

DAIRY NUTRITION: RATION GUIDELINES FOR MILKING AND DRY COWS



BASICS

OVERVIEW

- The digestive process in dairy cattle can be broken down into two major categories: ruminal and postruminal, also called intestinal digestion. The rumen is the first compartment of the stomach that ingesta enter when swallowed. The rumen of an adult dairy cattle has approximately a 50-gallon (190-liter) capacity. The bacteria present in the rumen utilize carbohydrates present in feed to supply the cow with volatile fatty acids (VFA). These bacteria become an important source of microbial protein for the cow as they pass out of the rumen and are digested postruminally. The second category is postruminal digestion. Key parts of the postrumen tract are the abomasum and the lower digestive tract (small and large intestines). The goal in feeding dairy cows is to optimize the fermentation of nutrients in the rumen into microbial protein and end products that are metabolizable by the dairy cow. Nutrients escaping rumen fermentation should be used to balance or enhance the products of fermentation.
- The goal of dairy nutrition programs is to maintain a high level of production and good cow health while minimizing feed costs. This is done by maximizing the intake of forages and other fiber sources while balancing the energy and protein requirements of the animal.

SYSTEMS AFFECTED

Mammary, metabolic.

GEOGRAPHIC DISTRIBUTION

Worldwide, depending on the environment.

RATION DEVELOPMENT

- There are several modeling software programs commercially available for developing diets for all classes of ruminant cattle. When creating and troubleshooting diets it is important to be familiar with the strengths and limitations of your specific program. Before creating a ration, it is important to have accurate feed analysis including dry matter on all feed ingredients and to know the dry matter intake (DMI) of the cattle.

DRY MATTER INTAKE

Milk Cows

- DMI is related to many factors such as: stage of lactation, mature body weight, digestibility of feedstuffs, breed of cattle, and production levels. The NRC contains equations for predicting

DMI based on milk production and stage of lactation. These equations are updated periodically and used in computer software to predict DMI for ration formulation.

- The animal will use nutrients for maintenance, growth, and lactation. As DMI and milk production increase the fixed maintenance cost is diluted out leaving a higher percentage of nutrients available for lactation and growth. Thus it is typically most beneficial to maximize DMI in an effort to optimize milk production.
- As DMI increases, the passage rate (Kp) of nutrients will increase which will generally lower the rate of digestion (Kd). If Kp is too fast, large slowly digested fiber particles such as straw should be added to slow Kp and increase Kd.

Estimated daily DMI for milk cows

3.75% Fat milk	Body weight (lb)			
	900	1,100	1,300	1,500
Lb/cow/day	DMI (lb/day*)			
30	32	35	38	42
50	34	37	41	44
60	36	39	43	46
70	39	41	46	49
80	41	44	49	51
90	43	47	52	54
100		50	55	58
100+		52	58	60

Dry Cows

- Far-off (2 to 8 weeks before freshening): DMI = 1.8 to 2% BW
- Close-up (0 to 2 weeks before freshening): DMI = 1.5% BW

DMI guidelines for dry cows

BW (lb)	DMI range (lb/day)	
	Far-off	Close-up
900	16 to 18	14 to 16
1,100	20 to 22	16 to 18
1,300	23 to 26	18 to 22
1,500	27 to 30	20 to 24

Check the Following When Observed DMI is Different than Expected

- First check that the diet on paper correctly matches the diet being consumed by cattle and there are no management issues prohibiting DMI:
 - Double check dry matter on all ingredients, especially forages which make up a large portion of the diet and can vary 10-15% day to day in dry matter percentage.
 - Weigh backs should be properly accounted for
 - Make sure cows have adequate access to feed and water 24 hours a day to maximize intakes.

- Check that equipment has properly functioning scales and they are calibrated correctly.
- Check digestibility of forages and consider mycotoxin or mold sampling if DMI is excessively low and no other cause can be found
- Compare observed milk production levels, component percentage, and actual body weight of the cattle with calculated levels in the ration.

WATER REQUIREMENTS

- Water is the most important nutrient on the dairy, and as such should be tested routinely with other feedstuffs.
- Cows should consume 3 to 5 lb of water/pound of DM consumed, a high producing cow will consume 25-30 gallons/day.
- Cows should have access to at least 4 linear inches of water tank per cow. For this reason, large open tanks are preferred over smaller tanks which are easier to clean but restrict access to free water.

ENERGY: REQUIREMENTS AND SOURCES

- Carbohydrates and fat are the major source of energy in dairy rations.

Ration recommendations and concentrations

Item (DM basis)	Lactation stage			
	Early-Mid	Late	Dry	Close-up
Net energy-lactation (NE _L), Mcal/lb	0.78-0.81	0.70-0.74	0.52-0.60	0.60-0.64
Non-fiber carbohydrates (NFC), %	37 to 42	30 to 42	20 to 30	30
Recommended starch levels, %	25-30	25-30	15-20	15-22
Recommended Sugar levels, %	5	2-5	2	2
Fat, add %, maximum	6	4	0	1

- Non-fiber carbohydrate (NFC) is a measure of starches, sugars and pectins. NFC values for feeds are calculated as follows:

$$\text{NFC (\%)} = 100 - [\text{NDF \%} + \text{CP \%} + \text{ASH\%} + \text{FAT\%}].$$

All values are on a DM basis.

Excess Ration NFC Symptoms

1. Low or fluctuating DMI
2. Milk Fat Depression
3. Metabolic Acidosis
4. Rapid hoof growth, sore feet
5. Excessive corn in the manure
6. Diarrhea and other signs of indigestion

Inadequate Ration NFC Symptoms

1. Low milk production
2. Considerable body weight loss, especially in early lactation
3. Poor reproductive performance

4. Increased metabolic disorders

Fat Feeding Guidelines

- There are two types of fat fed to dairy cattle: rumen available and rumen bypass (inert)
- Ruminally available fats are most strongly implicated in milk fat depression. Inert fats bypass the rumen and do not cause milk fat depression, but they add expense to the diet and can cause decreased digestibility of other nutrients when over-fed. To avoid milk fat depression use the following guidelines:
 - Maximum fat added to a lactating ration should be 6% of DM.
 - Maintain ruminally unsaturated fatty acids levels (RUFAL) at less than 650 grams/cow/day
 - General feeding guidelines, maximum amount of fat from source:
 - Animal (rumen available) fat: <0.1 lb/cow/day
 - Plant/vegetable: 2.2 lb/cow/day
 - Inert fats: 1.2 lb/cow/day
- Symptoms of excess fat feeding:
 - Low DMI
 - Over-conditioned (fat) cows

Grain Processing/Rumen Degradability

- Rumen degradability or digestion of starch from fastest to lowest in grains as follows: oats, wheat, barley, corn, sorghum.
- Processing also affects degradability with steam flaking, fine grinding, and ensiling increasing degradability compared to coarse or whole, dry grains.

Energy feeds

Feed	NE _L Mcal/lb	Fat %	NFC %	Feeding limit Lb/cow/day
Grains	DM basis			As fed
Corn, shelled	0.92	4	75	25
Ear corn	0.90	3	62	30
Barley	0.87	2	61	15
Oats	0.75	2	46	15
Byproducts*				
Beet pulp	0.81	3	30	10
Brewer's grains—wet	0.81	6	21	25
Corn gluten feed	0.82	3	19	15
Distiller's grains	0.99	10	16	5
Soybean hulls	0.85	2	14	10
Wheat midds	0.87	5	34	10
Fats				
Tallow	2.65	99	0	1
Vegetable fats				
Free oil	2.65	99	0	0.5

Cottonseed, fuzzy	1.01	20	13	7
soybeans, cracked	0.92	19	16	5
sunflowers, whole	1.10	40	10	3
rumen inert fats	2.5+	80+	0	1

* DM of byproduct feeds is highly variable

PROTEIN RECOMMENDATIONS AND SOURCES

- Crude protein (CP) is commonly used, however, the amino acid profile of the diet is the most important aspect to maximizing production in the most economical way possible. When developing diets for cattle producing more than 80 lbs milk/day, balancing for specific amino acids becomes more important than CP% of the diet
- Methionine and Lysine are the two most common limiting amino acids in dairy cattle.
- Rumen-degradable protein (RDP) and rumen-undegradable protein (RUP) are used to fine-tune protein feeding. Soluble protein (SP) is considered in some cases for rumen fermentation, and should be about 50% of RDP in rations.

Protein Checks and Considerations

1. All rations should be balanced for CP requirements first and then for RDP, RUP, and SP.
2. In high producing herds, formulate for a Lysine:Methionine ratio of 3:1. Additionally the ratio of methionine (grams) to ME should be approximately 1.1 and lysine:ME ratio 2.9.
3. Rate of digestion for common protein sources fast to slow: Urea, alfalfa haylage, soybean meal or canola, heat treated soybean meal.
4. There must be adequate carbohydrates in the rumen to match RDP. Only when both energy and protein are balanced properly will rumen function be maximized. Optimal rumen function leads to an increase in microbial protein passing out of the rumen and being digested in the intestine. MCP have excellent amino acid profiles for milk production which is what makes it economically advantageous to maximize their production.
5. Use several different feedstuffs for both energy and protein sources so that rates of digestion and passage are varied.
6. When excess protein is present in the form of MUN, it can be difficult to determine if the true issue is a lack of fermentable carbohydrates or if protein is actually being overfed. Computer software and these guidelines in addition to personal experience are important when manipulating ration protein levels.

Protein sources

Feed	CP	RDP	RUP	SP
	%of DM		%of CP	
Forages				
Alfalfa hay	20	70	30	35
Alfalfa haylage -	20	80	20	60
<40% DM	20	75	25	50
40–50% DM	20	70	30	40
>55% DM	12	63	37	35
Grass hay	12	70	30	50
Grass haylage	8	70	30	45
Protein sources				

Blood meal	88	20	80	10
Brewer's grains—dry	28	47	53	10
Canola meal	40	77	28	25
Corn gluten meal	68	45	55	5
Cottonseed—fuzzy	24	65	35	27
Distillers dry grains	32	45	55	15
Fish meal	67	30	70	10
Linseed meal	38	65	35	40
Meat and bone meal	54	45	55	15
Soybean meal—44%	49	65	35	18
Soybeans—raw	41	80	20	30
Soybeans—heated	41	50	50	18
Sunflower—meal	32	76	24	30
Urea	287	100	0	100

FIBER AND FORAGE RECOMMENDATIONS

Three measures of fiber should be evaluated in dairy rations: acid detergent fiber (ADF), neutral detergent fiber (NDF), and NDF from forage (NDF-forage). The NDF-forage considers the NDF from hays, haylages, corn silage, and 50% of the NDF in whole cottonseed. Any NDF from non-forage sources, such as grains or byproducts other than cottonseed, are not considered in calculating NDF-forage. Ration guidelines are below:

Effective, Physical, or Cud-Chewing Fiber

Cows need a minimum of 15 and preferably 20% of the forage particles to be more than 1.5 inches long to stimulate rumination. Cows should chew 11 to 12 hours/day or about 15 minutes/lb of DMI.

Assessing Fiber Adequacies in Rations

- Excess fiber
 1. Low milk production, cows not peaking
 2. DMI lower than expected
 3. High milk fat %
 4. Energy content of feed or ration is generally inverse of fiber content. High fiber levels mean low energy. Early lactation cows fed high forage rations may become ketotic and have rapid and excessive body weight loss.
- Fiber deficiencies
 1. Acidosis, off-feed problems, fluctuating DMI
 2. Low milk fat %
 3. Cows not chewing their cud.

Fiber recommendations

Measure	Lactation stage			
	Early	Mid	Late	Dry
NDF, minimum	28	28	32	35
NDF-Forage, minimum	20	21	21	25
NDF-Forage, maximum	24	26	28	—

MINERAL AND VITAMIN GUIDELINES

Some Key Mineral and Vitamin Evaluation Points

- Lactating cows
 - Calcium: >150 g/day or 0.75% of ration DM
 - No added phosphorus needed in many diets
 - Salt: 2 to 3 ounces/cow/day
 - Vitamin E: 800-1200 IU/day in high producing cattle
 - Close-up dry cows—without anionic salts
 - Calcium: <100 g/day without anionic salts
 - Potassium: <1% of DM (as low as possible)
 - Other minerals: same as for far-off dry cows
 - Close-up dry cows—with anionic salts
 - Calcium: 200 g/day
 - Magnesium: 0.5% of DMI
 - Minimal or no added salt to prevent udder edema
 - Potassium (K): 0.65% of DMI, or lower
 - Chloride (Cl): up to 0.8% of DMI
 - Sulfur (S): <0.4% of DMI
 - DCAD calculation: $[(\text{Na}\% \times 43.5) + (\text{K}\% \times 25.6)] - [(\text{Cl}\% \times 28.2) + (\text{S}\% \times 62.6)]$
- Goal: -10 to -30 meq/100 g of DMI

Ration guidelines

Mineral/vitamin	Lactation stage			
	Early	Mid	Late	Dry
	% of DM			
Calcium %	>0.80	0.70	0.60	<0.6 or >1.9
Phosphorus %	0.50	0.45	0.40	0.30
Magnesium %	>0.30	0.25	0.20	0.50
Potassium %	1.50	1.20	1.20	<1.1
Salt %	0.50	0.50	0.20	None added
Sulfur %	0.25	0.20	0.20	<0.4
Iodine PPM	0.60	0.60	0.60	0.60
Iron PPM	50	50	50	50
Cobalt PPM	0.10	0.10	0.10	0.10
Copper PPM	15	15	15	15
Manganese PPM	40	40	40	40
Selenium PPM	0.30	0.30	0.30	0.30
Zinc PPM	60	60	60	60
Vitamin A KIU	150	100	100	80
Vitamin D KIU	30	30	30	25
Vitamin E IU	1200	1200	600	1200

BODY CONDITION SCORES (BCS)

- Body condition should not drop more than 0.5 score from freshening to pregnancy.
 - Cattle that drop more than 0.5 BCS will suffer from reduced reproductive performance in the subsequent lactation.
- Cows should freshen at a BCS of 3-3.5.

SPECIAL CONSIDERATIONS FOR DRY COWS

- Far-off dry cows are often fed weigh-backs from lactating cattle which provide fiber without excess energy for these cattle.
- Cattle are typically fed a low energy, high NDF diet during the dry period. The goal is to limit weight gain during the dry period.
- If anionic salts are used, the urine pH of cattle must be routinely monitored and should be a narrow range 5.8-6.2.
- Close-up cows often benefit from the inclusion of chelated trace minerals that have a higher bioavailability and can help prevent metabolic diseases seen in the transition period.

NUTRITION MANAGEMENT

Feed Bunk

- 1 to 3% weigh back or feed remaining after 24-hour feeding period
- Cows need 24 to 30 inches of linear bunk space, but may get by at 12 inches if TMR fed and available at all times. Bunk space should not be limited in the fresh-cow group.
- Cows eat best in grazing position off smooth surfaces.



MISCELLANEOUS

SEE ALSO

Body Condition Scoring: Dairy Cattle (www.fiveminutevet.com/ruminant)

Dairy Heifer Nutrition: Basics (www.fiveminutevet.com/ruminant)

Milk Cow Nutrition Monitoring (www.fiveminutevet.com/ruminant)

Nutrition and Metabolic Diseases: Dairy

Nutrition Assessment (www.fiveminutevet.com/ruminant)

Protein Nutrition

Starvation

ABBREVIATIONS

BCS= body condition score

BW = body weight

DE = digestible energy

DM = dry matter

DMI = dry matter intake

FCM = fat corrected milk

MCP = microbial protein

ME = metabolizable energy

MP = Metabolizable protein
NFC = non-fiber carbohydrates
NPN= non-protein nitrogen
NE_L = net energy of lactation
PAF = processing adjustment factor
RDP = rumen degradable protein
RUP = rumen undegradable protein
TDN = total digestible nutrients

Suggested Reading

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Acknowledgment The author and Book Editors acknowledge the prior contribution of Jim G. Linn.