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Feeding Dairy Cows For Efficient Reproductive Performance

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Dairy cows require feed nutrients for maintenance, growth and lactation, and reproduction. The nutrient demands of maintenance (or survival) and lactation have a higher priority for absorbed nutrients than reproductive functions. Therefore, feeding programs can affect the reproductive performance of a herd, particularly as levels of milk production increase.

Dairy cattle can tolerate a fairly wide range of nutrient intakes for a short time without suffering poor reproduction. Serious deficiencies or excesses of individual nutrients over an extended period can impair reproduction.

Remember to look at the *total picture* and *balance* the ration with regard to all nutrients during the various stages of the lactation cycle and the dry period. Overfeeding one nutrient will not correct problems caused by poor management or deficiencies of another nutrient.

Start with a solid dry cow program

The dry period marks both the end of one lactation cycle and the start of another.

A good dry cow program should:

- develop proper body condition
- provide proper nutrition for the growing fetus
- prepare the digestive tract for the next lactation
- prepare the udder for the next lactation
- reduce metabolic, nutritional, and infectious disorders
- improve reproductive efficiency.

Cows which develop metabolic or nutritional disorders at or around the time of calving are more likely to develop secondary disorders during the next lactation and have impaired fertility than cows freshening without problems. Recent research results are summarized in Table 1. For example, a cow that freshens with milk

Table 1. Relationship between primary disorders at or around the time of calving and secondary disorders during the subsequent lactation.

	Primary Disorder						
Secondary Disorder	**Fat Cow Syndrome**	**Milk Fever**	**Difficult Calving**	**Retained placenta**	**Metritis**	**Displaced Abomasum**	**Ketosis**
Difficult Calving	X	X					
Retained Placenta	X	X	X				
Metritis	X	X	X	X		?	?
Displaced Abomasum	X	X	X	X	?		?
Mastitis	X	X	X	X	X	?	
Low Conception Rate	X	X	X	X	X	X	X

Adapted from Britt, 1988.

fever and a retained placenta will probably be diifficult to breed back. Feeding programs for dry cows which minimize metabolic disorders around the time of calving can improve reproductive efficiency.

Tips on dry cow feeding to help prevent milk fever, fat cow syndrome, ketosis, displaced abomasum and retained placenta include:

- avoid over-conditioning; strive for a body condition score of 3.5 to 4.0 at dry-off and calving
- limit calcium and phosphorus intakes to less than 100 and 45 grams per day, respectively; reduce these levels by 20 percent for Jersey and Guernsey cows
- hold Ca:P ratio to less than 2:1 without exceeding phosphorus limits
- avoid or limit-feed legume forages since they are high in calcium, potassium and sodium
- avoid feeding more than a 12 to 13 percent crude protein diet (dry matter basis) from dry-off to the precalving phase (2 weeks prior to calving)
- limit corn silage to less than 50 percent of forage dry matter, or limit-feed and keep ration moisture levels less than 50 percent
- dry cow rations should contain at least 35 to 40 percent neutral detergent fiber (dry matter basis), with 75 percent of the total fiber coming from coarsely chopped forage; dry cow rations containing 50 to 55 percent NDF (dry matter basis) are best
- provide a two-week precalving diet with 8 to 12 pounds of grain dry matter per day to adapt the rumen to the higher starch content of the early lactation ration; increase ration crude protein content to 13 to 14 percent (dry matter basis)
- gradually introduce grain over the first 4 to 6 weeks after calving, and introduce supplemental protein over the first 2 to 3 weeks
- niacin supplemented at 6 grams/cow/day during the precalving phase and the first 100 days of lactation may help over-conditioned or ketosis-prone cows
- provide adequate trace minerals and vitamins A, D and E.

The Dairy NRC's recommended nutrient densities of rations for dry cows are presented in Table 2. *All NRC recommendations in this publication are based on Dairy NRC 7989 figures.* Mineral recommendations are given as concentrations and as daily amounts assuming 28 pounds (1.8 to 1.9 percent of body weight) of dry matter intake per day. Vitamin levels are given as daily amounts recommended by NRC, as well as amounts commonly recommended by nutritionists and veterinarians.

Concentrations of trace minerals vary in forages, grains and by-products, and are too expensive to routinely measure. Furthermore, trace mineral availabilities in the gastrointestinal tract are not well defined. Try to meet at least half of the NRC trace mineral requirements for dry cows with supplemental sources, such as a good quality trace mineral salt, premix or commercial mineral or feed. Fortify the dry cow ration with selenium to .3 parts per million (dry matter basis) to provide 3 to 4 milligrams per cow per day.

Generally, nutritionists and veterinarians recommend higher amounts of vitamin A, D and E supplementation than the NRC recommends. Supplementing more than 75,000 to 100,000 units of vitamin A and 20,000 to 25,000 units of vitamin D per dry cow per day is unnecessary. Provide 350 units of vitamin E per dry cow per day, with at least one-half of that amount from supplemental sources. Ohio State research indicates that selenium/vitamin E injections two to three weeks before calving may be beneficial.

Table 2. Recommended nutrient content of dry cow rations (NRC 1989).

	Nutrient Content Dry Matter (DM) Basis	
	NRC 1989	**Desired**
NEI, Mcal/#	.57	.57 (.62)[1]
TDN, %	56	56 (61)
Crude protein, %	12	12(14)
Acid detergent fiber, % min.	27	35-38 (30)
Neutral detergent fiber, % min.	35	50-55 (45)
Calcium, %.	.39	.4-.6
Phosphorus, %	.24	.26-.32
Magnesium, %	.16	.16-.20
Potassium, %	.65	.65-.80
Sodium, %	.10	.10
Chlorine, %	.20	.20
Sulfur, %	.16	.16-.18
Iron, ppm	50	50-70
Cobalt, ppm	.10	.10-.12
Copper, ppm	10	10-12
Manganese, ppm	40	40-50
Zinc, ppm	40	40-60
Iodine, ppm	.25	.25
Selenium, ppm	.30	.30
	NRC 1989 IU/lb	**Amounts Commonly Supplemented (IU/day)**
Vitamin A	1800	75,000-150,000
D	540	25,000-50,000
E	7	200-400

NEI = Net energy of lactation; Mcal/#= Megacalories per pound

[1]Values in parentheses are for dry cows 2 weeks prior to calving.

ppm = parts per million (milligrams per kilogram).
IU = International Units.

Monitor body condition

Peak milk yield occurs before the peak in dry matter intake in early lactation. Between these peaks, lactational demand for energy exceeds energy intake, and the cow mobilizes body reserves to meet this deficit. Cows that lose a great deal of body condition in early lactation may also suffer impaired reproductive performance.

Table 3 shows that cows with major condition losses during the first five weeks after calving (condition score loss greater than 1.0) had lower first-service conception rates and longer days to first heat, ovulation and conception than cows with losses less than 1.0. Florida workers found that negative energy balance during the first nine weeks after calving was more severe in non-cycling than cycling cows. This difference in energy balance was related more to low dry matter intake than to high milk yield.

Table 3. Effect of change in body condition on reproductive performance in lactating dairy cows.

Condition change	1st Service conception (%)	Days to 1st ovulation	Days to 1st heat	Days to conception
Minor	65	27	48	73
Moderate	53	31	41	90
Severe	17	42	62	116

Source: Smith and coworkers, 1986. Cornell.

Condition change during first 5 weeks postpartum:
Minor <.4 condition score loss
Moderate .5-1.0 condition score loss
Severe >1.0 condition score loss.

Feeding programs that maximize energy intake to reduce the severity of weight loss in early lactation can improve reproductive efficiency. Increasing the proportion of grain in the diet is limited because dairy cows require a minimum amount of fiber and forage in the diet for proper chewing and rumination, and to maintain normal fat test. This energy deficit has created an interest in the use of animal, vegetable and ruminally inert fat sources to increase the energy density of diets for high producing cows. A Pennsylvania field study found first-service pregnancy rates of 62 percent for cows fed 1 pound of ruminally inert fat per day during the first 150 days of lactation, versus 42 percent for cows that weren't fed fat. However, supplementing the diet with 5-percent (dry matter basis) ruminally inert fat did not improve reproductive performance in a Wisconsin study.

Dairy managers who supplement fat have noticed improved body condition and persistency of lactation, and possibly improved reproductive performance in herds where under-conditioning was severe.

Tips on energy feeding include:

- strive for a condition score of 3.5 to 4.0 at calving and 2.5 to 3.0 at 40 to 60 days after calving
- maintain minimum dietary NDF from forage at 21 percent and minimum total dietary NDF at 27 to 28 percent
- feed the best forage to high producing and early lactation cows, and try to maximize their dry matter intake
- adjust grain feeding rates for mid- and late-lactation cows based on body condition as well as level of milk production
- consider feeding supplemental fats for at least the first 150 days of lactation.

Protein feeding

Researchers are now investigating the effects of protein feeding, and some have found that high levels of dietary crude protein can impair reproductive performance. More research is needed, however.

A portion of the crude protein in feeds is degraded by rumen microbes to peptides, amino acids, and ammonia with the remainder escaping microbial breakdown. Non-protein nitrogen (NPN) from feedstuffs, urea, or ammoniated silage ends up in the rumen ammonia pool. If adequate fermentable carbohydrate is present in the rumen, degraded intake protein and NPN can be incorporated into microbial protein and sent, along with undegraded intake protein, to the small intestine for digestion and absorption. If intake of degraded protein is excessive and/or intake of fermentable carbohydrate is low, ammonia in the rumen may exceed the level which can be utilized by rumen microbes. Blood urea nitrogen (BUN) levels will likely increase due to liver detoxification of absorbed ammonia if rumen ammonia levels are too high.

Pennsylvania workers found that BUN over 20 mg/100 ml was associated with reduced conception rate in cows from a herd with fertility problems that were reported to be related to overfeeding degradable protein. Oregon State workers reported a negative relationship between reproductive performance and increasing dietary crude protein from 13 to 19 percent (dry matter basis). However, Oklahoma State and Maine researchers found no adverse effects of increasing dietary crude protein from 15 to 20 percent and 13 to 20 percent (dry matter basis), respectively, on reproductive performance. BUN levels were above 20 mg/100 ml for the high protein diets compared to 10 to 15 mg/100 ml for the low protein diets. More research is needed to define the role of BUN as a diagnostic tool.

From a practical standpoint, it does not make economic sense to overfeed or underfeed protein to lactating dairy cows.

Some guidelines for protein feeding are as follows:

- balance the ration for crude protein according to level of milk production (1.0 pound crude protein per 10 pounds of 3.8 percent milk)
- for high producing and early lactation cows, 35 percent of the crude protein should be undegradable protein. You will need to substitute some "bypass" protein sources (such as heat-treated whole soybeans or meal, or grain or animal by-products) for solvent-extracted soybean meal, particularly in alfalfa based diets, since alfalfa protein is highly degradable
- limit NPN to .4 pounds urea equivalents per cow per day (.2 pounds in early lactation) and blend with protein sources more resistant to ruminal degradation than solvent soybean meal, such as heat treated soybeans or meal, or grain or animal by-products when fed to high producing cows; Michigan State workers found no adverse effects of urea feeding on reproductive performance when fed properly
- to improve protein and carbohydrate utilization,
  —feed grain 4 to 6 times per day
  —feed forage before grain
  —feed protein supplement along with grain
  —feed a total mixed ration
  —properly weigh and mix ingredients
  —routinely test forages and balance rations.

Minerals and vitamins

Table 4 presents the NRC recommendations for minerals and vitamins for high producing cows. Trace mineral recommendations are provided on a concentration basis as well as an amount assuming 52 pounds of dry matter intake. Vitamin levels are provided as daily amounts as recommended by NRC, and as amounts commonly recommended by nutritionists and veterinarians.

Feeding a calcium-deficient diet may delay uterine involution, and fertility can be impaired by feeding diets with Ca:P ratios of less than 1.5 or greater than 3.5. Feeding a phosphorus-deficient diet results in delayed onset of estrus, inactive ovaries, and repeat breeder problems. High phosphorus intakes along with low calcium intakes also depress fertility.

Some macromineral recommendations (all percentages are on a dry matter basis):

- balance rations for high producing cows at .75 to .80 percent calcium
- increase calcium to .9 to 1.0 percent and magnesium from .25 to .30 percent when feeding supplemental fat
- balance rations for high producing cows at .45 to .50 percent phosphorus
- provide other macrominerals as suggested in Table 4.

Trace mineral and vitamin deficiencies can result in delayed onset of estrus, inactive ovaries, repeat breeder problems, and/or infertility. As discussed earlier, concentrations of trace minerals in forages, grains and by-products can vary a great deal. Many producers meet at least half of the NRC requirement for trace minerals from supplemental sources, such as a good quality trace mineral salt, premix, or commercial mineral or feed. Rations for high producing cows should be fortified with selenium to .3 parts per million (dry matter basis) to provide 6 to 7 milligrams per cow per day.

Nutritionists and veterinarians generally recommend supplemental vitamin A and D in amounts greater than NRC recommendations. Supplementing rations for high producing and early lactation cows with more than 150,000 units of vitamin A and 40,000 to 50,000 units of vitamin D per cow per day is unnecessary.

Table 4. Recommended macromineral, trace mineral and vitamin content of rations for early lactation and high producing dairy cows.

	Nutrient Content Dry Matter (DM) Basis	
	NRC 1989	**Desired**
Calcium, %	.65-.80	.75-.90*
Phosphorus,%	.42-.49	.45-.50
Magnesium, %	.25	.27-.30*
Potassium, %	1.00	1.00-1.20
Sodium, %	.18	.18
Chlorine, %	.25	.25
Sulfur, %	.20	.20-.22
Iron, ppm	50	50-100
Cobalt, ppm	.10	.10-.12
Copper, ppm	10	10-12
Manganese, ppm	40	40-50
Zinc, ppm	40	40-60
Iodine, ppm	.60	.60
Selenium, ppm	.30	.30
	NRC 1989 IU/lb	**Amounts Commonly Supplemented (IU/day)**
Vitamin A	1450	75,000-200,000
D	450	25,000-75,000
E	7	200-400

*Increase calcium to .9-1.0% (DM basis) and magnesium to .30% (DM basis) when supplemental fat is fed.

ppm = parts per million (milligrams per kilogram).

IU = International units.

Continuous feeding of over 120,000 units of vitamin D per cow per day can be harmful. Rations that contain 350 units of vitamin E per cow per day, with at least one-half of that amount coming from supplements, should be adequate for high producing and early lactation cows

Research from Germany suggested that supplementation with beta-carotene, a vitamin A precursor, may reduce services per conception and increase estrus intensity and pregnancy rates. However, some U.S. researchers found no improvement in reproductive performance. Because of the high cost (25 to 40 cents per cow per day) of supplementation and variable research results, we don't recommend beta-carotene. However, adequate vitamin A in the diet is important.

Summing up...

Nutrition is an important component of a sound reproduction program. A good dry cow nutrition and management program can have a profound effect on your herd's reproductive efficiency.

Feed energy to achieve proper body condition at calving and to minimize the severity and duration of negative energy balance in early lactation. Feed protein according to level of production, and also consider the degradability of the protein ingredients you use. The ration should also provide proper levels of macro- and microminerals and vitamins.

Remember, though, that nutrition is only one component of your reproduction program. Environmental conditions, heat detection, timing of insemination, and semen storage and handling are a few of the factors that can affect your herd's reproductive performance. Feeding programs can't correct poor reproductive performance caused by poor management.

For more information, see publication A3429, *Feeding the Dairy Herd,* A2945, *Managing Dairy Feed Inventory,* and A2945-1 *Managing Your Feed Inventory Worksheets,* at your county extension office (Wisconsin residents) or at the Agricultural Bulletin Building, 30 N. Murray St., Madison WI 53715 (608-262-3346).

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