however, cows fed HFLS concentrate tended to be more persistent following peak milk production and had a higher milk fat percentage than cows fed LFHS concentrate.

Energy intake is determined by the quantity of DM consumed, energy density of the diet and the digestibility of the diet. In early lactation when DMI is low, the addition of fat to increase the energy density of diets has been done in hopes of increasing energy intake and thereby decreasing the length and severity of negative energy balance. In practice, supplementing fat in early lactation diets often causes a reduction in DMI (7) and may enhance the loss of body weight before peak production (1). Palmquist (13), in a recent analysis of fat utilization by lactating cows, has shown dietary fat provided in excess of the cow's ability to utilize fat decreases DMI. It was suggested to avoid excess fat feeding, the amount of fat consumed should not exceed the amount of fat excreted in the milk.

PROTEIN

Dairy cows require a quantity of protein each day and not a percentage of the diet. This protein must come from either rumen undegraded protein (UIP) in the feed, ruminal bacterial protein synthesis or a combination of the two. In general, bacterial protein supplies about two-thirds of the daily protein required. However, during the first month of lactation when DMI is low, the amount of protein synthesized in the rumen will be limited by the intake of ruminally fermentable carbohydrate. Thus, the intake of UIP or bypass protein is an important source of protein for cows in early lactation when energy from body weight loss is available for milk production. Both the total amount of crude protein (CP) and the proportion of UIP in the diet need to be increased in diets during the first month of lactation compared to later when peak DMI is reached.

METABOLIC DISORDERS

FATTY LIVER AND KETOSIS

Fatty liver and ketosis are two metabolic disorders that are closely related. Both commonly occur during early lactation when the cows are in negative energy balance (2,6,10). Fatty liver, which can occur as early as 1 to 2 days postpartum, precedes the development of ketosis, 3 to 6 weeks postpartum. The incidence rate for clinical ketosis is between 2 and 15% in dairy cows, but probably much higher for subclinical ketosis. The lack of a specific easy diagnostic test has made determining the incidence rate of fatty liver difficult (2,6).

During the first month of lactation, the energy derived from the loss in body weight may account for about 33% of the milk produced. The fatty acids released from mobilized body fat stores circulate as non-esterified fatty acids (NEFA) and are a major source of energy to the cow. The liver extracts a constant percentage, about one-third, of the circulating NEFA (2,8). Once taken up by the liver, NEFA can be: 1) completely oxidized in the liver to provide energy for the liver, 2) partially oxidized to produce ketones which are released back into the blood to serve as an energy source for other tissues, or 3) esterified to form triglycerides which accumulate in the liver (2,7). Ketosis can develop as a result of carbohydrate insufficiency in the liver leading to incomplete oxidation of NEFA and increased ketone production. Any factor decreasing the oxidation of NEFA in the liver increases esterification and subsequent accumulation of fat leading to fatty liver.

Prevention of fatty liver and ketosis during early lactation depends on both the nutritional management of the dry cow and early lactation cow. In dry cows, prevention of overconditioning and maintaining maximum DMI up to and immediately after parturition are the two most important factors. Overconditioned dry cows, BCS of 4 or greater, have a poorer DMI and are more susceptible to a greater negative energy balance immediately before and after parturition than dry cows with a BCS of 3.25 to 3.75 (14). Beginning two to three weeks prior to parturition, DMI starts declining followed by a rapid drop within 3 to 5 days of parturition. This occurs at a time when nutrient demands by the unborn calf are increasing and the cow is going through endocrinological changes preparing for lactation. The net energy-lactation density of diets should be increased from the .6 Mcal/lb in the early dry period to between .65 and .70 Mcal/lb the last 2 weeks before parturition. This increase should come through the addition of fermentable carbohydrates and higher quality forages rather than the addition of fat to the diet (6,15). Some recent research suggests increasing the CP of closeup diets to about 15% with 35 to 40% of the CP being UIP improved BCS and health of cows (18).

In addition to the nutritional considerations discussed above, niacin is commonly added to close-up and early lactation diets to prevent ketosis. In a recent review, Grummer (8) indicated feeding 6 to 12 grams of niacin starting 2 weeks prepartum and continuing through early lactation was beneficial in reducing plasma ketone bodies, but did not decrease plasma NEFA or increase blood glucose. Niacin fed prepartum through early lactation does not decrease the severity of fatty liver at 1 or 35 days postpartum. Propylene glycol is a glucose precursor which has been found to decrease fat deposition in the liver after calving (8). Drenching 10 ounces of propylene glycol for 10 days prior to parturition was as effective as 30 ounces. Slug dosing 1 lb of propylene glycol in 6 lb of highly palatable grain mix may be as effective as drenching and hasn't been found to reduce DMI (6). Feeding propylene glycol in a TMR may not be effective as the consumption of small amounts at any one time may not be adequate to stimulate the metabolic changes desired. Information on the effects of feeding other lipotropic agents such as methionine, choline and myoinositol is limited and is complicated by the degradation of these agents in the rumen.

DISPLACED ABOMASUM (DA)

The majority of DA's occur shortly after parturition with an incidence between .33% and 4.4%. The primary factors predisposing dairy cattle to DA's are: 1) advanced pregnancy or parturition, 2) abomasal hypomotility or atony, and 3) the production and accumulation of gas in the abomasum (17). Nutrition has implications in both 2 and 3.

Abomasal hypomotility can be caused from hypocalcemia, pain, inflammation or increased concentration of volatile fatty acids (VFA) in the abomasum. Because calcium is necessary for muscle contractions, lack of motility can occur during clinical or subclinical milk fever. Factors that contribute to increased concentrations of VFA in the abomasum include those that lead to increased concentrations of VFA in the rumen (increased production, reduced absorption or reduced rumen transit time). Feeding large amounts of grain per day (above 30 lb) or at any single feeding (above 7 lb), feeding high corn silage diets (75% or more of the forage DM), and any abrupt changes in the diet especially increases in grain, can cause increased VFA concentrations in the rumen. A deficiency of adequate functional fiber (long particle sizes) in the diet will reduce fiber mat formation in the rumen and rumination, and increase the passage of VFA to the abomasum. The VFA stimulate papillae development in the rumen and therefore, it is important to begin feeding a carbohydrate enriched close-up diet two weeks before parturition to stimulate their development in preparation for the increased grain fed postpartum.

The exact etiology of DA's remains unknown; however, the nutritional causes appear to be related to fiber content of diets and feeding management (12). The fiber requirement in early lactation diets was described previously. Adequate particle length to stimulate rumination is necessary. Approximately 20% or more of the feed particles in a diet need to be 1.5 inches long or longer. A good practical assessment of adequate particle length is to observe cows in a resting state. A minimum of 50% of the cows should be ruminating. A low milk fat test may be a conformation indicator of inadequate particle length, but should not be used as the sole indicator of inadequacy. Feeding 5 lb of long stemmed hay per cow per day should provide adequate particle length.

The management factors needed to help prevent DA's can be summarized as "smooth transitions". Diet adjustments should be made over a period of days. Grain feeding rates either prepartum or postpartum need to be increased gradually. Increases of 1 lb per cow per day should be considered maximum. Prevent other and concurrent peripartum diseases to avoid stress and off-feed.

SUGGESTIONS FOR FEEDING AND MANAGING THE EARLY LACTATION COW

1. Know DMI. Early lactation cows may be as much as 50% lower in DMI than the average of the herd or group they are in. Cows require quantities of nutrient and not percentages.

2. Encourage and maximize DMI by feeding:

   a. High quality forages;
   b. Several small meals per day;
   c. Highly digestible fiber sources in the concentrate;
   d. More than 20% of the forage particles 1.5 inches or longer;
   e. Adequate quantities of both rumen degradable and undegradable protein;
   f. Less than 2% of the DMI as added fat.

3. Do not overcondition cows. A BCS of 3.25 to 3.75 is desired.

4. Avoid feeding highly fermented wet feeds or moldy feeds to early lactation cows.

5. Use feed additives as needed in early lactation.

6. Two weeks prior to parturition, increase the energy and protein density of the dry cow diet.

   a. Increase energy density to .65 to .7 Mcal NE_L/lb.
   b. Increase the energy density in diets through the addition of highly digestible NFC feeds and not fat.
   c. Increase crude protein (CP) to 15% of the DMI with 35 to 40% of the CP as UIP.

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