Feeding in Today's Economy

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As this is written (Winter, 2010) feed prices have moderated from their historic highs but are still higher than long term averages. To confound this, milk prices are the lowest we have seen for several years. Feed costs are usually the largest single expense on a dairy farm and with above average feed costs and below average milk prices, feeding and nutrition of the dairy herd must be scrutinized now more than ever.

Expressing Feed Costs

Various terms can be calculated to describe feed costs:

- $/dry cow/day or $/all dry cows/day
- $/replacement/day or $/all replacements/day
- $/lactating cow/day (with or without feed costs for replacements and dry cows)
- $/cwt of milk (with or without feed costs for replacements and dry cows)
- Income over feed costs (with or without feed costs for replacements and dry cows)

1. Feed costs for replacements and dry cows are usually calculated as $/day for each animal. This is useful to determine whether the nutrition and ration balancing for these animals are appropriate, but a reasonable $/dry cow/day or $/heifer/day cost does not necessarily mean that feed costs for dry cows or feed costs for replacements are acceptable. You must examine the total feed bill for dry cows and the total bill for replacements. If your average $/dry cow/day is reasonable, but the average days dry is 90, you are spending too much feeding dry cows. The same is true if you are calving heifers at 27 months. Look at both cost per individual animal (dry and heifer) and cost for the entire group.

2. Lactating cows have to cover all the bills so it makes sense to include feed costs associated with heifers and dry cows when calculating feed costs for lactating cows; however, combining all feed costs into a single value does not allow you to determine whether specific costs are reasonable. You need to calculate the daily feed costs for lactating cows, dry cows, and replacements. These groups can be divided further; for example, early lactation cows and late lactation cows, young heifers and bred heifers, etc. Calculating feed costs for more specific groups can be useful in identifying what specific areas should be targeted for cost control, but it also requires substantially more time and effort to do so. The problem with feed costs expressed on a daily per cow basis is that it ignores milk production. A high producing herd is expected to have higher feed costs on a cow basis than a lower producing herd.

3. Feed costs per unit of milk accounts for differences in milk production. The most useful number is feed cost for lactating cows per cwt

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of milk. Including feed costs for dry cows and replacement (i.e., total feed costs/cwt milk) allows you to compare your farm to others but does not allow you to determine what areas of nutrition are cost-effective and which areas need work. The problem with expressing feed costs as $ for lactating cows/cwt of milk is that it ignores milk composition. Milk with a higher fat and protein concentration is worth more and may cost more to produce than milk with lower fat and protein.

4. Income over feed costs **(IOFC)** solves the problem of varying milk composition; however, IOFC is very sensitive to milk price. Feed costs can be excessive on a farm, but with a high milk price, the IOFC might look fine. On the other hand, a farm might have excellent feed cost control, but the price of milk is low making IOFC look bad.

No single expression of feed costs is appropriate for all situations. When evaluating a diet change, make sure you evaluate the correct measure of feed costs. If an additive is supposed to increase milk protein, do not evaluate that feed additive by comparing $/cwt of milk, use IOFC. On the other hand, if you are comparing last month's diet to this month and milk prices changed, $/cwt would be better than IOFC.

Feed Cost Control

Numerous factors affect feed costs and numerous approaches can be used to change them. Feed cost factors can be divided into the following broad classes:

1. Herd structure,
2. Ingredient selection,
3. Ration formulation specifications,
4. Feed wastage and shrink, and
5. Marketing/purchasing.

Marketing deals with contracting, futures, timing purchases, comparing suppliers, etc. These topics are beyond the scope of this paper (and my knowledge) and will not be discussed further.

Herd structure

How can you reduce feed costs by about $0.30/cwt of milk for a 100 cow herd averaging 70 lb of milk? Calve heifers at 24 months rather than 27 months. Herd structure, especially the number of replacements and dry cows (i.e., animals on welfare) has a substantial affect on feed costs. Reducing the number of heifers on the farm by calving at the correct age and keeping culling rate reasonable reduces the number of 'nonproductive' animals you have to feed (Table 1). Numerous resources are available on the proper feeding and management of heifers so that they will calve at the right age. Proper facilities, good nutrition and genetics, and general good cow management will all help keep culling at an acceptable rate. A little more attention to heifer management may have a much bigger effect on feed costs than the next 'new and improved' feed additive.

Ingredient selection

Often this is what most people start thinking about when controlling feed costs are discussed. The question that is often asked is "What can I feed that is cheap?", but the more correct question is, "What combination of ingredients will result in a lower cost diet, without adversely affecting milk yield"? Ingredient selection can have a substantial impact on feed costs, and ingredient prices should be monitored on a regular schedule. This does not mean diets should be changing constantly to chase the lowest ingredient prices. But, long term trends should be examined to determine if different ingredients should be included in diets. A study of ingredient costs from January 2005 through January 2009 was conducted by Dr. Normand St-Pierre (The Ohio State University, Columbus, personal communication) using prices from Ohio markets. Several feeds provided more nutrients per dollar than the general market the majority of the time (i.e., good buys most of the time). Conversely, several ingredients were consistently overpriced (i.e., provided fewer nutrients per dollar than the market average). Although past performance is no guarantee of future performance (this sounds like a disclaimer on a mutual fund), feeds in the 'Usually a Bargain' list should be considered, whereas feeds in the' Rarely a Bargain' list need to be evaluated carefully (Table 2).

The value, not the price, of an ingredient depends on its nutrient content and other factors, such as consistency, supplier support, and 'quality of the product'. An ingredient may be extremely cheap (or even free), but if it is spoiled and has pockets of mold throughout the load, it probably is worth less than free. A product that is highly variable in nutrient composition is worth less than one that is consistent, but at this time, we cannot put an dollar value on that. A supplier that can answer questions, provide technical support, and goes the extra mile to ensure your satisfaction provides definite value, but we cannot put a dollar value on it. The information in Table 2 does not consider any of the above factors, but you need to include those in your decision making.

Ration formulation specifications

We have reasonably accurate estimates for the requirements of many nutrients; however, in practice, diets are usually over formulated (i.e., a safety factor is used so that a diet exceeds the nutrient requirements of the average cow). A safety factor can be defined as the degree to which a nutrient is overfed to reduce the likelihood that the nutrient will be deficient or will limit milk production. For example, a cow may require 100 g of calcium for her level of milk production, but the diet is formulated to provide 120 g (a safety factor of 20%). For most nutrients, safety factors are absolutely essential to obtain maximal herd productivity. The question is not whether diets should be over formulated, but rather "How much should we over formulate?" The answer to that question is not a constant. It depends on milk price, feed costs, ingredients used, pen grouping system, farm/feed management, and also varies among different nutrients.

Some general relationships regarding safety factors include:

- As milk price increases and/or feed costs decline → Greater over formulation
- As milk price decreases and/or feed costs increase → Less over formulation
- Use of variable ingredients → Greater over formulation
- Use of consistent ingredients → Less over formulation
- Homogenous (parity, stage of lactation) pens → Less over formulation
- Heterogeneous pens →Greater over formulation
- Good feeding management (recipe is followed, test silage DM, proper mixing, standard operating procedures are used, etc.) → Less over formulation
- Poor feeding management → Less or greater over formulation
- Poor facilities/poor general management → Less over formulation

<u>Milk/feed prices</u>. The relationship between the magnitude of the safety factors and milk and feed price is basically risk versus reward. Over formulation of diets definitely increases feed costs. The higher the price of the ingredients, the higher the cost of over formulation. The reward of over formulation is potentially increased milk yields which may or may not occur. When milk is expensive and feed is cheap, the potential reward of more milk is usually worth the risk of higher feed costs. But when the opposite is true, a larger reward (i.e., greater marginal response in milk yield) is needed to cover the cost of over formulation.

Ingredient variation. The more variable the ingredients, the less confidence you have that the nutrient composition of the diet that is fed actually matches the formulated diet. On average, half the time, the diet will exceed your formulation goals, and half the time it will be below your goals. In theory, when a major nutrient is deficient, milk production will decrease, but when the nutrient is adequate, feeding more will not increase milk production. Therefore, the 50% of the time the diet contains more nutrient than expected, we do not expect a milk response, but the 50% of the time the nutrient is deficient, we expect milk yield to drop. The greater the variation (i.e., the less consistent the ingredients), the greater the potential drop in milk production.

Animal homogeneity within pens. A reason commonly given for over formulation is that if you feed for the average cow in the pen, cows producing above average will not get enough nutrients and yield will drop. This often will not occur because cows that produce more milk usually eat more feed, resulting in greater intake of nutrients. However, this is not true for early lactation cows; they can produce above pen average milk yields and have below pen average DM intake. The same is true for first lactation cows compared with more mature cows. Therefore, the variation in days in milk **(DIM)**, and to a lesser extent, parity, within a pen is usually more important than variation in milk yields. Pens that contain a diverse population of cows (based on DIM and parity) must be fed diets that substantially exceed the nutrient requirements of the average cow in the pen.

Feeding management. Good feeding management increases the confidence that the ration delivered to the cows is the ration that was formulated, and therefore, diets can be formulated to more closely match actual requirements. On the other hand, poor feeding management or poor general management may or may not dictate increased over formulation. With poor management, you are less confident that the formulated diet is the diet delivered to the cows, which could indicate the need for greater over formulation. On the other hand, poor management means that factors other than nutrient composition may be limiting production and over formulation will simply increase costs and not affect milk yield. Another factor that needs to be considered is cow health. Over formulating diets with respect to energy usually increases the risk of acidosis. Farms with poor management can be at high risk for acidosis, and feeding a diet with excess energy may lead to substantial problems.

Nutrients. The potential costs of overfeeding a specific nutrient (e.g., inflated feed costs, health problems, toxicity, etc.) must be balanced with the potential costs of underfeeding a specific nutrient (decreased milk yields, lower reproductive efficiency, health problems) when determining safety factors.

Vitamins and minerals. Mild underfeeding of these nutrients will likely not affect milk yields but could increase health problems, such as mastitis and retained fetal membranes and might reduce reproductive efficiency. For Ca, K, Na, and Cl, requirements are reasonably well-established (NRC, 2001) and few real-world antagonists exist; therefore, only a small safety factor (perhaps NRC plus 10%) is needed. For P, most available data show that current NRC requirement is more than adequate, so essentially no safety factor is required. A larger safety factor should be applied to Mg because high concentrations of dietary K (which frequently occur) substantially reduce Mg absorption. Trace mineral absorption is more likely to be impaired because of antagonists than most macrominerals, and therefore, larger (perhaps NRC plus 20%) safety factors for several trace minerals are justified. If known antagonists are present (e.g., S and Mo), then concentrations of specific trace minerals should be increased further. Based on recent studies (Weiss and Socha, 2005; Hansen et al., 2006), the NRC requirement for Mn is too low, and diets should contain approximately 2 times current NRC. The preponderance of available data show that feeding more than the current NRC recommendation for vitamins A and E to dry and lactating cows has no benefit (there are data showing positive effects of increasing vitamin E during the transition period). Although there are no data showing beneficial responses to feeding more vitamin D than currently recommended, there has been essentially no recent data evaluating vitamin D. In most cases, the safety factor for vitamins A, D, and E should be small (perhaps 10%).

Energy and protein. Rumen degradable protein **(RDP)** is inexpensive, but if it is deficient, milk yields could be reduced substantially. The NRC (2001) may overestimate the RDP requirement (Colmenero and Broderick, 2006), but because of low cost and potential positive milk or milk protein responses (Reynal and Broderick, 2005), actual dietary RDP should exceed the current NRC. The optimal safety factor for RDP has not been researched but probably is around 105% of NRC. Most feeds contain both RDP and rumen undegradable protein **(RUP)**; therefore, increasing RDP can also increase RUP and RUP is expensive. This is one reason why RDP should not be grossly overfed. Increasing RDP also increases MUN, and this has been related to reduced reproductive efficiency. Because the RDP requirement is a function of rumen fermentation and not milk production, the same safety factor can be applied to all lactating cows.

The optimum RUP is dependent on milk price, feed price, and the population of cows in a pen. If a pen includes cows of all stages of lactation (early, mid, and late lactation), in normal situations, the optimum milk production to balance for is about 1.25 X pen average milk yield (St-Pierre and Thraen, 1999), but you do NOT increase estimated DM intake based on the increased milk yield. For example, if the average cow in a pen is 150 DIM and produces 65 lb/day of milk, we expect her to eat about 50 lb/day of dry matter **(DM)**. When formulating the diet for the pen, provide enough RUP to meet the requirements of a cow producing 65 x 1.25 = 81 lb/day of milk, but keep estimated DM intake at 50 lb/day. In the era of high feed costs and low milk prices, that safety factor might not be optimal, but at the current time, we do not know the optimal value. Grouping cows based on stage of lactation will allow lower safety factors for RUP. For a group of cows, past peak DM intake, the RUP safety factor could be reduced to about 1.15 X pen average milk yield. The early lactation group should be fed at 1.3 X pen average milk yield. In theory, net energy for lactation **(NE_L)** should be fed at the requirement for the average cow in the pen, plus any desired change in body condition (i.e., no safety factor). The reason for this is that if cows are fed more energy than required, DM intake decreases so that NE_L intake is maintained. Because of all the errors in calculating NE^L, it should probably be slightly overfed based on the average cow in the pen. However, the best guide for establishing the safety factor for NE_L is to evaluate body condition score. If cows are too thin, increase energy density slightly. If cows are too fat, decrease energy density. Whatever adjustments are made, bear in mind the potential effects they might have on DM intake.

Feed wastage and shrink

Feeds that spoil during storage or are wasted during feed mixing or by the cow costs the same as the feed that was consumed by a cow. Feed shrink (defined as feed lost or spoiled during storage) and waste (feed lost during feed delivery and while in the feed bunk) is estimated at 5 to 10%. This means that if your cows consume 1000 tons of feed DM in a year, between 50 and 100 tons of feed DM was lost via shrink and waste. To reduce shrink, follow good silage making practices (harvest at correct DM concentration, chop at correct particle length, fill quickly, pack well, and cover the bunker with plastic). Some silage additives can also effectively reduce shrink. Reduce shrink of other feeds by protecting them during storage, feed out fast enough (e.g., wet brewers or wet distillers usually should be fed within 7 days of delivery) and ensure that they are the proper DM when delivered to the farm (e.g., a load of concentrate that is 82% DM rather than 88% will probably mold and should not be accepted).

Waste can be reduced by proper silo face management (when removing silage from the silo, do not disturb the face any more than necessary and only remove as much silage as will be fed that day). Properly designed and maintained feed bunks will reduce waste (head locks reduce feed waste, while breaks in the curb and holes in the feed bunk increase waste). Over filling feed bunks and offering too much feed over a day increases waste. In most situations, feed refusals for a pen of lactating cows should average about 2% of what was fed, but if bunk space is limited or if diets are high in starch (high risk for acidosis) the amount of overfeeding should be increased. Diets that are too dry or have a wide variety of particle sizes (e.g., long hay, concentrate, and silage) lead to more waste by the cows.

Summary

Controlling feed costs is more than simply buying cheap ingredients, although ingredient selection is important. Raising heifers to calve at 22 to 24 months and not having prolonged dry periods will reduce the feed dollars spent on unproductive units. Shop for nutrients and take advantage of local markets (e.g., Do you live near an ethanol plant?). Formulate diets for reasonable production goals. If factors such as poor facilities limit production rather than diet, do not waste money feeding for production that is not obtainable. Grouping cows based on stage of lactation, and to a lesser extent parity, will reduce feed costs by reducing over formulation.

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Table 1. Replacement herd size required to maintain a 100 cow herd (assumed a 10% cull/death rate for growing heifers)[1].

Cow Turnover, %	Age at First Calving, Months				
	22	24	26	28	30
26	53	58	63	67	72
30	61	67	72	78	83
34	69	76	82	88	94
38	77	84	92	99	106
42	86	93	101	109	117

[1]For example, if average age at calving was 26 months and the herd had a turnover rate of 34%, that herd would need to have 82 heifers at various ages to maintain a herd size of 100 cows.

Table 2. 'Bargain' feeds calculated from ingredient costs in Ohio from January, 2005 through January 2009 (N. St-Pierre, The Ohio State University, Columbus, personal communication)[1].

Usually a Bargain[2]	Sometimes a Bargain[2]	Rarely a Bargain[2]
Ground corn	Alfalfa hay	Beet pulp
Corn silage	Bakery byproduct	Blood meal
Distillers grains	Cottonseed meal	Citrus pulp
Feather meal	Meat and bone meal	Whole cottonseed
Corn gluten feed	Expeller soymeal	Corn gluten meal
Hominy	Soybean meal, 48% CP	Molasses
Roasted soybeans		Soybean hulls
Wheat midds		

[1]A bargain feed is defined as a feed whose value based on the concentration of net energy for lactation (NE_L), metabolizable protein, and effective neutral detergent fiber (NDF) is less than market average (nutrient costs determined using SESAME; The Ohio State University, Columbus, http://www.sesamesoft.com).

[2]Usually a bargain means that the feed was underpriced at least 75% of the time between January 2005 and January 2009; Sometimes a bargain was a feed that was underpriced between 25 and 74% of the time; Rarely a bargain was underpriced less than 25% of the time.