The Ethanol Revolution: How Will We Feed Cows in the Future?

Mary Raeth-Knight[1], Jim Salfer[2], and Jim Linn[1]
[1]Department of Animal Science, University of Minnesota, St. Paul
[2]University of Minnesota Extension, St. Cloud

Objectives of Dairy Nutrition

The main goal of dairy nutrition is to match the nutrient requirements of the cows with nutrients provided by feed ingredients. However, in addition, a quality dairy cow ration should optimize cow health and production, maximize forage feeding, minimize the excretion of nutrients and be cost efficient. This paper will outline current trends in feeding dairy cows and highlight some of the challenges we may face in the future when formulating dairy cow rations.

Trends

Forages: Increased use of corn silage and less alfalfa in dairy cow diets. In the last 10 years, states that ranked within the top 6 in milk production (CA, WI, NY, PA, ID, and MN) increased corn silage production from 120% to over 200%. In contrast, alfalfa production has either remained steady or slightly declined. Increased production and use of corn silage is most likely influenced by a number of factors. For example, corn silage is harvested once per season rather than three or more cuttings for alfalfa, which simplifies harvesting and storage. With a limited land base, corn silage also allows producers to harvest more tons of dry matter and TDN per acre than with legumes and grasses. Harvesting quality corn silage is less difficult than alfalfa, resulting in a more consistent feed ingredient. In contrast to alfalfa or grasses, corn silage contains both forage and grain and, therefore, provides a good source of fiber along with starch, which decreases the amount of additional grain required in the diet.

Forage fiber sources. Dairy cows need a minimum amount of longer fiber particles from forage to maintain rumen health. Even though it has a low nutritive value, there has been an increased use of straw in diets to provide a source of longer 'effective fiber'. In the future, we may see more tailoring of hay species (legumes and grasses) and quality to fit feeding method. For farms feeding long stemmed baled hay, soft stemmed high quality will be the desired hay forage; whereas, if the hay is chopped for feeding, a lower quality may be preferred to effectively meet fiber requirements. However, in some rations where corn silage and co-products will be providing the energy in the diet, high quality hay may not have an increased value over moderate quality hay.

Corn: Decreased availability of grain for use in dairy cow rations. Corn is increasingly being utilized for ethanol production. In 2000, the ethanol industry used approximately 600 million bushels of corn. This crop year, it is expected to reach 2.15 billion bushels and the projection for 2007 is 3.2 billion bushels. Currently, corn prices are at a 2½ year high. If this trend continues, starch will be one of the scarcest and highest priced nutrients in dairy rations and many dairy producers will be looking to alternative feeds as a replacement for corn. High producing cows need a certain level of starch (~25% diet DM) for good microbial protein production, rumen function and milk yield. However, as corn prices have increased, the prices for other grains that contain starch such as oats, barley and wheat have also increased.

One alternative to feeding corn grain is to feed more corn silage and fewer legumes and grass forages. Data from the University of Minnesota (Allen, 2001) indicate that feeding higher corn silage diets will allow dairy producers to feed decreasing corn diets with excellent performance. Cows were fed diets ranging from 31 to 50% corn silage (DM basis) and 28 to 0% corn (DM basis). Alfalfa hay was constant at 15% of ration DM. All diets resulted in at least 90 lb milk/day and cows receiving diets without any corn produced approximately 100 lb milk/day. It is important to note, however, that

cows were placed on their respective diet immediately after calving and as corn grain in the diet was decreased, additional fat was added to diets to achieve an equal energy level to the high corn diet.

Co-products: Increased availability of co-products for use in dairy cow rations. The amount of co-products from the ethanol, biodiesel and the food industry will continue to increase. Many of these co-products make excellent livestock feed. For dairy, however, there are three limitations to feeding large quantities of co-products:

Starch. To get top milk production, dairy rations need to contain about 25% of the DM as starch. In both the ethanol and food industry, the starch is utilized in the production of their respective products. Most co-products are very low or devoid of starch (Table 1).

Phosphorus. Most co-products from the ethanol or food industry are two to three times higher in phosphorus (P) content than corn (Table 1). Feeding high amounts of these co-products increases the total P content in the ration well above animal requirements. This will result in increased excretion of P in the manure and potentially P loading of the soil.

Protein. Most co-products contain more than 20% crude protein (CP) or 2 to 4 times the CP content of corn (Table 1). If co-products are used to replace feed ingredients in the ration that are low in CP (such as corn), it will be very difficult to formulate rations below 18% CP; especially if alfalfa is the major forage utilized in the ration. Feeding high protein rations results in more nitrogen excretion in the urine and manure, which will make it more difficult to comply with odor and air quality standards and increases the risk of surface and ground water contamination.

Table 1. Average starch, crude protein (CP) and phosphorus (P) content of co-product feeds.

Feed	% starch (as fed)	% CP (as fed)	% P (as fed)
Corn	**62**	**9**	**0.27**
Beet pulp, dry	2	9	0.10
Brewers grains	10	22	0.60
Canola meal	2	41	1.00
Corn gluten feed	12	24	1.00
Cottonseed	1	24	0.60
Distillers grains	10	28	0.70
Soybean hulls	1	10	0.10
Wheat midds	21	19	0.80

Mary Beth Hall (2003) and Dairy NRC (2001).

Distillers Grains

As the ethanol industry continues to rapidly develop, one of the major co-products of interest in dairy cow diets is distillers grains (DG). Currently, the ethanol industry produces 245 lb of distillers for every dairy cow in the U.S. This is the result of 17 lb of DG being produced from every bushel of corn utilized in ethanol production.

How much distillers grains can be included in lactating dairy cow rations?

In 2005, Kalcheur et al. conducted a meta-analysis of 24 studies in which wet or dried DG were fed to lactating dairy cows. The results are summarized in Table 2. Diets with greater than 30% DG resulted in decreased intake, milk yield and milk protein percent. However, the data indicated that DG can be fed up to 20% of the ration DM, about 10 to 12 lb/cow/day as fed, in lactating dairy cow diets without negatively impacting production.

Table 2. Performance of lactating dairy cows fed diets containing dried distillers grains with solubles (DDGS).

DDGS, % of DM	DMI, lb/d	Milk, lb/d	Fat, %	Protein %
0	48.9[b]	72.8[ab]	3.39	2.95[a]
4 to 10	52.2[a]	73.6[a]	3.43	2.96[a]
10 to 20	51.6[ab]	73.2[ab]	3.41	2.94[a]
20 to 30	50.3[ab]	73.9[a]	3.33	2.97[a]
>30	46.1[c]	71.0[b]	3.47	2.82[b]

[a,b] Means within a row without common superscripts are different at $P < 0.05$.

Things to consider when feeding distillers grains (DG).

Feeding high levels of DG (20% diet DM) may be possible in some dairy cow rations, but most producers stay at 10% of the ration or lower. Here are some things to watch out for and consider when feeding DG:

- The nutrient composition of wet and dried DG can be quite variable. If you are going to feed 10% or more of the ration as DG, know your source and nutrient quality guarantees.
- Wet DG in high corn silage or other fermented forage rations may result in rations being too wet, which could limit DM intake.
- DG and corn have similar energy values, but the energy in DG is from fat and in corn it is from starch. Substituting DG for corn grain will lower starch levels in the ration and may decrease milk production.
- Fiber from distillers is not 'effective' at promoting cud chewing or maintaining rumen function. Fiber from forage must be maintained in rations.
- High oil diets can depress milk fat test, especially with the use of Rumensin.
- Lysine levels in corn products are low and, therefore, lysine may be limiting in some DG diets.
- The high P content of DG may affect crop nutrient management plans.

Economics of DG replacing corn and soybean meal in lactating dairy cow rations:

The CP (28%) and net energy content (0.80 Mcal/lb) on an as fed basis of dry distillers grains with solubles (DDGS) is very similar to a 50 – 50 mix of corn and 47% protein soybean meal. Thus, from a protein and energy basis, adding 1 lb of DDGS into a ration should replace 0.5 lb of corn and 0.5 lb of soybean meal. Table 3 provides an economic value of DDGS at different corn and soybean meal prices. If DDGS can be purchased for less than the values shown in the table for your current corn and soybean meal price, substituting DDGS into the ration for a 50 – 50 replacement of corn and soybean meal will result in a ration cost savings.

Table 3. The economic value of dried distillers grain with solubles (DDGS) at varying corn and soybean prices.

	Soybean meal (47%), $/ton						
Corn $/bushel	**125**	**150**	**175**	**200**	**225**	**250**	**275**
2.00	$98.00	$110.50	$123.00	$135.50	$148.00	$160.50	$173.00
2.50	$107.00	$119.50	$132.00	$144.50	$157.00	$169.50	$183.00
3.00	$121.00	$133.50	$146.00	$158.50	$171.00	$183.50	$196.00
3.50	$125.00	$137.50	$150.00	$162.50	$175.00	$187.50	$200.00
4.00	$134.00	$146.50	$159.00	$171.50	$184.00	$196.50	$209.00
4.50	$142.50	$155.00	$167.50	$180.00	$192.50	$205.00	$217.50
5.00	$152.00	$164.50	$177.00	$189.50	$202.00	$214.50	$227.00

Conclusion

The demand for corn as an energy source has led to increased availability of co-products for use as livestock feeds and has increased the price of corn and other small grains. If these trends continue, we anticipate that some of the biggest challenges in feeding dairy cows in the future will be: 1) obtaining an economical starch source; 2) overcoming the limitations of incorporating high levels of co-products in dairy cow rations.