Industry Presentation

Feed Efficiency Is an Important Management Tool for Dairy Producers

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Introduction

The ability of dairy cows to convert feedstuffs into products for human consumption is generally referred to as *feed efficiency* and is expressed as pounds of milk produced per pound of dry matter consumed. This expression represents a gross measure of feed efficiency and does not account for nutrients partitioned to reproduction, growth, and tissue deposition; thus interpretation of the value obtained should consider stage of lactation, age, and stage of gestation for the herd in question.

Feed efficiency is often used to evaluate the diet formulation, but can be misinterpreted if environmental and management factors are ignored. The purpose of this presentation is to present an argument for the use of production efficiency, expressed as pounds of 3.5 % fat-corrected milk (**FCM**) produced per lb of dry matter intake (**DMI**), as a management tool and discuss some of the factors that influence production efficiency.

Measuring Feed Efficiency

The generally excepted measure of feed efficiency (**FE**) is pounds of milk produced per lb DMI consumed. This method does not account for the variation in milk fat produced, thus it is not always a good expression of the relationship between energy input and energy output. The use of 3.5 % FCM as calculated by the equation: 3.5 % FCM = (0.432 x lb of milk) + (lb of fat x 16.23) is preferred, because it corrects for milk fat content.

The use of 3.5 % FCM is particularly important when evaluating feed efficiency in Jersey herds. A Jersey herd that I interact with produces 64 lb of milk containing 3.9 % true protein and 5.1 % butterfat and consumes 48 lb of dry matter **(DM)** daily. The unadjusted milk FE is 1.33, whereas the 3.5 % FCM FE is 1.68. The difference in these two numbers is obvious and leads to very different conclusions on the status of the herd. A Holstein herd that I interact with produces 103 lb of milk containing 3.2 % true protein and 3.61 % butterfat and consumes 60 lb of DM daily. The unadjusted milk FE is 1.72, whereas the 3.5 % FCM FE is 1.74. The difference in these two numbers is not obvious and leads to the same conclusion.

The most difficult part of the FE equation to obtain in a herd is DMI. Some herds 1) use feed delivery systems capable of weighing the various diet components and the amount of total mixed ration (**TMR**) delivered to individual pens, 2) estimate daily feed refusal, and 3) record daily TMR offered, while others do not accurately measure the amount of feed consumed. Estimating DMI for herds that offer hay ad libitum or utilize pasture is particularly difficult.

The milk component of the equation can be obtained from bulk tank weights and butterfat percentage from the milk plant; these values can be used to estimate daily production per cow, if an accurate count of the number of cows contributing to the total is recorded daily. The use of daily milk shipped and daily DMI provides a reasonable estimate of FE for the whole herd. Daily milk production and feed consumed per pen provides more useful values for diagnostic purposes, particularly if cows are sorted by stage of lactation.

Feed Efficiency as a Diagnostic Tool

The goal for FE, on a whole herd basis, for a typical herd is 1.5 lb or more of 3.5 % FCM per lb of DMI. A typical herd is defined herein as consisting of 25 % early lactation cows, 25 % late lactation cows, and 50 % in between. Feed efficiency would normally average approximately 1.8 for early lactation cows, 1.3 for late lactation cows, and 1.5 for the middle group. Figures 1 and 2 illustrate changes in FE for primiparous and multiparous cows during the first 75 days of lactation. The two lines in these figures represent cows on two different diets; FE was not influenced by diet in this study.

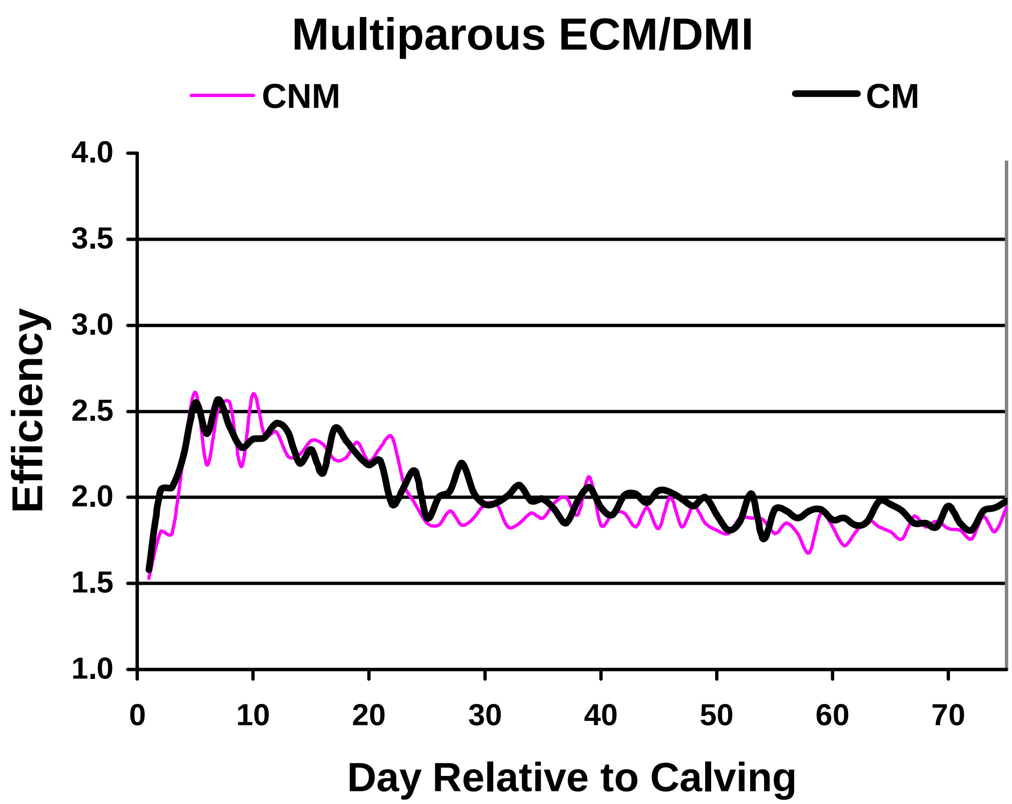

Figure 1. Effect of days in milk on feed efficiency in multiparous cows fed molasses (CM) or not fed molasses (CNM).

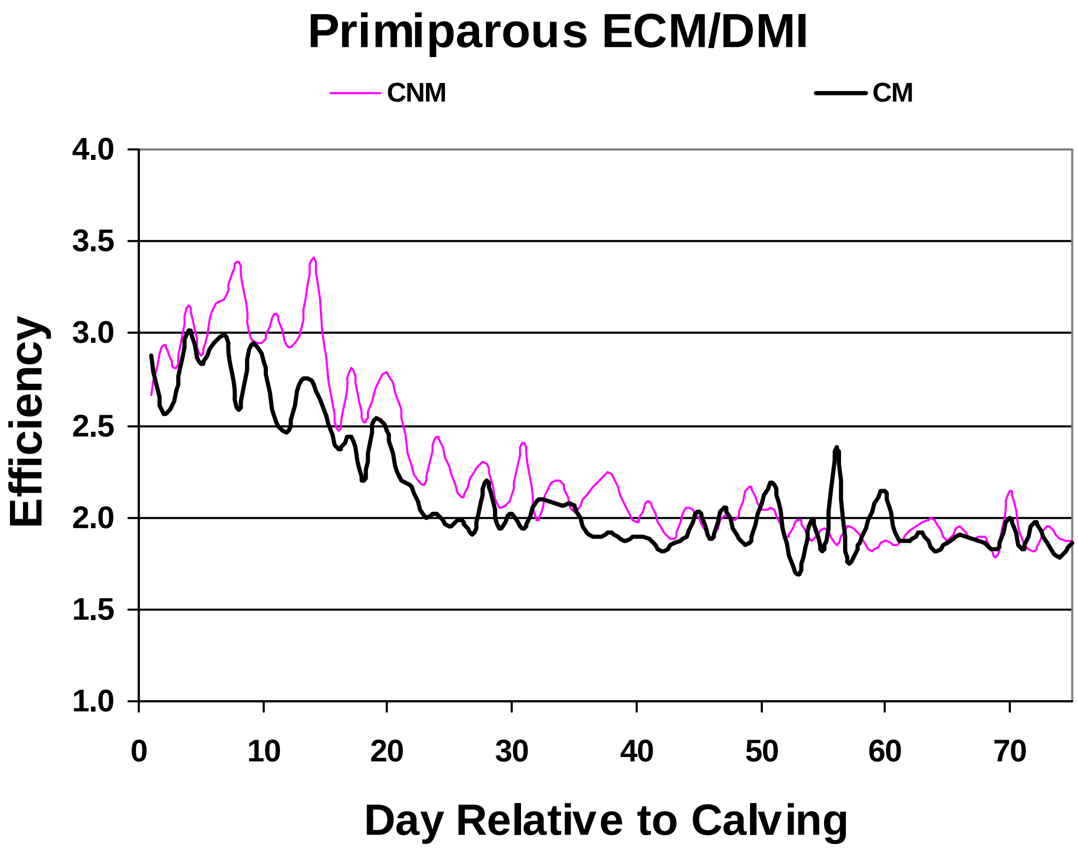

Figure 2. Effect of days in milk on feed efficiency in primiparous cows fed molasses (CM) or not fed molasses (CNM).

Tables 1 and 2 contain production data for Holstein cows offered three different diets during the first 30 weeks of lactation and illustrate the influence of diet and stage of lactation on FE. Feed efficiency in this study was expressed as energy corrected milk (**ECM**) divided by DMI and is similar to the value obtained when 3.5% FCM is used. Energy corrected milk accounts for the true protein content of milk and is calculated using the equation: ECM = (0.327 x lb of milk) + (lb of fat x 12.95) + (lb of protein x 7.2). Cows consuming diet C were more efficient during weeks 1-13 but significantly less efficient during weeks 14-30 of lactation. The logical explanation for this difference is that cows fed diet C used more tissue energy to support milk production during weeks 1-13 and partitioned feed energy during weeks 14-30 to replenish body energy stores.

These data illustrate the importance of evaluating FE according to stage of lactation and the impact of diet formulation during early lactation on total lactation production and FE. It is important to note that the difference in FE during weeks 14-30 was due to differences in milk yield; DMI was similar across diets. The impact of diet on FE can be determined in this study because management and environmental factors were similar for all cows. Dietary factors that influence FE include

Table 1. Effect of diet and stage of lactation on performance during weeks 1-13.[1]

Item	Diet				
	C	WCGF	SHSL	SEM	P=
DMI, kg/d	23.4	24.9	24.4	0.79	0.28
DMI, % of BW	3.61[b]	3.79[a]	3.88[a]	0.09	0.0002
Milk, kg/d	41.2	44.9	43.9	1.59	0.24
ECM, kg/d	43.2	45.3	44.1	1.60	0.53
ECM/DMI	1.96	1.86	1.85	0.058	0.22

[a,b]Means within a row not bearing common superscript differ (P < 0.01).
[1]The diets in this example were: C= Alfalfa hay, corn silage corn grain based diet; WCGF=20% of DM from hay, corn silage, corn grain, and soybean meal replaced with wet corn gluten feed; and SHSL=20% of DM from hay, corn silage, corn grain, and soybean meal replaced with a mixture of soybean hulls and corn steep liquor (75% soybean hulls. 25% corn steep liquor; DM basis).

Table 2. Effect of diet and stage of lactation on performance during weeks 14-30.

Item	Diet[1]				
	C	WCGF	SHSL	SEM	P=
DMI, kg/d	26.6	25.6	27.4	0.92	0.56
DMI, % of BW	4.42	4.26	4.42	0.014	0.99
Milk, kg/d	35.1[b]	39.7[a]	42.1[a]	0.87	0.003
ECM, kg/d	36.3[b]	39.9[a]	40.9[a]	0.57	0.0003
ECM/DMI	1.37[d]	1.56[c]	1.49[c]	0.037	0.014

[a,b]Means within a row not bearing common superscript differ (P < 0.01).
[c,d]Means within a row not bearing common superscript differ (P < 0.05).
[1]The diets in this example were: C=Alfalfa hay, corn silage, corn grain based diet; WCGF=20% of DM from hay, corn silage, corn grain, and soybean meal replaced with wet corn gluten feed; and SHSL=20% of DM from hay, corn silage, corn grain, and soybean meal replaced with a mixture of soybean hulls and corn steep liquor (75% soybean hulls, 25% corn steep liquor; DM basis).

digestibility, nutrient content, and nutrient balance.

Feed efficiency is not a constant across herds or within a herd throughout the year. The dairy cow has the ability, through the neuro-edocrine system, to partition nutrients to meet physiological demands in order to maintain normal body functions. Maintenance demands usually have priority over production functions, such as lactation and reproduction; an exception appears to be mammary function during early lactation when body tissue is mobilized in support of lactation. However, mammary priority does not trump maintenance for an extended period because, if nutrient delivery is insufficient to support lactation and rebuild body tissue stores then milk production decreases to the level that nutrient intake can support and meet maintenance requirements. In these instances, DMI is maintained, milk production decreases, and FE decreases.

Nutrient partitioning away from the mammary gland to support maintenance also occurs when temperature rises above or drops below the lactating cow's thermal neutral zone. Feed efficiency during summer months is often less than that observed during the cool seasons, because nutrients are partitioned to maintain normal body temperature. Dry matter intake may also be negatively impacted by elevated temperature, but not in proportion to milk production.

It is important to remember that mammary function is a luxury except during early lactation, thus only nutrients supplied above maintenance are available to support milk production. Therefore, environmental and management conditions that increase maintenance will reduce milk yield and FE. It seems logical to assume that excessive exercise, uncomfortable free stalls, and other conditions that interfere with cow comfort and rest time will have a negative impact on FE.

Economic Importance of Feed Efficiency

Feed is the largest single cost to dairy producers and its efficient use will improve net income and reduce potentially negative impacts on the environment. The following example illustrates the economic importance of even small changes in FE. Assumptions: Holstein cows weighing 1400 lb and producing 90 lb of milk containing 3.5% butterfat and consuming 58 lb of DM daily. Feed cost is $3.59 per day or $0.062 per lb of DM. Feed efficiency, 3.5% FCM = 1.55. The value of 3.5% FCM is $0.14 per lb. Thus, the total value of the product per day is $12.60 at a daily feed cost of $3.59 or income over feed cost of $9.01. If feed efficiency can be increased to 1.6 then DMI per 90 lbs of milk would be 56.25 lbs at a daily cost of $3.49. Income over feed cost in this case would be $9.11 or an increase of $0.10 per cow daily. Other examples might involve an increase in milk yield without a corresponding increase in DMI which would, likely, involve an improvement in diet digestibility or a reduction in maintenance requirements.

The recent approval of Rumensin® (Elanco, Greenfield, Ind.) for lactating dairy cows is of interest because it improves 3.5 % FCM FE by modifying ruminal digestion favorable to milk production. The specific effect of Rumensin tends to be diet specific, but in most cases an improvement of 2 to 3 % in solids corrected milk efficiency is realized. The current regulations relative to the inclusion of Rumensin in diets for dry and lactating dairy cows allows 11 to 22 grams per ton of total mixed ration DM (100 % DM). Typical inclusion rates would deliver 300 mg of monensin per head daily.

Summary

Feed efficiency can be a useful diagnostic tool in herds that can measure DMI and daily milk yield. Jersey herds should use fat-corrected-milk, but Holstein herds could use unadjusted milk if butterfat content is in the range of 3.4 to 3.6 %. The goal for 3.5 % FCM FE should be at least 1.5 for a typical herd. The FE value for a herd is influenced by management and environmental conditions as well as diet formulation.