Extension Circular 372

FEEDING AND MANAGING DRY COWS

PENNSTATE
1855

College of Agricultural Sciences • Cooperative Extension

CONTENTS

Proper management and nutrition of the dry cow are critical for obtaining maximum dry matter intake, good health, increased reproductive efficiency, and optimum milk production in the following lactation. These can be achieved by feeding balanced diets which will aid in avoiding metabolic disorders and maintaining improved disease resistance. Periodic checking on the body condition of cows assures adequate, but not excessive, body reserves of energy. Providing a sound health care program also is important to dry cow management. A successful dry cow program requires the dairy manager to know which disorders the dry cows are prone to, how to prevent them, and when necessary, how the manager and veterinarian may treat them.

THE DRY PERIOD

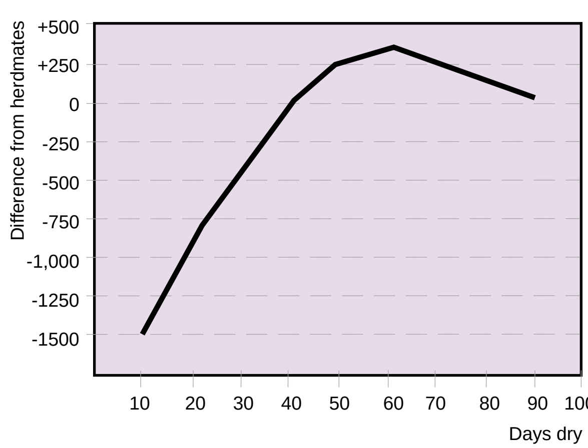
Restoring body energy and nutrient reserves is more efficient if accomplished during late lactation rather than during the dry period. The number of mammary secretory cells is a major factor affecting milk yield. These secretory cells normally proliferate during the later part of the dry period. The dry period is necessary, however, to allow the mammary gland to go through a normal period of involution and to ensure that the mammary cell numbers continue to proliferate normally during early lactation. A short or absent dry period greatly reduces the number of secretory cells in the mammary gland.

The amount of milk produced during a cow's lactation can be influenced by the length of her dry period. Many studies have shown that cows dry for 60 days give approximately 250 pounds more milk the following lactation, compared to cows dry fewer than 40 days, which produce around 500 pounds less milk the following lactation. Dry periods longer than 60 days show only a moderate decline in milk production compared to those cows dry 60 days. The reason for keeping dry periods close to 60 days is short dry periods do not allow enough time for mammary gland involution while long dry periods result in excess body condition. Figure 1 below illustrates that the optimum milk yield is greater for cows having a dry period close to 60 days than for those having greater or fewer days dry. While the dry period may be reduced slightly to 50 days with very persistent cows, it is not beneficial to reduce these dry days further.

The two considerations that must be taken into account when deciding to dry off a cow are the gains that can be achieved in production and profits from extending the current lactation, and any losses in production and profit in the following lactation that result from fewer days dry. As mentioned earlier, the closer the dry period can be kept to 60 days, the greater the opportunity to achieve optimum milk yields.

Another point to keep in mind is the production level that cows should be dried off at, which depending on a cow's production, may result in a dry period longer or shorter than 60 days. The production level for drying off a cow generally is defined as the daily milk yield at which the return from milk is equal to the labor cost for milking plus the cost of additional feed above maintenance and pregnancy levels. Both the current and subsequent lactation periods must be taken into consideration when making this decision.

Figure 1. Effect of the number of days dry on difference from herdmate milk in the subsequent lactation



FEEDING THE DRY COW

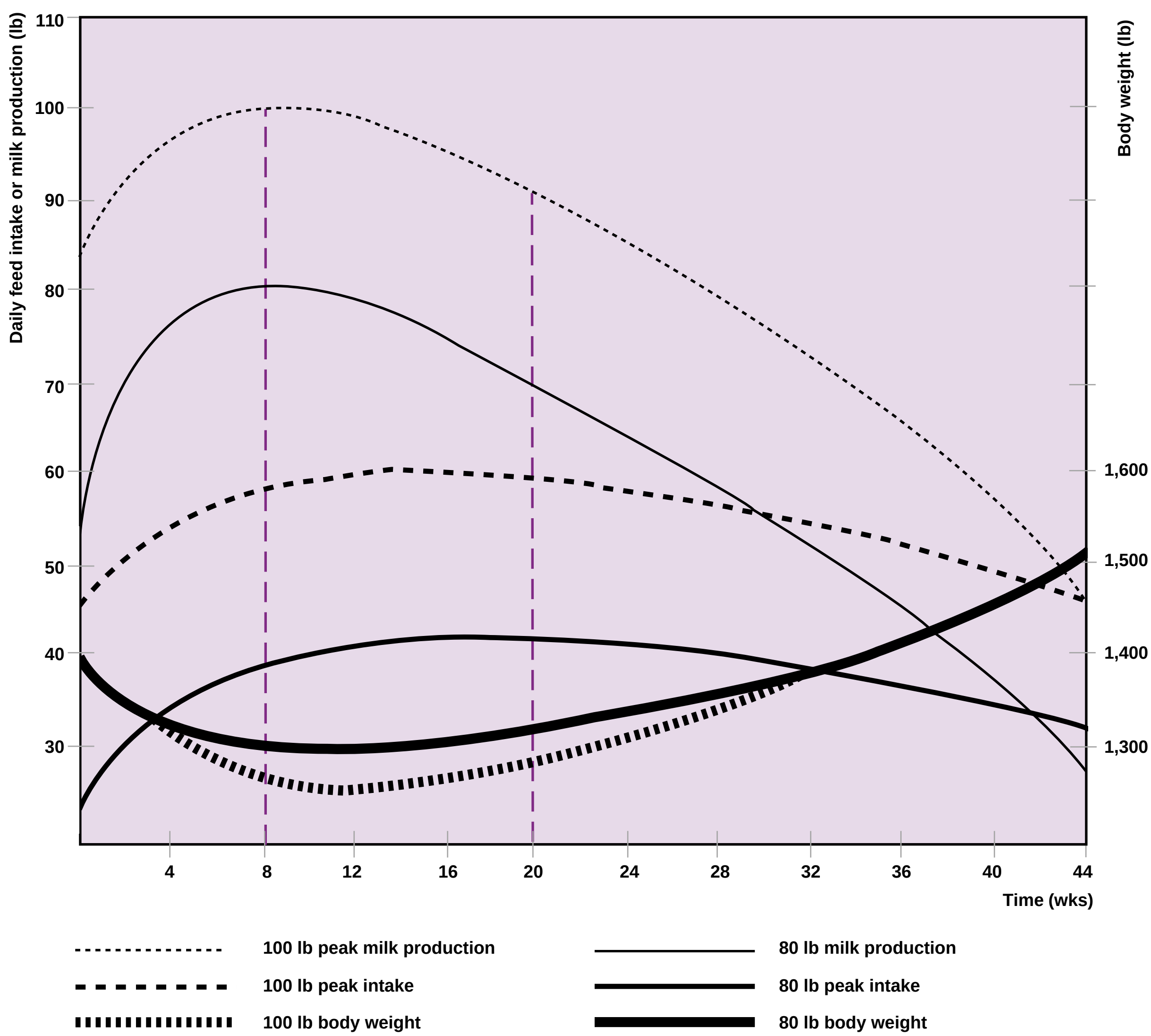
The purpose of controlling the nutritional status of the dry cow is to maintain body condition at 3+ to 4- (3.3–3.7) on a scale from 1 (thin) to 5 (fat). This control can be achieved by feeding a relatively low energy ration that provides adequate, but not excessive, levels of protein, minerals, and vitamins. Providing proper levels of these nutrients allows cows to calve with adequate, but not excessive, body fat, protein, and metabolite reserves. Once a cow freshens, she will need to rely on her energy reserves for the next 6 to 8 weeks to achieve maximum milk production (Figure 2 below). If the dairy cow does not have these reserves, she will develop a severe negative energy balance, which will limit her peak milk production and cause excessive body weight loss. At 8 to 12 weeks postpartum, beyond the point of peak milk yield, dry matter intake will normally peak, which allows the dairy cow to begin equilibration of energy input and output, thereby maintaining body energy reserves and replenishing her expended body reserves. Cows are able to show signs of heat and conceive more efficiently when maintaining or gaining body weight.

Forages

Producers must use greater care when choosing a forage to feed to dry cows then they would if they were feeding milk cows. Certain forages consumed in large quantities may increase a dry cow's risk of metabolic problems. Dry cows should be kept separated from the milking herd so that the proper forages and concentrates can be allotted to them.

Corn silage preferably should not provide more than 50 percent of forage dry matter intake. Dry cows fed corn silage greater than 50 percent forage dry matter may become overconditioned and have more metabolic and reproductive problems near calving due to the higher energy content of the forages.

Figure 2. Changes in milk production, feed intake, and body weight during a lactation



Fat cows may be more predisposed to calving problems, including a displaced abomasum, dystocia, and ketosis.

Legume or mixed, mainly legume forages should be limited to not more than 30 to 50 percent of forage dry matter intake. Heavy feeding of these forages can result in excessive protein, calcium, and potassium intakes, which make the cow more susceptible to udder edema, milk fever, ketosis, downer cow syndrome, and possibly certain types of reproductive problems caused by protein and mineral imbalances.

Grass or mixed, mainly grass forages are ideal for dry cows. If large amounts of legume or mixed, mainly legume forages must be fed to dry cows, use more mature, first-cutting forages, which will help limit their dry matter intake. A combination of corn silage and grass/legume forages often can provide a balanced overall forage ration for dry cows. However, based on current research pertaining to anion-cation balance, forages that were considered ideal for dry cows in the past, such as grass forages, can contain relatively high levels of potassium. This is a major concern because potassium plays a role in cation balance of the dry cow ration, which is a factor for milk fever. High forage potassium levels can result from increased potassium levels in the soil due to manure management strategies and excessive potassium fertilization.

Some considerations should be noted when feeding dry cows. If only silage or haylage is used during lactation, and if it is too finely chopped, producers should provide dry cows with approximately 10 to 25 percent longer forage particles, such as pasture, hay, balage, or coarsely chopped haycrop silage to offset problems such as rumen acidosis. Pasturing may also help reduce the amount of feet and leg disorders that can occur in cows kept on concrete flooring continuously during their lactation.

Within the limits recommended for intake of corn silage and legume forages, it is helpful to feed dry cows a “close-up” ration similar to those rations fed to the milking cows. If silages are being used for lactating cows, it may reduce stress to have silage in the ration for dry cows prior to calving. When nonprotein nitrogen (NPN) additives, such as urea, are fed to lactating cows, the additives should be incorporated in the ration at least three to four weeks prior to freshening to allow the rumen microorganisms to adapt to the NPN.

For health and metabolic reasons, it is important that dry cows eat sufficient forages. Daily forage dry matter intake should equal 1.6 to 1.8 pounds per one-hundred pounds of body weight. A complete ration of forages and grains should contain 70 to 88 percent forage dry matter. The higher percentage of forage (80 to 88%) is appropriate for early dry cows and the lower percentage (70 to 79%) is best suited to the close-up dry cow.

Grain

The grain requirement for a dry cow is often minimal. On medium quality forage diets, usually only a minimal amount of grain is needed to meet the energy needs of dry cows. It is recommended that an intake of at least 3 pounds of grain per head be fed daily throughout the dry period. Feeding this amount will maintain a rumen microbial population that is adapted to a ration containing grain and will increase mineral absorption. The grain also should reduce the occurrence of digestive and off-feed problems at calving. As stated earlier, a dry cow feeding program should be nutritionally balanced. To ensure that dry cows will freshen in peak condition, forages *must* be tested so an accurate grain mix can be developed to supply the proper amounts of protein, minerals, and vitamins. The levels of supplemental minerals and vitamins needed to completely balance a dry cow ration generally are higher than those used in grain mixtures for milk cows because of the need to concentrate these nutrients in a smaller quantity of supplement.

Concentrates for dry cows fed high protein forages may contain less protein than those used for milking cows fed similar forages. It is usually beneficial to have grain mixtures higher in fiber to offset low intakes from a ration high in corn silage or high quality haylage. If possible, the total ration dry matter for dry cows should not contain more than 13 percent crude protein or .66 percent calcium. Some recommended rations for early dry cows are presented in Table 1 on page 6. Grain intakes of 3 to 5 pounds daily often are adequate for cows and springing heifers for most of the dry period.

Grain intakes at higher levels may result in more cows developing udder edema or having displaced abomasum, higher incidence of metabolic disorders, and off-feed problems. Therefore, *cows should not have high levels of grain before they calve*. Concentrate intake should be increased on calving day to a level of 8 to 14 pounds per head daily or about 1 percent of body weight daily. First calf heifers should receive the lower level and high producing cows may be fed the higher amount.

In conventional feeding systems, grain should be gradually increased by .5 to 1 pound daily until grain intake is about 2 pounds greater than what is needed for milk production—if it is checked daily or at least weekly. In herds feeding a total mixed ration, animals should be placed on a ration with a minimum of 40 percent concentrate and a maximum of 55 percent concentrate as a percentage of the total ration dry matter. Pounds of grain dry matter intake should not

Table 1. Example rations for the early dry cow

	Ration 1	Ration 2	Ration 3	Ration 4
	Percent of ration dry matter[a]			
Mixed, mainly grass hay[b]	52.8	18.5	18.5	37.0
Grass silage[b]	–	–	41.7	–
Mixed, mainly grass silage[b]	–	41.7	–	–
Mixed, mainly legume silage[b]	–	–	–	30.6
Corn silage[b]	35.2	27.8	27.8	20.4
Shelled corn	7.1	6.9	6.4	9.6
48% soybean meal	4.1	2.7	3.2	1.7
Distillers grain	–	1.7	1.7	–
Mineral-vitamin mixture	.9	.7	.8	.7
	Nutrient density, dry matter basis[c]			
Crude protein, %	12.6	13.3	12.9	13.6
Undegradable intake protein, % of crude protein	34.4	32.2	33.2	31.4
Soluble protein, % of crude protein	31.7	39.5	37.5	39.0
Acid detergent fiber, %	32.3	34.2	33.8	34.0
Neutral detergent fiber, %	50.9	52.1	52.9	50.4
Net energy of lactation, Mcal/lb	.64	.62	.63	.63
Nonstructural carbohydrate, %	26.7	23.6	24.3	25.0
Calcium, %	.55	.57	.55	.67
Phosphorus, %	.32	.31	.32	.32

[a] Ration ingredients are listed as a percent of dry matter. Example: In Ration 1, if a cow is consuming 26 pounds of total dry matter intake, 52.8% or 13.7 pounds of dry matter is from mixed, mainly grass hay.

[b] Forage analyses used in example rations for the early and close-up dry cow.

	Mixed, mainly grass hay	Grass silage	Mixed, mainly grass silage	Mixed, mainly legume silage	Corn silage
	dry matter basis				
Crude protein, %	12.5	12.6	14.0	17.5	8.8
Soluble protein, % of crude protein	25.0	46.0	48.0	51.5	50.0
Acid detergent fiber, %	41.0	42.0	43.0	41.0	28.9
Neutral detergent fiber, %	62.0	63.0	61.0	54.0	49.0
Net energy of lactation, Mcal/lb	.57	.56	.54	.57	.69
Nonstructural carbohydrate, %	14.9	14.4	12.0	15.6	34.6
Calcium, %	.70	.65	.81	1.10	.25
Phosphorus, %	.25	.27	.27	.30	.23

[c] The mineral and vitamin levels not listed in this table for the four rations were met according to the requirements stated in Table 3 on page 10.

exceed 2.2 percent of body weight to avoid off-feed problems and metabolic disorders. After peak milk production, grain feeding can be adjusted to the actual milk production level.

MANAGEMENT

The dry period has three separate phases. At each stage dry cows should be given special attention. These special dry cow considerations may dictate, in certain management situations, a further subdivision of the dry cow group as shown in Figure 3 below.

Dry-off day and the first week after the last milking

Removal or reduction of feed is often a useful tool to reduce the quantity of milk produced. Ideally, grain should be eliminated and a medium to low quality forage fed about a week before the dry-off day, which should sharply reduce the amount of milk secreted. Farms where stanchions or computer feeders are used can employ this practice, but it is not always possible in group housing situations. Cows should not be milked partially for several days as a means to dry off, because partial milking increases the incidence of mastitis flare-ups.

The National Mastitis Council suggests dry treating all quarters from all cows with an approved long lasting dry-treatment product. In addition, a teat dip should be used and animals observed daily for a week or until the mammary gland has begun to involute and is not secreting milk. The mammary gland is very susceptible to new infections at this point in time. A clean and well-bedded environment is essential to help reduce the chance of udder infection. Your herd veterinarian may suggest a specific program of dry cow therapy that best matches your management program.

Dry period up to three weeks before freshening

The main portion of the dry period follows the initial week-long period discussed above. This is a time when the body condition of cows should dictate the energy level of the diet being fed. While it has been well documented that restoring or decreasing the body condition of a dairy cow is most efficiently done during late lactation, condition can still be influenced during the dry period. Cows having a body condition score of 3+ to 4- (3.3–3.7) at drying off that are fed a moderate energy concentrate throughout the dry period will allow for a modest positive energy balance. It is recommended that the body condition not fluctuate more than .25 to .50 body condition score.

Some vaccinations, parasite controls, vitamin-mineral injections, and hoof trimming procedures also should be performed during this main portion of the dry period. Routinely checking the cows will alert you to any early calving cows or others that may need special attention.

Transition diet during the last three weeks of the dry period

During the last three weeks of the dry period, many changes are needed in the nutrition and management of the dry cow. It is important that the rumen microorganisms and rumen papillae in these cows be adapted to the feedstuffs being fed to milking cows.

Much of the early dry cow's diet has consisted mainly of forage with minimal levels of grain needed. Increased grain feeding during the transition period is required to meet the dry cow's energy needs due to the rapidly growing fetus. This additional feed will help reduce any late gestation weight loss that the cow may experience in response to increased fetal growth.

Figure 3. Dry-cow grouping strategies

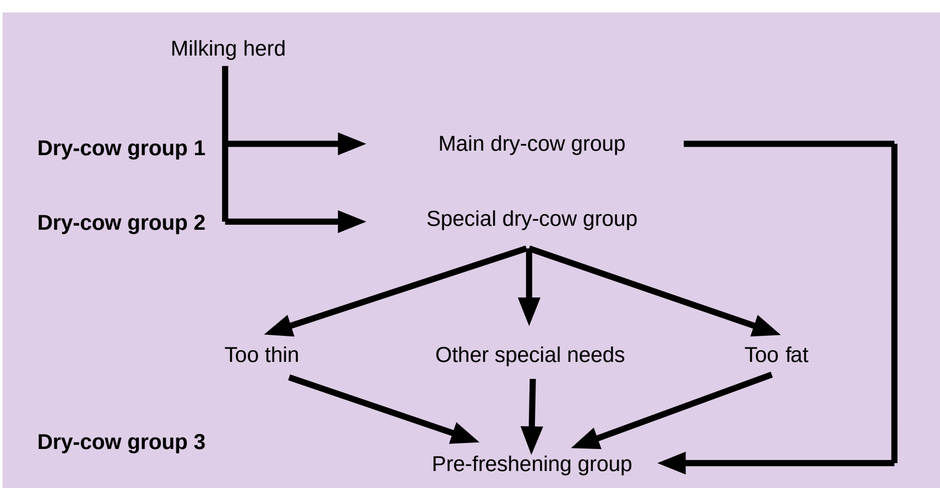


Table 2. Example rations for the close-up dry cow

	Ration 1[a]	Ration 2	Ration 3	Ration 4
	Percent of ration dry matter[b]			
Mixed, mainly grass hay[c]	12.7	42.4	21.2	21.2
Grass silage[c]	–	–	–	25.9
Mixed, mainly grass silage[c]	34.3	–	–	–
Mixed, mainly legume silage[c]	–	–	25.9	–
Corn silage[c]	25.9	13.1	25.9	25.9
One group milk cow TMR[d]	–	28.0	–	–
Shelled corn	16.2	13.9	20.9	17.5
48% soybean meal	3.8	2.1	3.4	6.3
Distillers grain	2.1	–	2.1	2.1
Anionic salts[e]	1.5	–	–	–
Mineral-vitamin mixture	3.5	.5	.8	1.2
	Nutrient density, dry matter basis[f]			
Crude protein, %	14.0	14.0	14.0	14.0
Undegradable intake protein, % of crude protein	31.7	36.7	34.3	35.7
Soluble protein, % of crude protein	33.3	29.5	35.4	31.5
Acid detergent fiber, %	28.5	27.3	27.9	28.3
Neutral detergent fiber, %	44.2	43.1	42.8	45.1
Net energy of lactation, Mcal/lb	.64	.69	.68	.68
Nonstructural carbohydrate, %	28.8	32.7	33.1	31.2
Calcium, %	1.57	.60	.54	.57
Phosphorus, %	.38	.33	.32	.32
Magnesium, %	.30	.24	.24	.25
Potassium, %	1.51	1.45	1.57	1.49
Sulfur, %	.42	.21	.21	.21
Sodium, %	.13	.14	.13	.14
Chlorine, %	.87	.41	.51	.47

[a] The dietary cation-anion balance for this ration is -64 mEq/kg or -6.4 mEq/100g. When the potassium level exceeds 1.2% or 1.3% in the total ration dry matter, it is difficult to achieve a DCAB within the ideal range. The level of chlorine and sodium formulated in all the rations includes chlorine and sodium from all feed sources.

[b] Ration ingredients are listed as a percent of dry matter. Example: In Ration 1, if a cow is consuming 23 pounds of total dry matter intake, 12.7% or 2.9 pounds of dry matter is from mixed, mainly grass hay.

[c] See Table 1 for the forage analyses.

[d] The one group TMR for milk cows contains a 50:50 forage to concentrate ratio. The nutrient content of the ration on a dry matter basis is crude protein 17.5%; undegradable crude protein 37% of CP; soluble protein 33% of CP; acid detergent fiber 20%; neutral detergent fiber 32%; net energy of lactation .76 Mcal/lb; nonstructural carbohydrate 39%; calcium .90%; phosphorus .48%; and magnesium .30%. In this example, the milk cow TMR does not contain a buffer.

[e] The anionic salt mixture contains ammonium chloride, calcium sulfate, and magnesium sulfate.

[f] The mineral and vitamin levels not listed in this table for the four rations were met according to the requirements stated in Table 3 on page 10.

The transition period offers the opportunity to acclimate the cow's rumen to the higher levels of grain feeding after freshening by introducing intermediate levels of concentrates. For the rumen microbes, this transition period entails a shifting of microbial populations away from the fiber fermenters in favor of the starch fermenters. For the rumen papillae, adaptation entails a gradual elongation of the papillae as volatile fatty acid production, especially propionic acid, increases. Well-adapted papillae are necessary to prevent ruminal acidosis in early lactation. A total change to a milking cow diet could adversely affect the mineral and protein status of the dry cow, especially diets high in legume forages. A partial change can allow for a better adaptation process in the rumen.

Increasing grain to 0.5 percent of body weight will allow the rumen to adapt to higher grain diets and provide more efficient absorption of minerals from the diet. Grain can be increased to 0.8 percent of precalving body weight for cows that are known to be good forage consumers. Goals during this period are to increase grain moderately while maintaining proper protein and mineral levels for dry cows, and to include forages similar to those of the milking cows when possible. It is more difficult to feed dry cows a ration similar to the milk cows if protein and minerals are out of balance during the last three weeks. Table 2 on page 8 presents some rations that can be fed during the close-up dry period.

Research has also shown that the addition of 6 grams of niacin (vitamin B6) to the diet will help decrease the risk of ketosis, and will allow animals to make the transition from dry cow to milking cow with less stress. It is particularly important to provide adequate selenium as well as vitamin E intake for greater disease resistance during this time.

Any final management practices such as mineral-vitamin injections should be done at this time. The animals should be moved to the calving area, where they will have a cleaner environment and can be more closely monitored.

NUTRIENT REQUIREMENTS

The dry cow has a multi-faceted nutrient requirement that is shown in Table 3 on page 10. Nutrients are needed to maintain and repair the cow's tissues, as well as to ensure proper growth if she is completing a first or second lactation. When a cow is pregnant, nutrients are needed for the maintenance and growth of the uterus, the fetus, the fetal fluids, the placenta, and the uterine tissues, as well as udder development.

While the dry cow's maintenance and growth requirements are relatively constant, the requirements of the uterus and fetus increase dramatically over a short period of time. Total nutrient needs and the proportion of the total needed to support pregnancy are much higher during the last months of gestation. It is often found that the cow's requirements are not met completely during this last phase of the dry period. When the requirements are not met, nutrients that the animal would normally use for its own general maintenance are diverted to maintain the growing fetus and uterus. The cow may lose weight in late gestation, which can create excess fat infiltration in the liver prior to calving.

Because the nutrient needs of the animal are metabolically prioritized, some dietary requirements such as energy, amino acids, vitamins, or minerals may be deficient. When such a deficiency occurs, the fetus will develop normally, while the cow's own nutrient reserves are depleted. The severity of tissue reserve withdrawal in addition to the postpartum feeding program will determine if production and health will be affected. In addition, if the cow needs nutrients to grow, the supply of nutrients needed for the developing fetus may be diminished. Therefore, proper nutrition is essential for the health, production, and growth of the dry cow.

METABOLIC DISORDERS

Management of the dry cow affects milk production, subsequent lactations, and most importantly, the incidence of metabolic disorders at or near calving time. These disorders include milk fever, ketosis, fatty liver syndrome, retained placenta, displaced abomasum, and udder edema. The major metabolic disorders that affect dry cows are usually the result of nutrition and feed management problems. The following disorders are most prevalent in cows around calving time.

Milk fever

Milk fever is a disorder that usually occurs around calving time and is most prevalent in older, high-producing cows. It is caused by a decreased mass in the calcium pool prior to parturition and failure of calcium absorption to increase fast enough after the onset of lactation.

An animal afflicted with this condition exhibits a decreased appetite and an inactive digestive tract. She will show signs of being dull, listless, and uncoordinated when walking, her ears will be cold, and her nose dry. A decrease in body temperature is common, usually ranging from 96^{o}F to 100^{o}F. The following blood analysis compares the blood calcium

Table 3. Guide to ration composition for dry cows

	Early	Close-up[a] regular[b]	Close-up[a] anionic[c]
Crude protein, %DM	12–13	13–14	13–14
Soluble protein, %CP	30–38	30–38	30–38
NEL, Mcal/lb DM	0.60–0.64	0.62–0.66	0.64–0.68
Forage NDF, %DM	27, min	27, min	27, min
Total NDF, %DM	36, min	36, min	36, min
NSC, %DM	26, min	26, min	26, min
Calcium, %DM	0.45–0.55	0.45–0.55	1.40–1.60[d]
Phosphorus, %DM	0.30–0.35	0.30–.035	0.35–0.40
Magnesium, %DM	0.20–0.22	0.22–0.24	0.28–0.32[d]
Potassium, %DM	0.80–1.00	0.80–1.00	0.80–1.00
Sulfur, %DM	0.19–0.21	0.19–0.21	0.35–0.40[e]
Salt, %DM, or:	0.25–0.30	0.25–0.30	0.25–0.30
Sodium, %DM	0.10–0.12	0.10–0.12	0.10–0.12
Chlorine, %DM	0.20–0.24	0.20–0.24	0.70–0.80
Manganese, ppm	44	44	44
Copper, ppm[f]	11–25	11–25	11–25
Zinc, ppm	70–80	70–80	70–80
Iron, ppm	100	100	100
Added selenium, ppm	.30	.30	.30
Added cobalt, ppm	.20	.20	.20
Added iodine, ppm	.50	.50	.50
Total vitamin A, IU/lb DM	3,500	3,500	3,500
Added vitamin D, IU/lb DM			
Minimum	750	750	750
Maximum	1,100	1,100	1,100
Total vitamin E, IU/lb DM	35–45	35–45	35–45
Approximate concentrate, %DM	12–15	24–30	24–30
Approximate DMI, %BW	2.00	1.80	1.80

[a] The last three to four weeks prior to expected calving.

[b] Regular or cationic (alkaline) diet.

[c] Anionic or acidic diet with a cation-anion balance of –10 to –15 milliequivalents per 100 grams of dry matter (mEq/100g DM). These values may be calculated from the percent element in diet dry matter using the following equation:

$$\text{mEq/100g DM} = \frac{\%Na}{0.0230} + \frac{\%K}{0.0390} - \frac{\%Cl}{0.0355} + \frac{\%S}{0.0160}$$

Example: Calculate the DCAB of a ration with Na at 0.15%, K at 1.10%, Cl at 0.80%, and S at 0.40% (all values are on a dry matter basis).

mEq/100g DM = [(.15 ÷ 0.0230) + (1.10 ÷ 0.0390)] - [(.80 ÷ 0.0355) + (.40 ÷ 0.0160)]

mEq/100g DM = (6.5 + 28.2) - (22.5 + 25)

mEq/100g DM = 34.7 - 47.5

mEq/100g DM = –12.8

[d] Based on continuing research and field experience, calcium levels of 1.5% to 2.0% and magnesium levels of .40% to .45% may be warranted.

[e] A sulfur level of 0.45% may be tolerated for short periods of time (three to four weeks).

[f] Use the higher or intermediate levels when an induced copper problem exists due to high iron, manganese, molybdenum, or sulfur intakes.

level drops in a normal cow to one with severe milk fever. Blood phosphorus levels also drop and blood magnesium levels increase at the same time with this metabolic disorder. In cases of milk fever complicated by lack of magnesium, the blood magnesium level may remain normal or even be depressed. Sometimes, the milk fever or downer cow problem is complicated by a toxemia from infection in the udder, reproductive tract, or digestive system. This type of toxemia or infection may be reflected in blood as a raised packed cell volume, depressed white blood cell count, and/or elevated blood urea nitrogen content. Treatment for milk fever may not be successful if the toxemia is not overcome.

Normal lactating cow:	8.4–10.2 mg/dl.
Normal at calving:	6.8–8.6 mg/dl.
Milk fever (slight):	4.9–7.5 mg/dl.
Milk fever (moderate):	4.2–6.8 mg/dl.
Milk fever (severe):	3.5–5.7 mg/dl.

Calcium gluconate is usually the recommended method of treatment for milk fever. It should be administered slowly so as to prevent heart failure. Response usually is rapid and relapses are fairly common. Other treatments would be the oral administration of 100 grams (3.5 oz.) of ammonium chloride per head daily for two to four days and high calcium boluses (75 grams total calcium carbonate) within eight hours after freshening. Downer cows that do not respond to the treatment can be given 2 pounds of Epsom salts in 1 gallon of water to provide highly available magnesium and eliminate toxins from the intestinal tract.

The most likely causes of milk fever are imbalances of calcium, phosphorus, and magnesium, and potassium overload as it relates to anion-cation balance. Milk fever thought to be caused by feeding high levels of calcium from forages (such as legumes), may have actually been caused by high potassium levels in forages. Many milk fever cases can be eliminated or lessened in severity if dry cow forages are analyzed and the appropriate grain mix formulated, especially for minerals and vitamins.

Milk fever can be prevented by feeding a balanced ration that contains the proper calcium, phosphorus, and potassium levels. The average intake of calcium and phosphorus for a 1,300 pound dry cow should be 50 to 70 grams of calcium per day and 33 to 36 grams of phosphorus per day. Magnesium and selenium requirements also need to be provided along with adequate amounts of vitamins A, D, and E.

Another method of preventing and controlling milk fever is balancing the dry cow ration for anions (negatively charged molecules) and cations (positively charged molecules). Sodium and potassium are the cations and chloride and sulfur are the anions. The dietary cation-anion balance (DCAB) equation most often used for determining milliequivalents per 100 grams of dry matter is: (mEq/100g) = mEq (Na + K) – mEq (Cl + S). Based on research data, the range that achieves the lowest incidence of milk fever is a DCAB of –10 to –15 mEq/100g (or –100 to –150 mEq/kg).

Balancing rations for anions affects the cow's acid-base status, raising the amount of calcium available in the blood. Urine acidity is affected by these changes in the cow's acid-base status. Checking urine pH can help producers and veterinarians monitor the effectiveness of a ration containing anionic salts (Figure 4 below).

Figure 4. Urine pH levels that predict calcium status of cows at calving

Ration DCAD	Urine pH of pre-fresh cow	Acid-base status of pre-fresh cow	Calcium status of fresh cow
positive (>0 mEq/100g)	8.0 to 7.0	alkalosis	low blood calcium
negative (<0 mEq/100g)	6.5 to 5.5	mild metabolic acidosis	normal blood calcium
	below 5.5	kidney overload, crisis	

SOURCE: Beede, D. Tri-State Nutrition Conference, 1995.

Achieving the desired DCAB requires feeding a combination of different anionic salts. The most common salts used are ammonium sulfate, calcium sulfate, magnesium sulfate, ammonium chloride, calcium chloride, and magnesium chloride. Special attention must be paid to the degree of hydration of specific salts in formulating rations as well as their costs and availability (Table 4 below).

There are several limitations of DCAB that need to be addressed before they are incorporated into a dry cow program. Some of the anionic salts are very unpalatable, which can depress intakes significantly in conventional feeding programs. In particular, ammonium salts may result in more intake and palatability problems, especially when a silage based ration in not being fed. Reduced intakes as a result of feeding anionic salts can lead to the development of other metabolic disorders. Much of the success with anionic salts has occurred when they are used in total mixed rations. These salts have proven more effective when calcium intake is high than when calcium intake is low (Table 3 on page 10). Animals should receive the specific diet at least three to four weeks prior to expected calving.

Forages presumed to be good dry cow forages may actually contain higher potassium levels that interfere with cation-anion balancing. When the potassium level in the total ration dry matter exceeds 150 grams, it is difficult to add the proper amounts of anionic salts to meet the ideal range for DCAB. Re-evaluating the ration and the forages may be necessary if more than .65 to .75 pounds of anionic salts are needed.

If DCAB is to be implemented in a herd, sodium, potassium, chloride, and sulfur must be included in the forage analyses. Buffers must not be used in anionic salt rations because they will counter the affect of the DCAB. Table 3 on page 10 provides recommendations for ration nutrient contents of both regular and anionic diets for close-up dry cows.

Ketosis

Ketosis is a metabolic condition that occurs when intake of nutrients, especially energy, is inadequate to meet production demands. It usually occurs a few days to six weeks after calving and in high-producing cows, with the highest incidence occurring at about three weeks after calving. Most high-producing cows go through a subclinical type of ketosis in early lactation when they are unable to consume enough energy to meet the energy output in milk. Cows with this disorder are known to have primary ketosis. The animals' temperature is not normally elevated in this case. An elevated temperature accompanying primary ketosis suggests additional complications.

Ketosis can also result from other problems that have occurred. Such problems as retained placenta, displaced abomasum, hardware, or any disease which reduces appetite, may result in secondary ketosis.

The cow's appetite, especially for grain, is reduced prior to and during either type of ketosis. When feed intake is low, animals will experience weight loss, rumen inactivity, and constipation. The animals usually have a gaunt appearance and milk production is decreased. Cows may appear depressed, restricted in their movements, their hair coat may appear rough, and their eyes may be glazed. Their breath may have a characteristic odor of ketones. Death from ketosis rarely occurs.

Cows that develop ketosis are usually in negative energy balance and, therefore, are mobilizing body stores of fat and protein because of a drop in blood sugar or glucose levels. When fat molecules reach the liver, they are converted to ketones, which results in elevated ketone levels in the blood.

Normal blood ketone levels in the cow are generally considered to be below 10 mg/dl. As the blood ketone level increases, the cow progresses into subclinical ketosis. The second major change in the blood accompanying elevated ketones is a decrease

Table 4. Chemical composition of commonly available anionic macromineral salts

Mineral salt	Chemical formula	N	Ca	Mg	S	Cl	DM
		Percent as-fed					%
Ammonium sulfate	$(NH_4)2SO_4$	21.2	-–	-–	24.3	-–	100.0
Calcium sulfate	$CaSO_4$*$2H_2O$	-–	23.3	-–	18.6	-–	79.1
Magnesium sulfate	$MgSO_4$*$7H_2O$	-–	-–	9.9	13.0	-–	48.8
Ammonium chloride	NH_4Cl	26.2	-–	-–	-–	63.3	100.0
Calcium chloride	$CaCl_2$*H_2O	-–	27.3	-–	-–	48.2	75.5
Magnesium chloride	$MgCl_2$*$6H_2O$	-–	-–	12.0	-–	34.9	46.8

in blood glucose. Normal levels in the dairy cow are about 50 mg/dl. Values below 40 mg/dl can be considered subnormal.

Tests are available to check the ketone levels of milk and urine. The ketone level of milk is about half the blood level, where as the ketone level of urine exceeds the level in blood by about four times. This makes the urine test for ketone levels overly sensitive for diagnoses, with most high-producing cows showing positive urine tests in early lactation, often without need for treatment. The milk test is considered more accurate for indicating when there may be a problem.

Factors that often can predispose cows to ketosis include inadequate protein and/or sulfur, lack of fiber for normal rumen metabolism, silage that has undergone abnormal fermentation (high in butyric acid), and overconditioned or fat cows. Also, major changes in the forage ration less than three to four weeks before freshening (such as the addition of NPN and excessive protein intake) may contribute to ketosis.

The primary aim of all treatments is to increase blood glucose and glucose supply to tissues, thus decreasing body fat mobilization. The treatment of choice is an intravenous infusion of glucose, which is the most rapid and direct way to supply sugar. However, relapses are common when glucose infusion is used as the sole treatment. This treatment should be followed by a longer acting treatment. Another alternative for treatment is the use of glucocorticoid, which causes the cow's body to produce blood sugar from body protein. Prolonged use of glucocorticoid is not desirable because it depletes body protein and reduces disease resistance. ATCH hormone can also be used since it stimulates the adrenal gland to produce glucocorticoids. All of these drugs should be used under the direction of a veterinarian.

Sodium propionate or propylene glycol are two oral sugar precursors that can be fed or drenched. They are used by the cow to produce glucose in the liver and can be fed at a rate of 0.5 to 1.0 pound per day or at 3 to 5 percent of the grain mix. They also can be fed on silage or in a total mixed ration. Propylene glycol can be used as an outside source of glucose. It is often used after glucose or hormone treatments.

Producers can avoid ketosis outbreaks by preventing obesity in late lactation and dry cows. Over conditioning causes depressed appetites at freshening and may increase fatty liver problems. It is best not to feed more than 0.5 percent of body weight in grain during the dry period. Changes in the ration should be made slowly and poor quality feeds should be avoided. High quality forages should be fed at 40 to 50 percent of the total ration. Feeding niacin is also recommended at 6 grams per day for two to ten days starting two weeks prior to calving.

If 10 percent or more cows have ketosis on an annual basis, ketosis should be considered a problem. The best way to prevent ketosis is to implement nutritional and feeding practices that will maximize energy intake, provide adequate glucose precursors, and minimize body fat mobilization.

Fatty liver syndrome

In the ruminant, approximately 90 percent of fat synthesis occurs in the adipose tissue with very little occurring in the liver. Any condition that places the cow in negative energy balance and results in excessive fat mobilization leads to increased amounts of free fatty acids in the blood. When fatty acids increase in the blood, the liver increases its uptake of free fatty acids. Since a ruminant's liver has only a limited ability to handle fat synthesis, lipid deposition and accumulation occurs in the liver, hence fatty liver syndrome.

This disorder occurs several days after calving when animals are most likely to go off-feed and are most likely to be in negative energy balance. Older animals with a history of ketosis and cows with extended dry periods are usually at the greatest risk. This syndrome generally begins when animals become overconditioned after receiving large amounts of a high energy diet during the dry period. As a result, they are more susceptible to metabolic disorders and are more likely to go off-feed. Cows that enter the dry period overconditioned should not be placed on a diet. Placing overconditioned cows on a diet puts them in negative energy balance and initiates the cycle that leads to fatty livers.

The symptoms are similar to ketosis: depressed appetite, overall depression, and general weakness. Fatty liver syndrome often is associated with other problems at calving, including off-feed cases, ketosis, mastitis, retained placenta, and displaced abomasum. These animals sometimes die due to liver damage and other complications.

Animals afflicted with fatty livers usually do not respond to treatment. The same therapies used to treat ketosis (i.e. intravenous glucose and oral glucose precursors) can be tried but they are not very effective. The best method of treating fatty acid infiltration of the liver is to minimize the rate of lipid mobilization by the animal. The lipid mobilization rate can be moderated with proper nutrition and feed management practices that minimize the degree of negative energy balance. Producers can help prevent fatty liver syndrome by monitoring body condition on late lactation and dry cows to avoid cows becoming overconditioned, by checking that animals are not gaining or losing more than one-half body condition score during the dry period, by restricting the amount of corn silage fed, and by not overfeeding grain.

Retained placenta

Retained placenta or afterbirth occurs when the placenta fails to separate from the uterine wall shortly after the time of calving. A cow should normally clean within an hour or so after calving. If the cow fails to clean within 12 hours after birth, it is very likely that the cow is going to retain her placenta.

There are several possible causes of retained placentas. Abnormal parturition can increase their incidence including dystocia, premature birth, excessively large fetus, stillbirth, twinning, and abortions. Abnormal parturition is most likely due to a hormonal imbalance.

Certain infections such as contagious diseases (i.e. brucellosis, IBR, BVD, and leptospirosis) can increase the risk of retained placenta. Nonspecific infections that are not contagious (i.e. Salmonella and Actinomyces pyogenes) can infect the placenta. In both situations, these infections can cause the calf to be aborted or stillborn, which increases the incidence of retained placenta.

Strong evidence suggests that nutrition deficiencies of selenium, vitamin A, vitamin E, and carotene can increase the risk of retained planceta. Vitamin deficiencies could occur on a ration containing large quantities of hay, on poor quality forage, on inadequate fresh forage, or on forage that was not properly supplemented. Other possible nutritional causes of retained placenta include excessive calcium, especially in cows fed over 30 to 50 percent of the forage dry matter intakes as legume forage. Retained placenta also can be caused by a deficiency of calcium and phosphorus resulting from inadequate supplementation and by excessive vitamin D intake over 50,000 to 100,000 IU per head daily.

There appears to be a tendency for overconditioned animals to be predisposed to retained placentas. This predisposition can be a problem where excessive corn silage is consumed (over 50 percent of the forage dry matter intake) and grain is overfed (over 0.5 to 0.8 percent of body weight).

Consult with a veterinarian if a cow has not cleaned within 24 to 48 hours. The uterus sometimes can be damaged if the placenta is not ready to detach. The normal incidence of retained placenta is about 5 to 10 percent. If it is higher, evaluate the dry cow ration and consider submitting blood samples for analysis from 6 to 12 dry cows. The blood analysis should include calcium, phosphorus, magnesium, selenium, vitamin A, vitamin E, carotene, and blood urea nitrogen.

Retained placentas can be prevented by minimizing stressful conditions during the dry period and at calving. Feeding a nutritionally sound ration that prevents the occurrence of metabolic diseases such as milk fever also can reduce this risk. Evaluate the status of calcium, phosphorus, selenium, vitamins A, D, and E, and carotene in the diet. Avoid extremes in the dry cow's body condition.

It may prove beneficial to give selenium-vitamin E injections (20 mg selenium and 680 units of vitamin E) one or two times during the dry period. Such an injection is often given in a split dose three weeks before calving and at calving time. Researchers have demonstrated that supplemental vitamin E and selenium given during the dry period not only reduce the incidence of retained placenta but also may result in less mastitis, metritis, and fewer cystic ovaries after calving. Another method of preventing retained placenta is to inject vitamin A and E (1 to 3 million units of vitamin A; 1,000 units of vitamin E).

Displaced abomasum

Displaced abomasum (DA) or a twisted stomach, occurs when the abomasum (true stomach) becomes misplaced. Eighty to 90 percent are left DAs and 10 to 20 percent are right DAs. When DA occurs, food passage to the stomach is restricted and the abomasum fills with gas. DAs usually occur one to three weeks after calving and affect 2 to 4 percent of the cows in the herd.

Cows suffering from a DA go off-feed, have reduced levels of milk production, and have an arched back. The cow will have mild diarrhea or very little manure passage, and what passage there is will be followed by very dark, foul smelling feces or diarrhea. Producers listening to the cow's rumen will hear little or no noise due to the digestive tract blockage.

There are various causes for DAs. Pregnancy can displace the abomasum or cause damage to the tissue that normally holds the abomasum in place. Therefore, at calving the abomasum does not fall back in place. Also, the fresh cow may not be eating enough and her rumen may not be full, leaving more room for the abomasum to shift. Nutritional causes are a lack of bulk in the diet and too much grain or finely chopped forages, notably corn silage, which can cause a low rumen pH. Sudden jarring of fresh cows (during trucking, for instance), poor muscle tone due to ketosis, milk fever, being off-feed, or lack of exercise can also cause DAs. Ingestion of feeds containing mycotoxins has been implicated with DAs.

Two major treatments are rolling a cow on her back and performing surgery. Consider economics before selecting the surgery treatment. Production will generally be reduced by up to 15 percent for the lactation. If a cow is a top producer, a 70 to 80 percent economic recovery rate is possible in uncomplicated cases. Otherwise, the chances of recovering costs may be less than 50 percent. Additionally, other problems may arise after surgery.

The best prevention is to control feeding practices both before and after calving. Feed at least 3 to 5 pounds of long stem hay, especially on rations where the silage is finely chopped. Maintain a ration with at least 70 to 76 percent forage dry matter for the close-up dry cows. Fresh cows should be offered a ration containing at least 45 to 60 percent of the total dry matter as forage. Limit grain to 0.5 to 0.8 percent of body weight before calving. Restrict the amounts of any feeds suspected or confirmed as containing mycotoxins to close-up dry cows and early lactation animals.

Udder edema

Most udder edema is partially related to the sharp drop in blood serum proteins that occurs near calving time. This drop is closely associated with the transfer of gamma globulins to colostrum and it is usually more severe in animals calving for the first time than in subsequent lactations.

This condition occurs when there is an excessive accumulation of fluid between secretory cells within the udder, which causes swelling that often extends forward under the skin in front of the udder. The source of the fluid is seepage of proteins from the blood. Udder edema causes sore udders that possibly interfere with milk let down. Also, the animal's teats will shorten and strut outward, making it more difficult to keep a milking machine in place. Edema can lead to physical problems, such as cracking of the udder and, in severe cases, it can damage the udder attachments.

The exact cause of udder edema is not known but high sodium and potassium intakes have been attributed to this condition. Other contributing factors may be a protein or nutrient deficiency, overfeeding grain prior to freshening, anemia, and poor circulation due to weak or broken udder attachments. Blood pressure changes and impaired lymph flow out of the udder may also be involved.

Several procedures may prove helpful in the treatment of edema. These include udder supports for cows with poorly attached udders and moderate exercise, which helps stimulate lymph circulation. Drugs such as diuretics can be used to speed up the removal of water from the body. Corticosteroids are another drug that can be utilized, but only with extreme caution and only under the direction of a veterinarian, due to the drugs high potency and other resulting complications.

The best way to prevent udder edema is to avoid feeding the cows excess salt during the dry period and to carefully monitor the feeding program for bred heifers and dry cows. Grain should be fed according to recommended levels. Overfeeding grain, especially to springing heifers, can increase the occurrence of edema.

Providing moderate exercise during the close-up dry period may help maintain normal circulation of lymph, which may reduce swelling. In addition, producers should try to prevent chilling and bruising of udders and should milk out problem cows before calving.

In a good dairy management program, dry cows must receive the same level of care as the milk producing cows, if not better care. Nutrition and feed management play a major role during the dry period. The main goal of dairy producers is to get as much milk from their animals as efficiently as possible. The only sure way to achieve maximum production is to have the dry cow forages tested, the grain mix balanced, and to keep the cows housed in a clean environment. These measures will help to reduce the risk of metabolic disorders and help ensure that the dairy cow starts her lactation in optimum condition and health.

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Penn State College of Agricultural Sciences research, extension, and resident education programs are funded in part by Pennsylvania counties, the Commonwealth of Pennsylvania, and the U.S. Department of Agriculture.

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Produced by Ag Communications and Marketing

Web code: XD0001