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FATS AND PROTEINS RESEARCH FOUNDATION, INC.

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STRATEGIES FOR FEEDING FAT TO DAIRY CATTLE

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Adding fat to the diet of high-producing dairy cows has become a common practice for most high-producing herds (Table 1). Energy demands exceed energy intake for 80 to 100 days postpartum. Severe weight loss can lead to ketosis, fatty liver formation, reduced reproductive performance, and decreased milk yield. Cereal grains can provide an economical source of energy, but fiber minimums and excessive of fermentable carbohydrate limit the amount that can be fed. Fat supplements (includes oil sources in this paper) can provide a concentrated source of added energy without changing ration fiber and carbohydrate dynamics. This paper will provide an update on the applied aspects of fat supplementation.

FAT SOURCES

Commodity fats refer to feed ingredients that provide fat along with other nutrients such as protein, fiber, and minerals). Oilseeds, animal fats, and animal fat-oil blends would fit in this category (Table 2) and are referred to as rumen available fat, unprotected fat, and free fat by nutritionists. These sources are usually cheaper source of fat energy to incorporate in the diet. Specialty fats are specifically processed products that provide fat as their prime nutrient (Table 2). These fats are commonly referred to as ruminal inert fat, protected fat, escape fat, and by-pass fat and are more expensive per unit of energy provided compared to commodity fats. Commodity fats can affect rumen fermentation by absorbing on bacteria and feed particles coating the feed or bacteria lower feed digestibility. Unsaturated fatty acids are more toxic because they bind more to the bacteria and impact the rumen fermentation. Exposure of the unsaturated fatty acids in the rumen due to oilseed processing (whole seed, rolled, ground, or extruded) or oil will impact field results.

The energy values for fat is between 5.8 and 8.0 Mcal NE/kg depending on the reference (NRC), experimental energy balance measurements, or calculated values based on fatty acid composition. At this time, most nutritionist use a similar value per gram of fat consumed. Ohio workers reported similar fatty acid digestibility (approximately 80 percent) for several specialty and animal-vegetable blends. If fats are excessively hydrogenated or heat damaged, digestibility can drop below 50 percent. More research is needed to establish actual energy content and digestibility related to processing.

RESPONSES TO FEEDING FAT

Pennsylvania workers summarized research results to various fats (Table 3). The one or more of the following observations can be seen in the field.

1. Milk yield increases of 3 to 8 percent (1 to 2.5 kg) per .45 kg of added fats have been reported. If all energy consumed from .45 kg of fat where directly converted to milk production, the predicted milk response could be 2.5 to 3 kg. Energetically, the conversion of metabolizable energy to milk energy is highest with dietary fat compared to forage and concentrate sources or mobilized body reserves.

2. Fat test can be maintained (during negative energy balance) or increased .2 to .3 percentage point. The added fat raises circulating blood lipid levels which contribute 40 to 50 percent of total milk fat precursors.

3. Reproductive performance can be enhanced because cow return to positive energy balance sooner which can affect follicle size, ovum fertility, and circulating blood progesterone levels. Pennsylvania researchers reported 20 percent higher first service conception and shorter calving intervals with added fat.

A daily shortage of one megacalorie of net energy during the first 20 days of lactation increased the period to first ovulation by 2.7 days.

4. Cows can lose over 120 kg of body weight in early lactation. If cows maintain high milk yields, it is nearly impossible to gain this lost body condition back prior to the next lactation which can affect future milk production (referred to as sophomore slump in young cows) and reproduction.

5. Ketosis continues to be a serious metabolic risk in early lactation. Cows that lose more than one kg of body reserve can experience lowered dry matter intake and increased risk of fatty liver formation.

Overall, energy status can be improved with fat supplementation without risking excessive starch and low fiber intakes.

LEVELS OF ADDED FAT

Basal diets typically contain 2.5 to 3 percent fat from forage and grain sources. Cows can support 25 to 30 kg of 4%FCM from high-quality forages and concentrates. Cows over 25 kg can be fed .45 to .7 kg of added fat from commodity fat sources or a total of 4.5 to 5 percent total fat in the ration dry matter. The choice or combination of commodity fats will depend on the following factors.

1. Forage program and supplemental nutrients needs. For example, if added protein is needed, canola or soybean seed would be more attractive while cottonseed provides functional NDF. Animal fats would complement a nutritionally balanced TMR adding more energy.

2. Facility constraint and handling. Fuzzy cottonseed will not flow or auger in most automated feed delivery systems for example.

3. Palatability of the fat product. Animal fats and soybean products are palatable and readily consumed by cows. Fats can also reduce dustiness, separation of finer feed particles (such as minerals), and sorting which improves total ration palatability.

4. Cost of the fat supplement compared to available alternatives ($0.10 to $0.50 per .45 kg of supplemental fat adjusted for other nutrients).

The next increment of added fat would be provided by specialty fat products increasing the diet fat levels from 5 to 7 percent. These fats sources will be inert in the rumen and not affect rumen microbial characteristics and fiber digestion. The maximum amount of fat appears to be 7 to 8 percent in the ration dry matter or 16 to 20 percent of metabolizable energy from fat sources. Ohio researchers recommend that one third of dietary fat would be provided from typical feed sources, one third from commodity fat sources, and one third from specialty fat sources.

RATION CHANGES WITH ADDED FAT

When supplement fat is added to dairy rations, several adjustments should be considered.

1. Adequate fiber form (20 to 22 percent effective NDF) and level (19 to 20 percent ADF) are needed to maintain rumen digestion, especially with unsaturated oilseed sources. One guideline is to increase total ADF levels 1 to 2 percent points higher (from 19 to 20 percent for example) in added fat diets.

2. Calcium should be increased .2 percent above normal levels (from .7 to .9 percent of the ration dry matter). Magnesium levels should also be increased from .25 to .30 percent in the total ration dry matter. Ohio workers suggest fats can form soap-like products in the lower digestive tract reducing the availability of calcium and magnesium for absorption.

3. Fat does not provide available energy for the rumen microbes resulting in no additional microbial protein synthesis. In effect, fat is a by-pass energy sources for the lactating cow. Pennsylvania researchers suggest an additional 72 grams of undegraded intake protein (UIP) per megacalorie net energy from added fat sources (over 3 percent found in the ration).

4. Added fats should be gradually increased in the ration allowing for palatability changes (taste, odor, and form) and microbial adjustment, especially with unsaturated source. Remove fats gradually from the diet for similar reasons and allow for dry matter intake adjustments.

5. Limit the amount of supplement fat in early lactation (initial 3 to 5 weeks postpartum). Wisconsin workers suggest high levels of dietary fat can depress total ration dry matter intake. When high fat rations are fed and cows are mobilizing body weight, cow may decrease feed intake (containing the high fat) in an attempt to lower circulating levels of fatty acids (NEFA).

6. Milk protein percent is lower when supplemental fat is fed (Table 3). This effect could be related to an effect on rumen microbes (less microbial protein), reduced uptake of amino acids by the mammary gland, less blood flow to the mammary gland, or dilution of protein by increased milk yield. Including 6 to 12 grams of niacin or protected amino acids have increased milk protein when fat was added, but the responses are variable.

7. Liquid fats should be added to concentrate prior to adding to the TMR rather adding it to the silage or the final TMR based on Illinois results and field reports. Lower dry matter intake and digestibility have been reported when fat is added to forage.

ECONOMIC CONSIDERATIONS

Illinois workers estimated the return from feeding supplement fat based on milk yield response and improved reproduction (Table 4). If cows respond as predicted, the benefit to cost ratio is favorable. Commodity fats provide a wider profit margin compared to specialty fats. Another approach (Table 5) is to compare fat sources when substituted for corn ($2.75 a bushel) and 44 percent soybean meal ($270 per ton). Breakeven prices and profit margins were calculated using a predicted milk increase based on energy.

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Table 1. Use of fat supplements in U.S. dairy herds averaging 11,096 kg of milk (adapted from Jordan, 1993).

Fat source	% Herds
Whole cottonseed	72
Tallow .	46
Specialty fats	41
Other fat sources	21

Table 2. Common fat sources fed to lactating cows (adapted from Shaver, 1990)

Commodity Fats	Fat (%) (% Unsat)	Additional Information (Source)
Distillers, corn	10(81)	Protein (UIP) and phosphorous source
Meat & bone meal	10(52)	Protein (UIP), calcium, and phosphorous sources
Canola seed	40(95)	Protein source, seed coat must be broken
Cottonseed	20(71)	Effective NDF and protein, feed whole
Soybeans	19(85)	Protein source (UIP=45 to 60% if effectively heated) (UIP=20% fed as raw bean)
Tallow/grease	100(52)	Solid at room temperature
Animal/veg blend	100(72)	Variable in composition

Specialty Fats

Megalac	80(43)	Calcium salt of palm oil fatty acids (Church and Dwight Company)
Energy Booster	99(14)	Relatively saturated free long chain fatty acids (Milk Specialties Company)
Booster Fat	90(50)	Tallow plus soybean meal treated with sodium alginate (Balance Energy Company)
Alifet	92(33)	Hydrogenated tallow with wheat starch (Alifet USA)
Dairy 80	80(13)	Hydrogenated tallow with phospholipids (Morgan Manufacturing Company)
Carolac	98(39)	Hydrogenated tallow (Carolina Byproducts)

Table 3. Effect of fat sources on milk yield, composition, and dry matter intake (adapted from Chalupa and Ferguson, 1992).

Fat	Milk (kg)	Fat (%)	Protein (%)	DMI (kg)
Tallow	+1.3	-0.10	-0.08	+0.4
Cottonseed	+0.3	+0.19	-0.10	-0.3
Soybeans (raw)	+0.8	-0.10	-0.17	-1.0
Soybeans (roasted)	+1.5	+0.03	-0.08	0
Soybeans (extrude)	+2.7	-0.50	-0.12	-0.1
Megalac (1st lact)	+0.8	+0.07	-0.02	-1.9
Megalac (2nd+ lact)	+2.3	+0.04	-0.13	-0.5
Energy Booster	+2.3	+0.16	-0.02	-0.3

Table 4. Potential economic response to supplemental feeding of fat for 120 days in early lactation (adapted from Davis, 1989).

	Milk Increase		
	3%	5%	8%
Value of extra milk a	$35	$58	$92
Value of breeding efficiency b	$60	$60	$60
Fat cost c	$60	$60	$60
	($30)	($30)	($30)
Benefit:Cost ratio	1.6:1	2:1	2.5:1
	(3.2:1)	(3.9:1)	(5.1:1)

a. Cows produced 36 kg at 3.5% fat priced at $12 per 45 kg
b. Reduced calving interval by 20 days at $3 per day saving
c. Fat cost: specialty fat at $.50 per .45 kg, commodity fat at $.25 per .45 kg

Table 5. Economic comparison of various fat sources at different prices (adapted from Davis, 1989).

Fat Source	Fat Price ($/unit	Extra Milk (kg/cow/day)	Profit ($/day)
Soybeans	6.50/bu 7.50/bu 8.35/bu	.5 .5 .5	.17 .08 Breakeven
Cottonseed	180/t 220/t	.8 .8	.19 .09 Breakeven
Energy Booster	50/45kg 75/45kg	3.0 3.0	.26 Breakeven