Feeding $10 Corn for Fun and Profits

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Take Home Message

1. The sudden feed price increases that we have experienced in the last two years are likely to be with us for the long-term, although strong price fluctuations are likely to occur in the short-term and well into the future unless there were to be radical changes in U.S. food and energy policies. Producers must learn to deal with this changed landscape.

2. Growing cost-efficient feeds such as corn silage affects directly the bottom-line. The selection of high-yielding, high-quality hybrids and varieties can substantially affect feed costs over the next 12 months.

3. If you grow a high-quality forage, it is critical to maintain its quality during harvest and storage. Optimal harvest time, kernel processors, effective silage inoculants, quick ensiling, intense packing, and effective covering of the silo are time-proven technologies and practices that have seen their economic values doubled in the last two years.

4. You can't keep purchasing the same feeds all the time! Feed markets change and a producer must periodically assess the economic value of the feeds being purchased.

5. Feeds should be used with predictable efficiency by the cows. The goal is not to achieve a very high feed efficiency (this can in fact be costly) but to achieve an optimum feed efficiency. A producer must measure what is actually being fed to monitor feed efficiency.

6. Verify that your feeding program is economically competitive. Calculate your income-over-feed costs and compare it to the Cow-Jones Index to determine your competitiveness.

7. Get the cows bred and keep the barn full.

Introduction

Feed costs have always been a dominant portion of the cost of producing milk in the United States. The unprecedented, nearly insane rise in market prices of all feedstuffs that has occurred in the U.S. in 2007 and 2008 has stimulated much interest in feed management and measures of the economic efficiency of feed use on dairy farms. A few years ago, $3/bu corn occurred sporadically following a disastrous crop year. We all knew then that corn would soon fall back in the $2/bu price range.

But 2007 brought us $3.50/bu corn with little hope for price reductions even in the long-term. Still, $6/bushel corn seemed impossible. Little did we know that spring 2008 was going to take care of this mental barrier. And few foresaw the corn and soybean prices meltdown that we experienced in mid-summer 2008. So what's next? Will we see $10/bu corn next winter, or will it be $2/bu? Are the futures markets really good predictors of the prices to come?

Whether we see $10/bu or $2/bu corn should not be vital to the management of a dairy farm. Clearly, high corn price would have brutal economic consequences – profitability certainly would be severely impacted, but the fact that we have permanently entered a new era of higher and more volatile feed prices should be sufficient in itself to justify a critical evaluation of one's entire feeding program. At a minimum, this entails:

1. Growing cost-efficient feeds,
2. Preserving the value of the harvested crops,
3. Purchasing the right feeds,
4. Targeting optimal feed efficiency from balanced diets, and
5. Ensuring "nutrition" competitiveness.

Growing Cost-Efficient feeds

For most farms in the U.S., this implies a greater proportion of crop acres dedicated to corn silage as opposed to grass and legumes. Although alfalfa contains considerably more crude protein than corn, most of the protein is highly soluble and, consequently, rumen-degradable. Over the years, the economic value of rumen-degradable protein (**RDP**) has declined markedly. Currently, it is pretty much worthless. So the additional protein in alfalfa is really not worth much, if anything at all. Corn silage, however, contains substantially more energy than either grass or alfalfa. The cost of dietary energy in dairy cow rations has nearly tripled in the last two years. Thus, a high energy forage such as corn silage is worth considerably more per ton than a medium or low energy forage. In addition, corn silage is a highly mechanized crop and is much less susceptible to the vagaries of the weather during growth and harvest than most other forage crops.

Regardless of the crop, the hybrid and variety selection is much more important now than in the past. The last decade has brought incredible innovations in plant breeding and genetics. There are vast differences between corn hybrids and plant varieties that affect dramatically yield and quality. In corn silage production, the right hybrid at the right place can significantly affect a dairy farm's bottom line.

Preserving the Value of the Harvested Crops

Harvesting at the right stage of maturity affects the quality of both haycrops and corn silages. At each cutting, the window of time for the optimal harvest of alfalfa is very short. Each day past the optimal cutting stage results on an average in a 1% drop in forage dry matter digestibility. Using today's prices, each day that the harvest is delayed past the optimal cutting time results in a $2.00-$3.00 per ton drop in the value of alfalfa hay.

Corn silage is generally more forgiving regarding optimal stage for harvest. With bunker silos, total plant moisture in the 65-68% range at harvest results in optimal digestibility and intake. This range generally provides a one week window for optimum harvest. The use of a kernel processor at harvest can lengthen the optimal window. Its effect can be noticeable when whole plant moisture drops under 65%.

Because the quality of the silage can deteriorate rapidly once the plant is chopped, it is very important to fill the silos quickly, to treat with an effective silage inoculant, to sufficiently pack bunker silos, and to cover the silo with an effective air barrier (plastic sheet) properly weighted down (discarded tires or other effective devices). Because of the increase in feed prices, the value of these practices and technologies has at least doubled in the last two years. So if they were cost efficient two years ago, imagine what their return is right now!

Purchasing the Right Feeds

Feed ingredients are constantly jockeying for a position in dairy rations. But markets are in constant fluxes; supply and demand keep changing. What may have been a bargain months ago may now be overpriced. A few years ago, we designed a new method for comparing feeds based on their market prices. The method has been computerized in a Windows-based software named *Sesame*[2].

As an example, Figure 1 reports the results for central California in mid-January 2009. These specific results are only applicable to central California, and only in mid-January 2009. I write a regular column on this topic in the Ohio State dairy newsletter (Buckeye Dairy News – accessible at http://dairy.osu.edu). Numerically, results would be different for Idaho or Wisconsin for example, but the conclusions reached would not be markedly different.

In Figure 1, the column labeled 'Actual' list the prevailing market prices for California in mid January (bulk, TTL delivered). The column labeled 'Predicted' reports the break-even prices calculated by Sesame. Hence, one can find in this table that rolled barley and canola meal are two feed ingredients that were particularly overpriced, whereas rice bran or distillers dried grains were definite bargains.

Periodically, producers should use a tool such as Sesame to determine whether what they are currently purchasing is predominantly in the bargain column as opposed to the over-priced one.

Targeting optimal feed efficiency from balanced diets

A nutritionally balanced diet should perform according to nutritional expectations. That is, the conversion of feeds into milk should be done with an efficiency that is predictable.

During the 1990's, it was often stated that the first objective of nutrition management and feed formulation was to maximize feed intake of lactating dairy cows. This dogma was derived from the strong association (correlation) between daily dry matter intake (**DMI**) and milk production. Of course, this interpretation was incorrect because a correlation (or simple regression) does not imply a cause and effect. Over time, field observations of DMI that were disproportionately high to milk production levels were being reported, raising concerns about the validity of the "maximize DMI" dogma. I remember all too well visiting a herd where apparent daily DMI exceeded daily milk

[2] Available at www.sesamesoft.com

production. Gradually, this dogma was replaced by one based on gross feed efficiency (**GFE**), which at first was simply expressed as pounds of milk per unit of DMI, and later replaced by slightly more complex measures such as pounds of 3.5% fat-corrected milk or energy-corrected milk per pound of DMI. Unless one is facing a situation of milk production with abnormally low or high fat content, the use of any of these energy corrected feed ratios generally leads to the same (and sometimes erroneous) conclusions as the simple GFE based on raw milk production.

There are some issues associated with the interpretation of the GFE.

Effect of stage of lactation on gross feed efficiency. Figure 2a presents typical lactation and DMI curves for a 1,500 lb cow in her third lactation, producing 22,000 lbs of milk per year with an average fat and true protein contents of 3.60 and 3.10%, respectively. Milk production peaks at 101 lbs/d at 50 day in milk (**DIM**), while DMI peaks at 58.5 lbs/d at 80 DIM.

Figure 2b shows the calculated GFE over the course of the lactation. Predictably, GFE is the highest in early lactation (2.21 in the first month), decreasing gradually over the lactation cycle to reach a value of 0.78 in the eleventh month. After the third month of lactation, the decline in GFE over time is nearly linear, dropping 0.11 unit per month of lactation (0.0037 unit per day). Over the entire lactation, GFE averages approximately 1.4, a value about equal to the GFE at 150 DIM. Because of the significant effect of DIM on GFE, it seems important that the benchmark be adjusted for DIM in herds that do not have uniform calvings throughout the year. Essentially, the benchmark should be reduced by 0.11 units for each month that the average DIM exceeds 150 d.

This also points out the importance of getting the cows bred. For each month that conception is delayed, the herd is expected to loose 0.11 point of feed efficiency. Using an average feed cost of $0.10/lb of dry matter, this means that a herd with an average DIM of 150d would be consuming 100 ÷ 1.4 = 71.4 lbs of feed DM per cwt produced, equating to a feed cost of $7.14/cwt. In contrast, a herd at 180 DIM would be consuming 100 ÷ 1.29 = 77.5 lbs of feed DM per cwt produced, equating to a feed cost of $7.75/cwt. The additional 30 days open costs the whole herd $7.75 - $7.14 = $0.61/cwt produced. In a herd of 2000 cows producing 22,000 lbs/year, the additional 30 days open results in a decreased profit of $268,000/year!

Effect of milk production level on gross feed efficiency. In theory, increased productivity should be associated with increased GFE due to the dilution of the maintenance requirements. In Figure 3, we calculated the GFE over a lactation cycle at three levels of production: 16,000, 22,000, and 28,000 lbs/year. The average GFE over the lactation cycle drops from approximately 1.6 to 1.4 when production is reduced from 28,000 to 22,000 lbs/year, and to 1.15 when production is further reduced to 16,000 lbs/year. Animal production has a profound effect on the expected GFE. If GFE is to be used as some sort of efficiency benchmark, it is clear that the target must be adjusted for the level of production in a herd. Whether the actual level of production is optimal is a very different question than whether the animals are converting feeds according to nutritional (physical) expectations.

Effects of ration energy density. The calculations done so far assume that the diets are formulated according to NRC requirements. For example a 1,500 cow producing 75 lbs/d of milk at 3.6% fat, 3.1% protein, and 5.7% other solids has a total NE_L requirement of 34.7 Mcal/d and is expected to consume 51.8 lbs of DMI per day, thus requiring a diet with an energy density of 0.67 Mcal/lb to attain a zero energy balance. Changing the energy density of the diet would likely alter DMI. We know enough about cows to calculate the expected GFE for diets of different energy densities (Table 1). Over a range of reasonable diet NE_L densities (0.65 to 0.74 Mcal/lb), GFE varies by nearly 0.2 units. Depending on the relative costs of grains, forages, and fats, increasing the energy density above the implied energy density "requirement" does improve GFE, but this may lead to reduced income. The important point here is to remember that **the objective should NOT be to maximize feed efficiency but to achieve a feed efficiency in line with the expectations.**

Setting up meaningful gross feed efficiency benchmarks. In Table 2, we propose target GFE for Holstein cows at different levels of milk production. If milk production is expressed in lbs of milk/cow per day (i.e., milk production for a herd - or for a pen - is at a given point in time) then the target GFE is read directly from the table. For example, a pen of cows milking 80 lbs of milk per day has a GFE benchmark of 1.54. If milk production is expressed as rolling herd average or other forms of annual production, then the benchmark GFE must be adjusted based on the current average days in milk of the herd (or pen) as explained previously. For example, a herd with a 22,000 lbs RHA at 180 DIM would have a target GFE of 1.4 (from the table) – 0.11 (to account for the month deviation in DIM from 150 d) = 1.29. In either case, because measurements of both production and DMI are subject to errors, deviations of actual GFE from target GFE of less than 0.05 unit should be ignored, while deviations of less than 0.10 unit should probably not be of any great concern. Of course, monitoring GFE is a worthless activity unless one ensures relatively accurate and precise measurements of both milk production and DMI.

Diagnostics and interventions.

<u>Measured GFE is greater than target GFE (feed efficiency seems too good to be true):</u>

1. Some diet components may have an actual energy concentration greater than the value used in feed formulation. You may consider gradually replacing some of the more expansive, energy dense ingredients by cheaper and less energy dense feeds.

2. Are the cows loosing an excessive amount of weight and condition score? If so, you'll be paying back later with much added interest… Physical factors such as rumen fill or other management factors could be limiting intake. The digestibility of the diet and/or its energy density may need to be raised.

3. Verify the numbers. Forage moisture may in fact be less than values used for diet formulation. Also, ensure that the correct head count was used to calculate DMI.

4. Verify the feed (mixer) scale.

<u>Measured GFE is less than target GFE (feed efficiency seems bad)</u>

1. Are the cows gaining an excessive amount of weight and body condition? If so, this indicates a fundamental problem with the diet or the management of the animals. Somebody needs to intervene.

2. Some diet components may in fact have a lower energy concentration than the one used for balancing the diet. For example, forages may not be as digestible as calculated. Try increasing the ration energy density if at all possible.

3. Verify the numbers. Forage moisture may be greater than the value used for balancing the diet. Verify the head count used for calculating DMI. Ensure that intake is solely for lactating dairy cows and does not include dry cows, pre-fresh cows, shortly fresh cows, or even replacement heifers. Sometimes, DMI is based on the amount of feed offered and has not been corrected for feed refusal and wastage.

Ensuring Nutrition Competitiveness

Whereas physical feed efficiency tries to answer the question "are the cows processing (digesting) the diet in line with what should be expected?", economic feed efficiency attempts at answering "is the feeding program economically optimal; is it competitive?". It is important to note here that the objective should *never* be to minimize feed costs per hundredweight of milk. Although not quite correct, the maximization of income-over-feed-costs (**IOFC**) acts as a reasonable target for management.

We are all aware of the striking gyrations of milk prices in the U.S. over the last decade. Figure 4 shows adjusted Class III milk prices in FMMO from January 2005 through October 2008. Milk prices averaged $15.29/cwt, with a minimum of $11.17/cwt in May of 2006 and a maximum of $22.00/cwt in July 2007. What is often forgotten is that in most FMMO, milk is now component priced. That is, most of the mailbox price is in fact determined by prices and milk composition for fat, protein, and other solids (**OS**). Figure 5 reports the evolution of fat, protein and OS prices over the same period of January 2005 through October 2008. This figure makes evident that much of the substantial increases in milk prices experienced in 2007 were due to sharp increases in milk protein prices and to a lesser extent to OS prices.

For a long time, the USDA has tracked a measure of economic efficiency using the milk-to-feed (**MTF)** ratio, essentially the ratio of the price of a cwt of milk (numerator) to the cost of 50 lbs of corn, 8 lbs of whole soybeans, and 41 lbs of hay (denominator). For some reasons, economists like to bring almost everything into a ratio. The MTF fails to be a reliable benchmark of profitability for many reasons, most importantly because it is a ***ratio*** of two entities, whereas profitability is the ***differences*** between two entities (net income = revenues minus expenses). We have proposed a new benchmark based on the difference between milk revenues and the costs of providing the required nutrients. This benchmark is completely dissociated from any specific diet. *Sesame* is used to calculate the cost of the nutrients and the requirements are calculated using the National Research Council tables of nutrient requirements.

Figure 6 shows the evolution of unit costs for net energy for lactation (**NE_L**), metabolizable protein (**MP**), and effective NDF (**e-NDF**) during the period of January 2005 through October 2008 for the midwest (ne-NDF costs are not presented because they didn't vary much during this period of time). From this figure, it is evident that the rises in feed prices experienced over the last 18 months have translated, as expected, in increased unit costs of nutrients, although nutrients have shown different patterns over time.

Calculating the benchmarks. Table 3 shows in details how the economic efficiency benchmark is calculated, using price and cost figures for February 2008. A spreadsheet to assist making these calculations (Cow-Jones-Index.xls) can be downloaded at http://dairy.osu.edu.

The primary outcome of these calculations is what we have facetiously named the *Cow-Jones Index* (**CJI**). Just as people can track the performance of their stocks investments by comparing their returns to the Dow-Jones Index, dairy producers and their nutritionists can now compare over time their nutrition costs and milk revenues to an index that summarizes the movement of both the milk and the feed markets (Figures 7 and 8).

Diagnostics and intervention. When a herd's IOFC deviates substantially from the CJI, the following questions must be addressed:

1. Are you growing or buying the right feeds? *Sesame* can be used to answer this question.
2. Are you buying competitively (i.e., are you a good buyer)?
3. Are you assembling the correct diet? Are feed put in the right combination?
4. What DMI are you using, the one on the feeding chart or the one actually consumed?
5. Who pays for feed refusals? Who pays for feed shrink?
6. What costs are you using? Are forage priced based on their total costs of production (including storage) or just variable costs?
7. Are feed converted to milk as expected (i.e., is the GFE near its target)?

Other non-feed actions

1. Get cows pregnant. We calculated the additional feed consumed per cwt of milk due to additional days open. The total economic losses due to poor reproduction are in fact much greater than just the additional feed costs. It takes the same amount of labor (and parlor capital) to milk a cow producing 50 lbs/d compared to a cow producing 100 lbs/d. So many other costs when expressed per cwt go up with poor production and reproduction.

2. Keep the barn full. The depreciation and barn maintenance costs the same whether the barn is full or half-full. Recently, I have seen many small and medium sized herds with unfilled barns. This can get very costly very rapidly.

Table 1. Effect on ration net energy for lactation (NE_L) density on target gross feed efficiency (GFE) for Holstein cows producing 75 lbs/d of milk at 3.6% fat, 3.1% protein, and 5.7% other solids.

NE_L (Mcal/lb)	DMI (lbs/d)	Target GFE	Forage (% of DMI)[1]	Forage (lbs/d)	Grain (lbs/d)
0.65	53.4	1.40	66.7	35.6	17.8
0.66	52.6	1.43	63.3	33.3	19.3
0.67	51.8	1.45	60.0	31.1	20.7
0.68	51.0	1.47	56.7	28.9	22.1
0.69	50.3	1.49	53.3	26.8	23.5
0.70	49.6	1.51	50.0	24.8	24.8
0.71	48.9	1.53	46.7	22.8	26.1
0.72	48.2	1.56	43.3	20.9	27.3
0.73	47.5	1.58	40.0	19.0	28.5
0.74	46.9	1.60	36.7	17.2	29.7

[1] Forage and grain amounts are calculated assuming an NE_L of 0.55 Mcal/lb for forage and 0.85 Mcal/lb for grain. Shaded cells are according to NRC (2001).

Table 2. Target gross feed efficiency (GFE) for Holstein herds at various levels of milk production expressed either as rolling herd average (RHA) or average daily milk production.

RHA (Lbs/y)	Target GFE	Milk production (Lbs/cow per d)	Target GFE
16,000	1.16	55.0	1.25
17,000	1.20	57.5	1.28
18,000	1.24	60.0	1.32
19,000	1.29	62.5	1.35
20,000	1.32	65.0	1.38
21,000	1.36	67.5	1.41
22,000	1.40	70.0	1.44
23,000	1.43	72.5	1.46
24,000	1.47	75.0	1.49
25,000	1.50	77.5	1.51
26,000	1.53	80.0	1.54
27,000	1.56	82.5	1.56
28,000	1.58	85.0	1.58
29,000	1.61	87.5	1.60
30,000	1.63	90.0	1.63
31,000	1.65	92.5	1.64
31,000	1.68	95.0	1.66

Table 3. An example of the calculation of the Cow-Jones Index (a.k.a., income over nutrient costs) for February 2008.

Animal Inputs				
Cow weight (lbs)	1500			
Milk (lbs/d)	65			
Fat (%)	3.6			
Protein (%)	3.0			
Other solids (%)	5.7			
Milk component prices input (from FMMO)				
Fat ($/lb)	$ 1.3010			
Protein ($/lb)	$ 4.0180			
Other solids ($/lb)	$ 0.0803			
Nutrient unit costs inputs (from Sesame)				
NE_L ($/Mcal)	$ 0.1330			
Metabolizable protein ($/lb)	$ 0.2922			
Effective NDF ($/lb)	$ 0.0732			
Non-effective NDF ($/lb)	$(0.0906)			
Nutrient requirements (from NRC)				
NE_L (Mcal)	31.33			
Metabolizable protein (lbs)	4.64			
Effective NDF (lbs)	10.15			
Non-effective NDF (lbs)	3.38			
Milk income	**$/cow/day**		**$/cwt**	
Fat	$ 3.04		$ 4.68	
Protein	$ 7.84		$ 12.05	
Other solids	$ 0.30		$ 0.46	
TOTAL		$ 11.18		$17.20
Nutrient Costs				
NE_L	$ 4.17		6.41	
Metabolizable protein	$ 1.36		2.09	
Effective NDF	$ 0.74		1.14	
Non-effective NDF	$(0.31)		$(0.47)	
TOTAL		$ 5.96		9.17
Income over nutrient costs		$ 5.22		8.03
The Cow-Jones Index			**8.03**	

Figure 1. Example of an output from the *Sesame* program prepared for central California in mid-January 2009.

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PricePredictionReliability	40.817

Estimate of Nutrient Unit Costs		
Nutrientname	Estimate	
NEI -3X (2001)	0.063770	**
RDP	0.108014	~
Digestible RUP	0.457194	**
ne-NDF	0.033079	~
e-NDF	0.135773	**

- A blankmeans that the nutrient unit cost is likely equal to zero
- ~ meansthat the nutrient unit cost may be close to zero
- * means that the nutrient unit cost is unlikely to be equal to zero
- ** means that the nutrient unit cost ismost likely not equal to zero

Calibration set							
Name	Actual [/T]	Predicted [/T]	Lowerlimit	Upperlimit	Corrected	75.0% CI	75.0% CI
Alfalfa Hay #1 -25.0 CP, 3	225.000	238.434	220.971	255.898	263.071	245.607	280.535
Alfalfa Hay #2 -20.0 CP, 4	200.000	219.331	200.843	237.818	230.208	211.721	248.696
Almond Hulls	128.000	150.957	135.022	166.892	-	-	-
BarleyGrain, rolled	210.000	163.317	153.018	173.617	-	-	-
Blood Meal, ring dried	700.000	651.849	618.124	685.574	-	-	-
Canola Meal, mech. extrac	330.000	253.312	237.400	269.225	-	-	-
Corn Germ Meal	200.000	233.617	218.724	248.510	-	-	-
Corn Grain, steam flaked	190.000	162.185	149.287	175.083	-	-	-
Corn Silage -Central Valle	55.000	65.236	59.792	70.681	65.236	59.792	70.681
Cotton Seed Hulls	220.000	171.928	141.401	202.455	-	-	-
Cotton Seed Meal, 41% C	310.000	338.147	325.166	351.128	-	-	-
Cotton Seed, Whole w lint	317.000	294.836	269.280	320.393	-	-	-
Distillers Dried Grainsw S	180.000	257.064	241.035	273.094	-	-	-
Feathers Hydrolyzed Meal	500.000	513.857	491.431	536.283	-	-	-
Gluten Feed, dry	210.000	215.917	204.804	227.030	-	-	-
Gluten Meal, dry	490.000	515.814	490.959	540.669	-	-	-
Hominy	180.000	154.761	143.546	165.976	-	-	-
MeatMeal, rendered	330.000	368.796	347.341	390.251	-	-	-
Molasses, Sugarcane	175.000	88.474	78.426	98.521	-	-	-
Pima Cottonseed, craked	282.000	309.139	286.290	331.988	-	-	-
Rice Bran	140.000	178.896	164.968	192.824	-	-	-
Soybean Hulls	185.000	166.312	139.601	193.023	-	-	-
Soybean Meal, expellers	405.000	416.517	398.999	434.035	-	-	-
Soybean Meal, solvent 44	360.000	318.719	297.028	340.409	-	-	-
Soybean Meal, solvent, 48	370.000	358.435	339.372	377.497	-	-	-
Tallow	250.000	261.742	220.838	302.645	-	-	-
Wheat Bran	157.000	157.908	139.498	176.319	-	-	-
WheatMiddlings	160.000	169.324	153.109	185.538	-	-	-

Appraisal set			
Name	Actual [/T]	Predicted [/T]	Corrected
Fish Anchovy Meal, mech.	920.000	483.224	-

Sesame 3.03: Regression results (Sesame [Administrator])

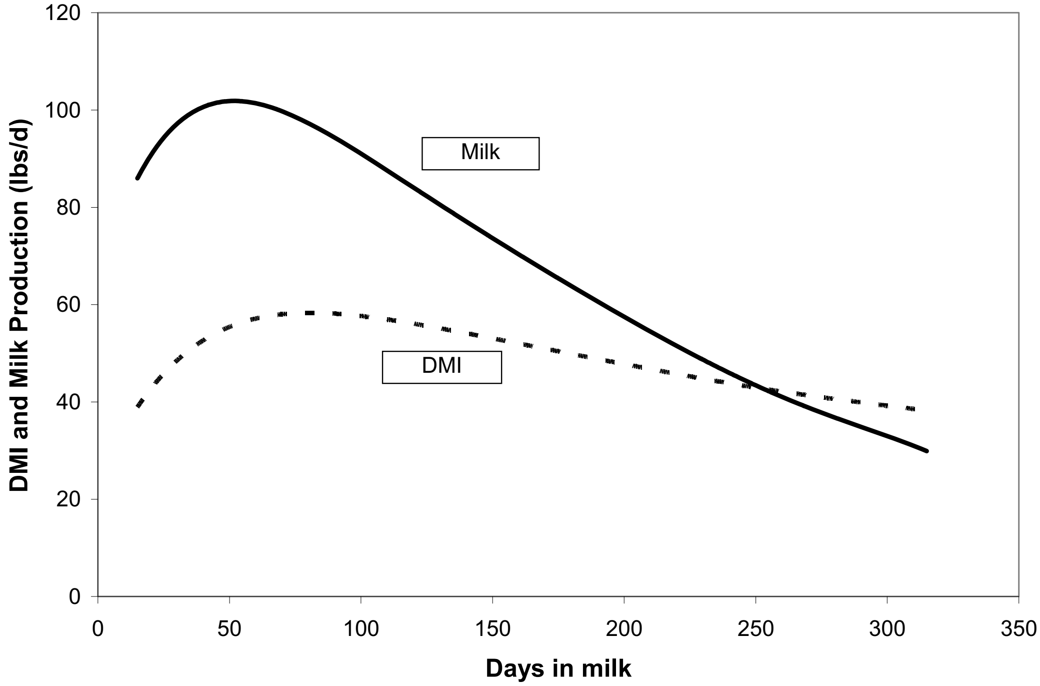

Figure 2a. Daily dry matter intake (DMI) and milk production of a third parity cow producing 22,000 lbs of milk in 330 days. Lactation curve was calculated using a gamma function (Kellogg et al., 1977); DMI was estimated according to NRC (2001).

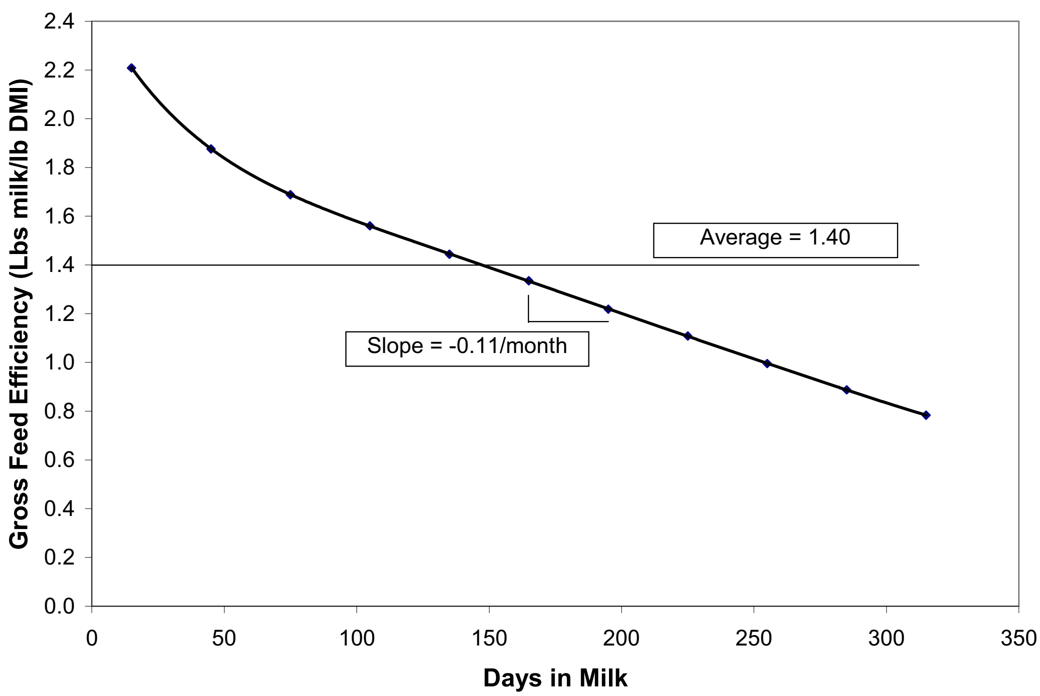

Figure 2b. Instantaneous gross feed efficiency across a lactation cycle for a cow with production and intake characteristics reported in Figure 1a.

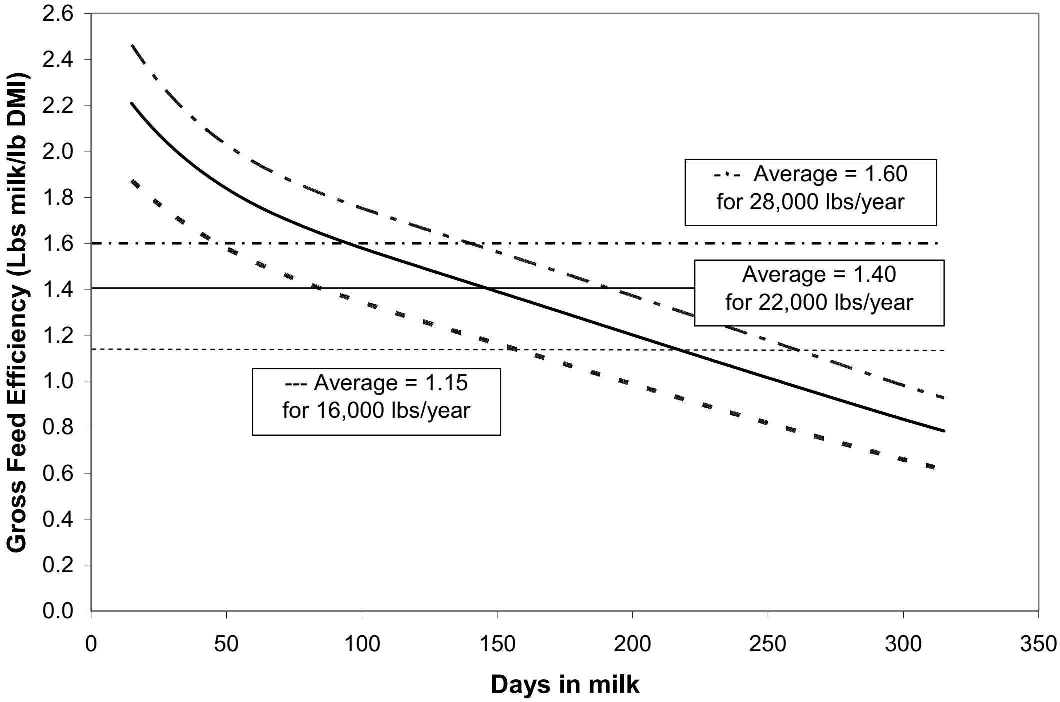

Figure 3. Comparative gross feed efficiency across a lactation cycle for a cow producing 16,000 (---), 22,000 (—) and 28,000 (-▪ -) lbs of milk in a 330 d lactation.

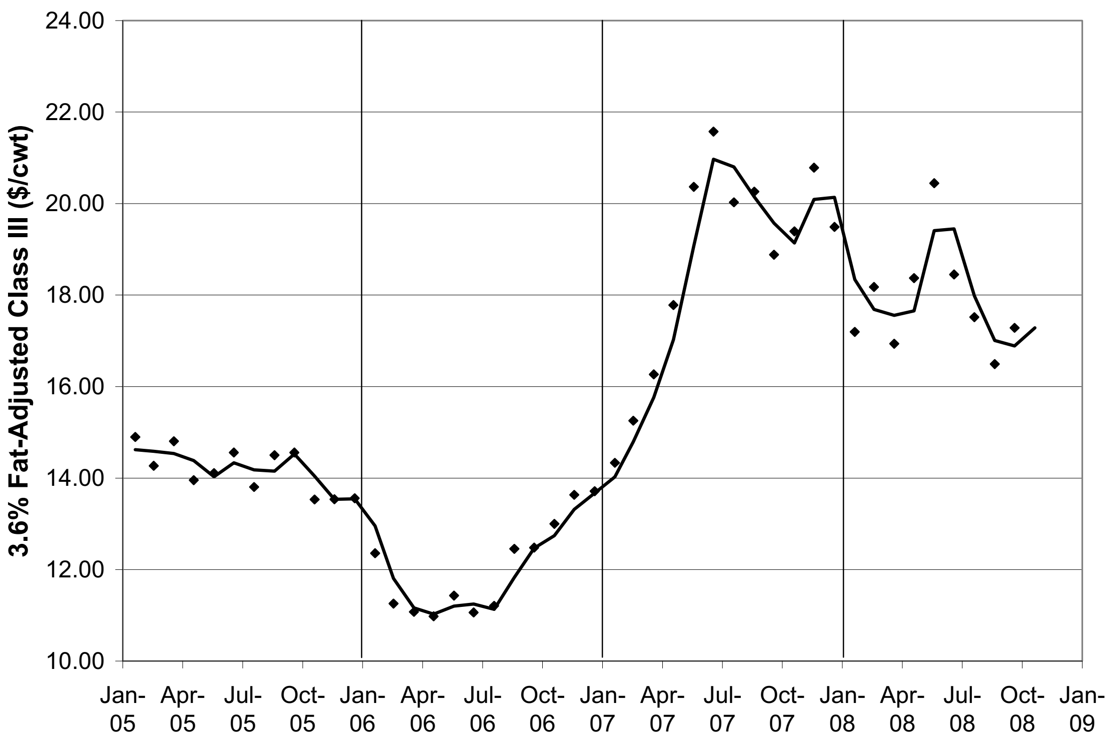

Figure 4. Uniform milk prices in Federal Orders from January 2005 through October 2008.

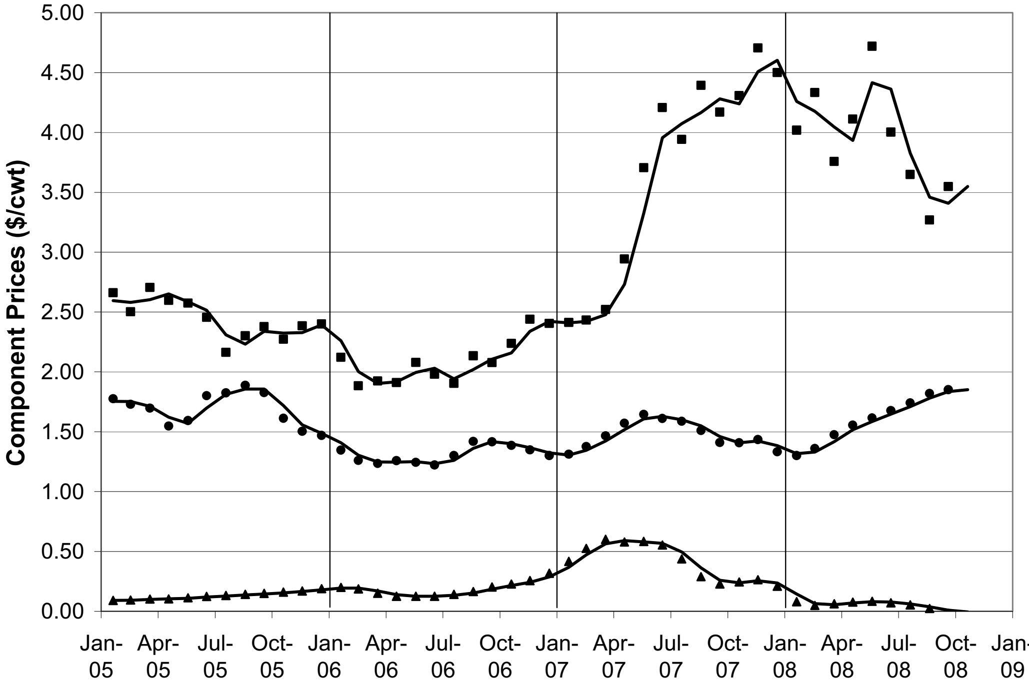

Figure 5. Milk component prices in Federal Orders from January 2005 through October 2008; ■ = protein ($/lb), ● = fat ($/lb), and ▲= other solids ($/lb).

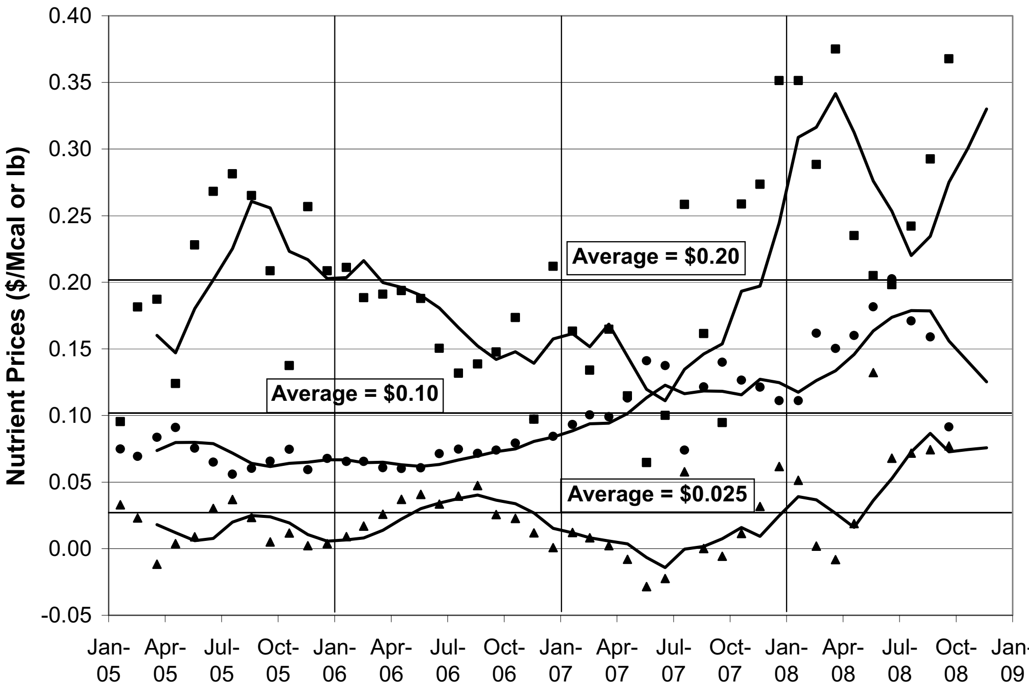

Figure 6. Costs of nutrients between January 2005 and October 2008; ■ = cost of metabolizable protein ($/lb), ● = cost of net energy for lactation ($/Mcal), ▲ = cost of effective NDF ($/lb). Results are from *Sesame*, using central OH prices.

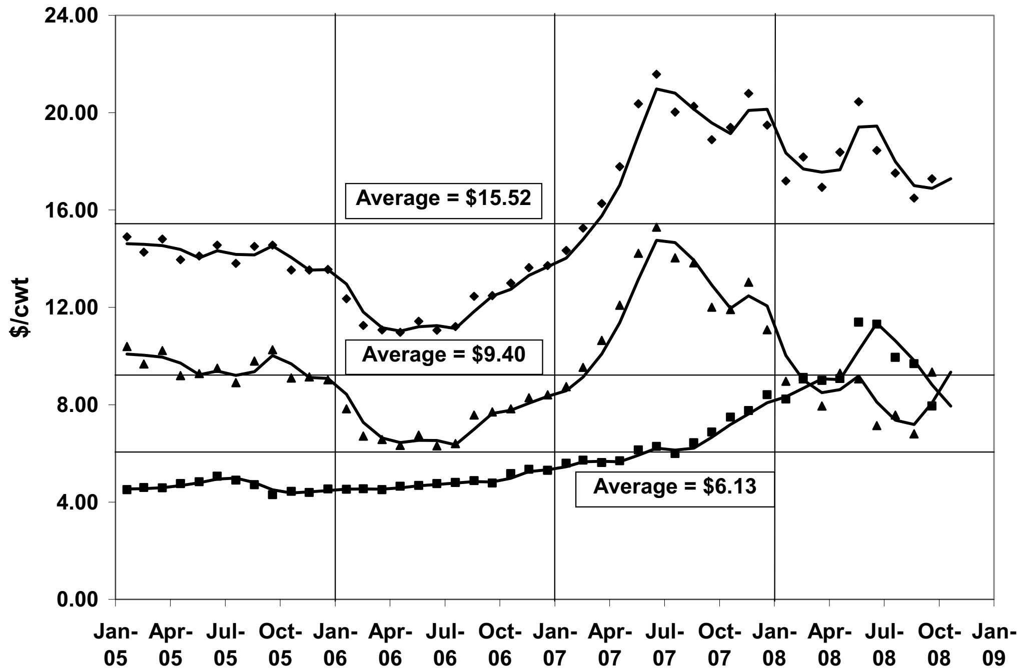

Figure 7. Milk revenues (■), nutrient costs (●), and income-over-nutrient-costs (▲ – the Cow-Jones Index) between January 2005 and October 2008.

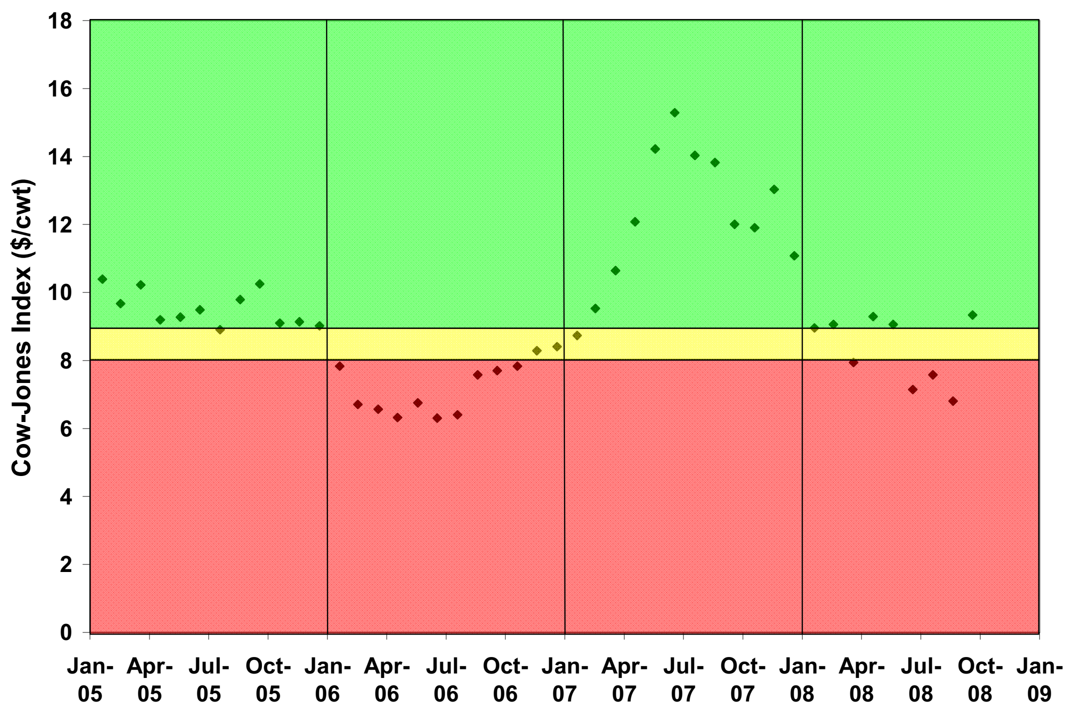

Figure 8. The Cow-Jones Index between January 2005 and October 2008. The average dairy producer loses money when the index falls below $8.00/cwt, makes money when it exceeds $9.00/cwt, and experiences variable and marginal profitability when the index falls between $8.00 and $9.00/cwt.