How to make the most of feed for the dry cow

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Under ideal conditions, dairy cows produce milk during 305 days of the year and are dry the remaining 60 (**Table 1**). In reality, feeding for high production should begin during the dry period or towards the end of the previous lactation. With dry periods shorter than 40 days, there's not enough time to regenerate the mammary tissue; this may result in production losses of 20-40 percent during the next lactation. Dry periods longer than 70 days do not promote an increase in production and may result in calving difficulties that are costly to the producer.

Recent research has demonstrated that the minimum days dry to maximize production depends on parity (Kuhn et. al., 2006). Cows of first and second lactation had little production losses with shorter periods of 40 to 45 days. For mature cows, dry periods of 50 to 65 days were needed, probably because they are less persistent. The authors concluded dry periods shorter than 30 days and longer than 70 days reduced lifetime productivity, with the impact of dry periods in excess of 80 days even worse than those shorter than 30 days. One advantage of 40-day dry periods is that cows can be maintained in a higher energy plane of nutrition, which reduces the negative energy balance after calving and, therefore, fat mobilization. Up to 2007, only 14% of the dairy herds in the U.S. had dry periods between 40 and 49 days, with the majority (51.8 percent) between 60 and 69 (**Table 2**).

TABLE 1 Dry period: Average days by herd size in U.S. dairies, modified from USDA Dairy 2007.

Herd size (number of cows)			
Small (less than 100)	Medium (100-499)	Large (500 or more)	All
58.2	56.3	59.6	57.8

TABLE 2 Average days dry at U.S. dairies, modified from USDA Dairy 2007.

Average days dry	Percent of dairies
Less than 40	2.5
40-49	14.1
50-59	21.1
60-69	51.8
70 or more	10.5

TABLE 3 Percent of operations that group close-up cows by size, modified from USDA Dairy 2007.

Herd size (number of cows)			
Small (less than 100)	Medium (100-499)	Large (500 or more)	All
47.1	74.9	96.0	63.9

TABLE 4 Feed intake of dry cow*

Days pregnant	240	270	279
Bodyweight (lbs)	729	751	756
Age (months)	57	58	58
Dry matter intake (lbs)	14.4	13.7	10.1

*Holstein cow; mature weight = 1,494 lbs.; BCS = 3.3; calf weight 100 lbs.; daily gain = 1.5 lbs. Source: NRC 2001.

Feeding

In the past, dry dairy cows were fed diets of low-energy content, at best supplemented with some concentrate as calving approached. It is an increasingly common management practice to separate dry cows into "far-off" (first 30 days) and "close-up" (last 30 days). The feasibility of grouping cows is related with the facilities available on the farm, which is why in the U.S. twice as many large dairies as small dairies have close-up groups (**Table 3**).

Far-off dry cows

According to the NRC (2001), the nutrient content of dry cow diets during their first 30 days should be the following (DM basis): 12 percent crude protein (CP), 0.59 Mcal NEl per lb, 27 percent ADF, 35 percent NDF, 0.37 percent Ca, 0.26 percent P, 1,800 IU vitamin A, 540 IU vitamin D and 7 IU vitamin E per lb. It is also important to adhere to the following general management practices:

- Supply a minimum of 1 percent of bodyweight of large-particle-size forage (hay). Grass hay should be given priority, as high calcium and low phosphorus in legumes can increase the incidence of hypocalcemia; administering enough fiber minimizes digestive upsets following calving.

- Avoid administering corn silage free-choice, as it results in excessive energy intake and increases the possibility of DAs and fatty livers.

- Limit grain intake to the amounts required to fulfill the requirements of energy and protein.

- Maintain calcium intake under 3 ounces per day, while at the same time supplying adequate amounts of phosphorus (1.3 to 1.5 ounces per day) to minimize the incidence of hypocalcemia.

The far-off dry group can be further divided into one group that needs to gain weight and another that needs to maintain it. The objective is always to maintain or improve body condition without fattening. Under no condition should dry cows be allowed to lose weight, because the

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TABLE 5 Percent of U.S. cows with clinical problems; Modified from USDA Dairy 2007

Problem	1996	2002	2007
Laminitis	10.5	11.6	14
Dystocia/metritis	NA	3.7	4.6
Hypocalcemia	5.9	5.2	4.9
DA	2.8	3.5	3.5

TABLE 6 Effects of the energy concentration in precalving diets

	NEl (Mcal/lb) Low	NEl (Mcal/lb) High	Production	Precalving	Postcalving
Janovick (2010)	0.62	0.73	+ DA + Ketosis	- NEFA + Insulin + Glucose + Leptin	+ AGNE + BHBA
Janovick (2009)	0.62	0.73	+ Milk + Fat (% and lb/d) + Efficiency	Improved energy balance	Negative energy balance Greater bodyweight loss
Rabelo (2003)	0.71	0.77		Improved energy balance + DMI -pH decreased BCS	
Doepel (2003)	0.61	0.73		Improved energy balance + DM and OM digestibility	Improved energy balance
Mashek (2000)	0.69	0.74		+ Insulin - NEFA	
Minnor (1998)	0.61	0.74	+ Protein (% and lb/d)	- NEFA -BHBA - Liver glycogen + DMI and NEI Improved energy balance	- NEFA - BHBA - Liver glycogen

DA = displaced abomasum; NEFA = non-esterified fatty acids; BHBA = beta hydroxybutyric acid; OM = organic matter

risks of dystocia and culling during the following lactation will increase. In order to do this, it is important to consider the impact days pregnant has on their daily feed intake (**Table 4** on page 1).

Close-up dry cows

The last 3 weeks precalving (close-up cows) and the first 3 weeks postcalving are called the "transition period" (Grummer, 1995). Most of the metabolic problems of the dairy cow happen during the first two weeks of the lactation, and even infectious processes (e.g., mastitis, paratuberculosis, salmonellosis, etc.) start to manifest themselves clinically during this period (Goff and Horst, 1997). Health problems during the transition period have a negative impact on the profitability of the operation due to increased veterinary expenses, reduced production, reduced reproduction performance, early culls and deaths. Despite increased research studying the transition period, these problems continue to manifest themselves and have even increased over the last 11 years (**Table 5**). This increase is likely associated with the parallel genetic improvement and resulting milk production increase per cow.

During the last 3 weeks of gestation, the requirements for energy increase due to fetal development and colostrum production. The mammary gland at 4 days postcalving has increased demands for glucose (3X), amino acids (2X) and fatty acids (3X) when compared to the **gravid uterus** at 250 days of gestation (Bell, 1995). At the same time, dry matter intake (DMI) is reduced by almost 30 percent during the last 3 weeks of gestation, which is attributed to the high estrogen concentration around calving (Grummer, 1993.) This mismatch between nutrient intake and demand generates a negative energy balance (NEB) toward the end of the pregnancy that is prolonged for several weeks after calving. Nearly 25 percent of the cows that left the herd in Minnesota between 1996 and 2001 did so during the first 60 days in milk (DIM) (Godden et. al., 2003). In a review of 26 experiments, a positive energy balance was achieved at 50 DIM with a maximum NEB at 11 days postcalving (Brixy, 2005). This period has been associated with immunosuppression, precalving problems and increased interval to first insemination.

Recent research suggests cows arrive at the dry period with BCS of 3.0 instead of the previous recommendation of 3.5–3.75 (Contreras et. al., 2004). This BCS has to be maintained until calving (Brand, 1996), as cows gain BCS more efficiently during lactation than during the dry period, due to differences in nutrient partition between both periods. Cows with lower BCS at dry-off have a tendency to put on weight, while those with high BCS tend to lose it during the dry period (Bar, 2001). Researchers (Hayirli et. al., 2002) found that feed intake around calving drops linearly as BCS increases, as a result of greater mobilizations of body reserves. In reality, cows with higher BCS represent a greater problem than cows with lower-than-desired BCS. Dry cows carrying excessive condition are more susceptible to develop cystic ovaries and other reproductive problems, hoof problems after calving, retained membranes, displaced abomasums and ketosis.

Energy needs

The NRC (2001) suggests an increase of 0.14-0.18 Mcal NEl per lb of feed during the three last weeks of gestation, to achieve a final energy density of 0.7-0.74 Mcal NEl per lb. The most effective alternative to increase energy in the transition diet is to increase the concentration of non-fibrous carbohydrates (NFC), because they allow for the adaptation of the rumen to high-production diets postcalving. There are two sites for this adaptation to occur:

1. rumen microorganisms
2. rumen papillae

When significant amounts of NFC (i.e., cereal grains) are incorporated into the diet, bacteria that utilize starch develop rapidly (3-5 days). Large quantities of volatile fatty acids (VFA), propionic acid in particular, are produced, which stimulates the development of rumen papillae in a process that requires 4 to 6 weeks (Dirksen et. al., 1985). The growth of bacteria that utilize lactic acid originating from propionic is also slow (3-4 weeks). This results in an accumulation of lactic acid (Calsamiglia, 1995). The time gap between VFA production and development of rumen papillae leads to an accumulation of VFA and gas, with the subsequent risk of acidosis and displaced abomasums (DA).

The maximum concentration of NFC in precalving diets should not exceed 43 percent of the DM (NRC, 2001). This is consistent with experiments that suggest that diets precalving with high NFC (43-45 percent) accentuate the DMI depression (Minor et. al., 1998; Rabelo et. al., 2003). Six experiments analyzed the effect of NFC concentration (high or low) in precalving diets. Although the range of NFC was large (18-45 percent), most experiments reported higher DMI precalving with the higher NFC diets, provided they did not exceed 43 percent of DM (Overton and Waldron, 2004). These results are consistent with others (Hayirli et. al., 2002) who suggested that DMI precalving was positively correlated with NFC content of the diet. Available data suggests that diets with moderate concentrations of NFC (36-38 percent) are adequate for precalving (Overton, 2004).

TABLE 7 Commercial precalving diets with different energy concentrations

Feedstuff (% DM)	High energy	Low energy
Corn silage	4.26	5.00
Alfalfa hay	1.42	-
Grass hay	-	3.00
Wheat straw	1.42	2.00
Beet pulp (wet)	1.23	-
Dried distillers grains	-	0.40
Wheat middlings	-	0.35
Soybean meal 48	0.85	1.15
Ground corn	0.79	-
Anionic salts	0.83	0.63
Vitamin/mineral supplement	0.61	0.63
Nutrients		
Total lbs DM	25	29
Forage:Concentrate	62:38	76:24
NFC (% of DM)	37.4	23.52
NDF (% of DM)	36.7	48.10
ADF (% of DM)	23.7	31.28
CP (% of DM)	15.44	14.23
NEl (Mcal /lb.)	0.71	0.60
Fat (% of DM)	2.68	3.07
Ca (% of DM)	1.37	1.43
P (% of DM)	0.31	0.42
DCAD (Meq/kg)	-1.0	-11.13

Although based in sound research, the ability of these high-energy diets to decrease the incidence of disease and improve production is inconsistent (Drackley, 2007). Based on the NRC requirements, it was observed (Drackley et. al., 2007) that a Holstein cow weighing 1,496 lbs required 14-15 Mcal NEl daily. These researchers recommended dry period and precalving diets should be 0.59-0.63 Mcal NEl per lb DM for an estimated DMI of 25 to 28 lbs per day. The best way to achieve this low-energy density is by diet dilution with finely chopped straw.

The effects of the energy level (high and low) in precalving diets on energy metabolism, production and prevalence of peripartum diseases are presented in **Table 6**. Most experiments reported benefits when diets high in energy were fed as suggested by the NRC (2001). Conversely, data collected by the European company Keenan from 27,000 cows and 277 herds show a positive effect in the reduction of the prevalence of problems around calving when the energy of the diet was diluted with straw (Drackley, 2007). It has to be noted that in the experiments, cows were housed and fed individually, not allowing for social interaction and competition as would happen in a commercial dairy operation. It is possible the apparent success of these types

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of diets in the field may be more attributed to the low K content in the straw altering the DCAD balance and reducing the incidence of hypocalcemia than to the lower energy density. In addition, none of these studies has evaluated the reduction of microbial protein synthesis as a result of reduced supply of NFC. Possible collateral effects due to reduced colostrum production and/or lower weight and survival of calves born to cows with restricted dietary energy intake need to be considered. Two examples of commercial close-up diets with high and low energy contents are presented in **Table 7** (on page 3).

Protein needs

Fetal growth, udder development and colostrum synthesis are greatly responsible for the increase in protein needs during the last three weeks of gestation. This nutrient increase is parallel to a DMI reduction, which causes a negative protein balance. In contrast with the NEB and fat removal, protein mobilization is limited, and once the reserves are depleted, milk production and synthesis of immunoglobulins are compromised.

The NRC (2001) suggests springing heifers should be fed precalving diets with 13.5-15 percent CP, whereas mature dry cows can be fed diets containing 12 percent CP. Other authors (Overton, 2004; Park et. al., 2002) consider 12 percent too low for mature cows. According to one of them (Overton, 2004), diets in the field are usually formulated to supply between 2.4 and 2.6 lbs per day of metabolizable protein (MP). This can be achieved with diets that contain approximately 13-15 percent CP and 36 percent NFC (based on 24-26 lbs DMI per day). The content of lysine and methionine should be above 6 and 2 percent of MP, respectively (CNCPS, 2009).

Calcium homeostasis

At calving, calcium requirements are quadrupled, which results in cows experiencing variable degrees of subclinical to clinical hypocalcemia (Horst et. al., 1997). To improve calcium mobilization, one study suggested to generate a light metabolic acidosis by modifying the equilibrium between anions and cations (Na+K)-(Cl+S) in the diet. The use of salts rich in anions (ammonium sulphate and chloride are the most frequent) or supplements with hydrochloric or sulphuric acids is currently recommended. One constraint is the reduction in intake caused by the low palatability of these salts. In addition, they are expensive, and because there is commonly only one close-up lot, they are also administered to springing heifers, which generally do not benefit from supplementation. Use of anionic salts in precalving diets in the U.S. is currently not widespread, with only 23 percent of the dairy herds using them (APHIS, 2007).

A more economical and easier way to generate metabolic acidosis in cows is to decrease the cations in the diet. Care has to be taken so that particular minerals do not fall below their requirements. In particular, watch for concentrations of Na and Mg, which may already be low in some feedstuffs. One study (Goff and Horst, 1997) reported that reducing the potassium concentration in the diet to 1.1 percent prevented the occurrence of clinical hypocalcemia in multiparous Jersey cows. Many producers in the Midwest control hypocalcemia by using forages with low concentrations of potassium, with the objective to achieve less than 1.3 percent in the diet DM (Overton, 2004).

Important facts about potassium (K):

• Some plants accumulate K in their tissues at concentrations greater than those required by the animal.

• Grasses generally have less K than legumes (1.68 percent vs. 2.55 percent)

• K's concentration decreases with plant maturity.

• Hay has less K than silage.

• Nearly 86 percent of the K ingested is excreted in the urine.

Dairy producers might find useful to identify a field on the farm that has low soil potassium concentration and use it exclusively to grow forages for close-up diets. Soil fertilization (both organic and/or inorganic) has to be managed in order to reduce the potassium input. Periodically test the soil to be sure the concentration is adequate.

Summary

Body condition has to be monitored throughout lactation to make sure cows arrive to the dry period with optimum level of body reserves (BCS=3). Current research suggests that traditional dry periods (50-60 days) with two different feeding groups, far-off and close-up, reduce metabolic problems during transition. It is necessary to maintain a lower nutrition plane during the first 5 weeks and increase energy and protein density in the diet during the 3 weeks prior to calving. This approach maintains their condition throughout the dry period and adapts them physiologically to the more nutrient-dense diet postcalving.

References omitted due to space but are available upon request.

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PROGRESSIVE DAIRYMAN

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