FATS AND PROTEINS RESEARCH FOUNDATION, INC.

Director's Digest

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FAT AND ANIMAL PROTEIN BY-PRODUCTS IN DAIRY CATTLE FEEDING PROGRAMS

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Peak energy intake lags behind peak energy output in early lactation and as a consequence cows are in negative energy balance. Severe negative energy balance can result in poor persistency of lactation, metabolic disorders, and poor reproductive efficiency. Milking cows are supplemented with high starch grains, such as corn or barley, to increase the energy density (TDN% or Mcal NEl/lb) of the ration. However, the amount of grain or starch that can be fed is limited because milking cows require a minimum amount of fiber and forage in the ration for proper chewing activity and rumen function, and consequently to maintain normal milk fat test. Fat supplementation is an effective method of increasing the energy density of milking cow rations while providing adequate fiber and forage. Feeding fat has generally improved persistency of lactation in research trials. Body condition and reproductive efficiency have been improved in some but not all trials. These findings are consistent with feedback from dairy managers and nutritionists feeding supplemental fat. Commonly used fat sources in the Midwest include whole cottonseed, full-fat soybeans, tallow, and various ruminally-inert fat products.

A portion of the crude protein (N X 6.25) is graded by rumen microbes to peptides, amino acids, and ammonia. The remainder escapes microbial breakdown and is commonly referred to as "bypass" protein. Adequate intake of degradable protein (DIP) is needed to optimize carbohydrate (fiber and starch) digestion in the rumen and flow of microbial protein from the rumen. Adequate intake of undegradable protein (UIP or bypass) is needed to provide the proper amount of total protein flow to the small intestine for digestion and absorption, since the amount of protein supplied by microbial synthesis from DIP is not adequate to meet the needs of high producing cows. Research trials and on-farm experiences have generally indicated positive results to feeding high producing cows protein sources resistant to breakdown in the rumen. Further, it is particularly important to incorporate adequate "bypass" protein in rations containing supplemental fat since replacing fermentable carbohydrate in the ration with fat reduces net rumen synthesis of microbial protein. The largest on-farm milk yield increases to feeding supplemental fat seem to occur when rations are formulated properly for "bypass" protein.

Traditional sources of "bypass" protein include brewers or distillers, dried grains, corn gluten meal, and heat-treated soybeans or meal. Research data are limited for production responses related to feeding milking cows animal protein by-products (APB), such as blood meal, feather meal, fish meal, or meat and bone meal. There is much interest in feeding APB since they are relatively concentrated sources of "bypass" protein that are often more economical supplements than traditional "bypass" protein sources. Many high producing herds in the Midwest are feeding APB in total mixed ration (TMR) feeding systems. The purpose of this paper is to provide guidelines for feeding fat and APB to milking cows.

FAT FEEDING GUIDELINES

Potential fat sources for milking cows are summarized in Table 1. Factors that should be considered when deciding which fat source to use include: 1) forage program and supplemental nutrient needs, 2) facility constraints on ingredient handling, storage, and feeding, 3) feeding system constraints on palatability of the fat supplement, 4) rumen inertness of the fat supplement, 5) cost per pound of fat, and 6) effects on milk yield and composition.

Whole cottonseed (WCS) and full-fat soybeans (SB) contain 20 percent fat (DM basis). WCS are high in neutral detergent fiber (NDF) and are an excellent source of "effective fiber" in milking cow rations. WCS work best in rations for high producing, early lactation cows needing a source of by-product fiber because of low fiber forages or short forage supplies. Minimum NDF from forage can be set at 19 percent (DM basis) for rations containing WCS compared to 21 percent (DM basis) without WCS. California work suggests similar "effective" fiber values for fuzzy and mechanically delinted WCS. Acid delinted WCS is an inferior source of fat and fiber for milking cows relative to fuzzy or mechanically delinted WCS.

Relative to soybean meal (SBM), SB are low in crude protein (42 versus 50-55 percent) and in the case of heat-treated SB high in "bypass" protein (45-55 versus 35 percent UIP-CP). Raw soybeans contain only 25 percent of the crude protein as undegradable protein (UIP-CP). Heat-treated SB work best in rations for high producing, early lactation cows needing additional "bypass" protein. They work particularly well in alfalfa silage based rations since alfalfa protein is highly degradable in the rumen. Raw SB work well when fed in corn silage based rations or to cows averaging 16,000 to 18,000 pounds of milk per lactation since the need for additional "bypass" protein is lower in both cases. Raw SB can be fed to cows producing more than 19,000 pounds of milk per lactation if fed along with high "bypass" grain or animal protein by-products to meet undegradable protein requirements.

Tallow is 100 percent fat and provides no other nutrients to the ration. Commercially available ruminally-inert granular fat sources range from 82 to 99 percent fat and provide no other nutrients to the ration except for calcium in the calcium salts of palm oil. These ruminally-inert fat sources are summarized in Table 2 and are commonly referred to as rumen "bypass" or "protected" fats.

SB and granular fat products are easier to handle, store, and feed than WCS or tallow. Fuzzy WCS are difficult to handle through augers and bins. Use of mechanically delinted WCS helps alleviate this problem. Tallow must be melted and can be difficult to blend with the TMR or feed individually in stall barns, but many top herds in the Midwest have been successful. Blending tallow with the protein concentrate or grain mix at the feed mill can make it easier to feed tallow.

Heat-treated SB are more palatable than other fat sources when topdressed. Some cows may adapt slowly to consuming WCS, tallow, or granular fats as a topdress, but many top herds in the Midwest have been successful. Blending these fat sources with the grain or forage at the time of feeding can help alleviate palatability problems. Feeding fat in a TMR reduces consumption problems and palatability differences between fat sources. However, it is difficult to adapt cows to tallow in some herds. Bringing cows up to a full pound of fat gradually over a two week period and feeding only .25 lb. for the first few days can be beneficial. Also, adapting cows to the tallow or APB odor for a few days prior to feeding seems to be helpful. Calcium salts of palm oil fatty acids are the least palatable of the granular fats (Refer to Table 2), but this isn't much of a problem in a TMR.

Depression of fiber digestibility in the rumen can be a problem when supplemental fat is fed to milking cows. This can reduce dry matter intake and may contribute to milk fat depression. Certain fats are toxic to microbes within the rumen that are responsible for fiber digestion. Polyunsaturated fatty acids are saturated or hydrogenated by rumen microbes, but too much vegetable oil entering the rumen at once can lead to incomplete hydrogenation. Endproducts of this incomplete hydrogenation may help cause the milk fat depression typically observed when rations high in vegetable oil are fed. WCS and SB contain oil high in polyunsaturated fatty acids. However, WCS and SB are suitable fat sources for milking cows because they are slowly digested in the rumen and therefore the oil is gradually released into the rumen. This allows for more extensive saturation or hydrogenation of the polyunsaturated fatty acids in the rumen and less chance for reduced fiber digestibility or milk fat depression.

Saturated fatty acids are less soluble in the rumen than polyunsaturated fatty acids and therefore are less likely to affect rumen microbes. Tallow is a relatively saturated fat and therefore is reasonably inert in the rumen. Fat from whole oilseeds is less inert in the rumen than tallow but whole oilseeds are suitable fat sources because of their "slow release" properties. The primary advantage of the granular fat sources is that they are inert in the rumen and therefore do not affect rumen digestion. However, rumen inertness has only been well documented in research trials for the calcium salts of palm oil and prilled saturated free long-chain fatty acids (Refer to Table 2). Most fat feeding guidelines recognize that there is a ruminal limitation to the amount of "unprotected" fat that can be fed and fat feeding strategies above these levels generally include ruminally-inert fat sources.

Supplementing a pound of fat from WCS or SB generally costs 10 to 20 cents per cow per day after considering the value of the protein and minerals in whole oilseeds. Feeding a pound of tallow costs 20 to 22 cents per cow per day. Ruminally-inert granular fats usually cost twice as much as commodity fats at 40 to 55 cents per cow per day to supplement a pound of fat.

The milk yield response in research trials to supplementing a pound of fat has averaged 3 to 4 pounds per cow per day. This benefit has generally been in improved persistency of lactation rather than peak milk yield. There does not appear to be a milk yield advantage to using one fat source over another when rations are formulated properly for other nutrients. WCS shows more of a tendency to increase milk fat test than the other fat sources, particularly when substituted for a portion of the grain in low fiber rations. Feeding fat depresses milk protein .1 to .2 percentage units. This depression has been observed with whole oilseeds, tallow, and ruminally-inert granular fats. There may be less of a tendency for this depression to occur when WCS is substituted for forage. Wisconsin workers suggested that adding niacin to the ration may alleviate this depression. The milk protein response to niacin has been variable across research trials. More research is needed to determine how fat feeding depresses milk protein test and how to prevent it.

Since the milk yield response to added fat is similar for the various fat sources it seems reasonable to recommend supplementing the first pound of fat from the cheapest source available. In most cases this will be vegetable fat from either WCS or SB. Deciding betweeen WCS and SB should be based on whether the ration needs additional fiber or protein as well as local availability and price of these two ingredients. Intake of supplemental vegetable fat should be limited to 1.5 to 2.0 lb. per cow per day or 3 percent of ration dry matter. This limits intake of WCS or SB to 7 to 10 lb. per cow per day or 15 to 18 percent of ration dry matter. This is a fairly liberal recommendation and these levels may need to be reduced when fat is slug fed in a topdress. Additional supplemental fat should come from a source relatively inert in the rumen such as tallow or granular fat depending on handling, feeding, palatability, and cost considerations. Total supplemental fat should be limited to 5 percent of ration dry matter or 2.5 to 3.0 pounds per cow per day. This results in total ration fat levels of 8 percent of ration dry matter.

Herds reaching the 17,000 to 18,000 pounds of milk per lactation level are candidates for the first pound of added fat. Herds averaging 20,000 plus pounds of milk per lactation have experienced good success with feeding a second pound of supplemental fat. Some Wisconsin herds averaging more than 24,000 pounds of milk per lactation are utilizing three pounds of added fat in their rations. but we know little about the economic returns to feeding these high fat rations. Most of the herds supplementing fat at high levels are using a combination fat approach with the first 1.0 to 1.5 pounds of fat coming from whole oilseeds, the second pound from tallow, and the third pound from ruminally-inert granular fat product. Research is needed to determine the most economical strategy for adding fat to milking cow rations.

Feeding the first 1.0 to 1.5 pounds of fat can begin at calving. There may be some benefit to including .25 lb. added fat per cow in the 2-week prefresh ration to better adapt fresh cows to fat feeding. It may be better to delay the feeding of the second pound of fat until 4 to 5 weeks after calving if allowed by the feeding system and grouping strategy, since Wisconsin research suggests that there is little benefit to supplemental fat in the very early stages of lactation. Fat should be fed into the lactation period as long as level of milk yield and body condition merit the extra energy. Cows that lack persistency and are getting too fat are candidates for either a low energy ration or culling, not a high fat ration! Formulate rations properly for "bypass" protein when feeding supplemental fat. Balance rations for .9 to 1.0 percent calcium and .3 to .35 percent magnesium (DM basis). Rations should contain 19 to 20 percent acid detergent fiber (ADF) and 21 percent NDF from forage (DM basis). Monitor persistency of lactation. body condition, and reproductive efficiency to determine the response to feeding supplemental fat.

GUIDELINES FOR FEEDING ANIMAL PROTEIN BY-PRODUCTS

APB are defined in the 1989 Feed Industry Red Book as follows:

BLOOD MEAL (BM) - Produced from clean, fresh animal blood, exclusive of all extraneous material such as hair, stomach belchings, and urine except in such traces as might occur unavoidably in good manufacturing processes. Types of BM include conventional cooker dried, flash dried, and spray dried. Spray drying produces a product that readily takes up and retains moisture and is not suitable for feed use. Cooker drying is an older process that has been used for many years, but the results are not uniform. Flash drying is a newer process which produces a product uniform in color with a high lysine content (about 9 percent of CP) and with 80 to 90 percent of the lysine available.

HYDROLYZED FEATHER MEAL (HFM) - Product resulting from the treatment under pressure of clean, undecomposed feathers from slaughtered poultry, free of additives and(or) accelerators. Not less than 75 percent of CP must be digestible as measured by the pepsin digestibility method. Although HFM has a relatively poor balance of amino acids particularly lysine and methionine which are thought to be co-limiting for milk production, it is a good source of sulfur because of its high systine content (about 5 percent of CP). This high content of cystine may conserve some of the "bypass" methionine in the ration for milk production making the amino acid profile of HFM appear more favorable, but research is needed on the quality of HFM amino acids for milking cows.

FISH MEAL (FM) - FM is the clean, dried, ground tissue of undecompose whole fish or fish cuttings, either or both, with or without the extraction of part of the oil. FM has an excellent amino acid profile, close to that believed to be required for milk production.

MEAT & BONE MEAL (MBM) - MBM is the rendered product from mammal tissues, including bone, exclusive of blood, hair, hoof, horn, hide trimmings, manure, stomach and rumen contents, except in such amounts as may occur unavoidably in good processing practices. It contains a minimum of 4 percent phosphorus with the calcium level not more than 2.2 times the actual phosphorus level.

MEAT MEAL (MM) - Defined the same as MBM except that no minimum phosphorus level is required.

Potential "bypass" protein sources for milking cows are summarized in Table 3. Factors that should be considered when deciding which "bypass" protein source to use include: 1) feeding system constraints on palatability of the protein source, 2) CP, UIP and amino acid content, 3) ingredient quality, and 4) cost per unit CP and UIP.

Brewers or distillers dried grains, expeller soybean meal, and cooked soybeans are the most palatable "bypass" protein supplements and work best in grain mixes and protein concentrates for topdressing. HFM and FM seem to be the least palatable of the APB. Palatability should not be a problem when feeding 1.5 to 2.5 lb. of MBM/MM or .5 to 1.0 lb. of BM per cow per day in a TMR. However, even with a TMR working up to these levels over a two week period starting out with .25 lb. for the first few days may ease the transition. Cows may accept APB more readily if they have already been adapted to tallow. Including .25 pounds APB per cow in the 2-week prefresh ration may help fresh cows adapt to APB.

Feeding APB as a topdress is generally not possible due to a palatability problem. Blending APB with the grain or forage at the time of feeding can help alleviate palatability problems. MBM or MBM/BM can be mixed at 7 to 10 percent of the protein concentrate with reasonable palatability of the topdress. Even at this low inclusion rate cows should be adapted to MBM/MM and BM gradually and molasses addition to the protein concentrate may improve its palatability. HFM and FM are very difficult to topdress, inclusion rates in a protein concentrate are generally less than 3 to 5 percent and even this level of inclusion can be a problem. Inclusion of HFM or FM into a TMR must be done gradually to prevent depression of intake of the TMR.

Some high producing herds in the Midwest are successfully feeding 2.0 to 2.5 lb. of MBM and .5 to .75 lb. of BM per cow per day in TMR's. A few herds are feeding .5 lb. HFM as well. FM is not widely utilized because of quality variation and high cost per unit CP and UIP relative to other APB. More research is needed to determine the most economical strategy for feeding APB.

The inclusion rate of MBM may be limited to 2.0 to 2.5 lb. per cow per day since feeding this amount adds roughly 40 to 50 grams of phosphorus to the cows daily ration. Since the relative biological availabilities of calcium and phosphorus are good, supplemental mineral needs are reduced making the use of MBM economical in many feeding programs. The amount of APB to supplement is largely determined by the "bypass" protein requirements of the cow. Rations for high producing, early lactation cows should be formulated for 18.0 to 18.5% CP with 35% UIP-CP, 38% UIP-CP for high fat rations. Rations exceeding 38 to 40% UIP-CP may benefit from blending .15 to .25 lb. urea per cow with the APB to help meet the DIP needs of rumen microbes. Since APB are low in DIP caution must be observed to not underfeed DIP when feeding high levels of APB, particularly with forages of low protein degradability such as corn silage, dry hay, or low-moisture haycrop silage.

CP and UIP content of APB relative to SBM and traditional sources of "bypass" protein are presented in Table 4. APB are concentrated sources of CP ranging from 54 to 90 percent CP versus 50 percent CP in SBM and 25 percent CP in distillers dried grains. This allows for a pound of CP to be supplied to the ration in 1 to 2 lb. of APB versus 4 to 5 lb. of distillers dried grains (Refer to Table 5). Further, APB are concentrated sources of "bypass" protein with 65% UIP-CP versus 35, 45, and 55% UIP-CP for SBM, cooked soybeans, and distillers dried grains, respectively. This is why feeding 1 to 2 lb. per cow per day of APB can make a significant impact on the UIP content of milking cow rations.

Grams of "bypass" lysine and methionine per lb. of CP consumed relative to SBM and traditional sources of "bypass" protein are presented in Table 5. BM, FM, MBM, and MM have a high "bypass" value for lysine relative to SBM. Of the traditional "bypass" protein sources only expeller SBM and cooked soybeans have a high "bypass" value for lysine. With the exception of HFM, "bypass" protein sources have a slightly higher "bypass" methionine value than SBM. FM and corn gluten meal have the highest "bypass" value for methionine. FM has the highest combined "bypass" value for lysine and methionine. HFM has a poor "bypass" value for both lysine and methionine. However, the high cystine content of HFM may conserve methionine in the ration and therefore improve its value as a "bypass" protein supplement. If so, HFM/BM blends may have some potential. BM/corn gluten meal blends could provide a good "bypass" lysine and methionine balance. More research is needed to determine amino acid requirements of milking cows and proper "bypass" amino acid supplementation strategies.

Research trials to evaluate effects of APB on dry matter intake (DMI) and milk yield and composition are summarized in Table 6. Wisconsin workers found no differences in DMI or milk yield between MM, MM/SBM, SBM, or urea supplemented rations formulated to 15% CP. Replacing SBM with 1.5 lb. FM per cow in 20% CP rations increased milk yield 2.4 lb. per cow per day in a Wisconsin trial. Unlike many trials, milk fat test was not depressed by feeding FM in this study. Cornell workers suggest that feeding more than 150 grams per day of fish oil may depress milk fat test and therefore feeding less than 1.5 to 2.0 lb. FM per cow per day may be a good strategy to prevent this depression. BYU workers found no significant differences in DMI or milk yield when replacing 50 and 100% of the supplemental CP from MBM with .5 and 1.0 lb.HFM per cow per day. However, milk yield was reduced 2.2 and 4.2 lb. per cow per day at the low and high level of HFM supplementation, respectively. Cornell researchers saw no improvement in milk yield during the first 100 days of lactation to increasing UIP-CP from 32 to 38-42% in 17 to 18% CP rations using either FM or commercial APB blends containing HFM, MBM and BM. Wisconsin and Minnesota workers are evaluating milk yield responses to feeding APB. Feedback from top herds in Wisconsin feeding MBM and(or) BM has been positive.

One of the major concerns about using APB as feed ingredients is their quality and nutrient consistency. Variation in nutritive value of APB can be due to variation in source of raw materials available to rendering operations and(or) processing conditions such as pressure, temperature, and cooling time at different locations and at different times. For example, UIP-CP content of FM can vary from 30 to 70 percent depending on processing conditions. These include the length of time the raw fish are stored before processing, type of dryer used, duration of heating, and extent of solubles add-back (Stern and Mansfield, 1989). Inconsistent quality is a drawback of using FM in the Midwest, particularly since sources of MBM/MM and BM are readily available from renderers. Also, of particular concern is the variability in content of digestible protein in HFM. Purchase ingredients from reputable APB suppliers or feed dealers who are willing to assure minimum quality standards. Laboratory tests need to be developed and implemented to evaluate protein degradability of APB in the field. For now the best quality test for any feed ingredient is what the cow thinks. Monitor feed intake and peak milk yield closely when supplementing APB. MBM/MM must be stored and handled properly to avoid problems with salmonella contamination. MBM/MM should be stored in a clean, dry bin or container covered to prevent contact with dogs, cats, rodents, and birds.

Relative feed values of potential animal and plant by-product sources of "bypass" protein are presented in Table 7. Feed values were calculated relative to corn for energy, soybean meal for CP, limestone for calcium, and dicalcium phosphate for phosphorus. Ingredients should be considered a good purchase if priced lower than the feed value listed in the table at relevant SBM prices. Feed values were also calculated on a UIP basis. Use UIP feed values when purchasing "bypass" protein supplements to balance rations for high producing, early lactation cows. Use CP feed values when rations do not need extra "bypass" protein. Prices for MBM/MM and HFM generally are substantially below these UIP break-even values in Wisconsin and their use can often reduce feed costs. The poor amino acid profile of HFM makes it difficult to pay much more for HFM than MBM even though it contains about twice as much CP. BM generally is priced at or slightly above its UIP breakeven value in Wisconsin. FM is generally priced above its UIP breakeven value in the Midwest, but it contains the best amino acid profile. Local availability and cost relative to the feed value must be considered when deciding which "bypass" protein source to feed.

When fed properly APB can reduce the cost of producing a cwt. of milk through increased production per cow and reduced feed costs. Fat feeding generally increases ration costs, but when done properly this practice can improve persistency of lactation, body condition, and reproductive efficiency resulting in higher profits per cow.

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Table 1. Summary of potential fat sources for milking cows[1].

Fat Source	Fat %	Other Nutrients Provided	Handling, Storage and Feeding	Palatability		Rumen Inertness	Cost/lb fat Cents/cow/day	Response		
				Topdress	TMR			Milk	Fat	Protein
Whole Cottonseed	20	Fiber	-	?+	+	?-	10-20	+	+	?-
Full-Fat Soybeans	20	Protein, Bypass[2]	+	++	++	?-	10-20	+	?0	-
Tallow	100	None	-	?+	?+	?+	20-22	+	?0	-
Ruminally Inert Fat	82-99	None or negligible amounts	+	?+	+	+	40-55	+	?+	-

1 + = positive characteristic or response. - = negative characteristic or response. 0 = no response. ? = questionable characteristic or response.
2 Cooked soybeans contain 45 to 55% UIP - CP compared to 25% UIP - CP in raw soybeans.

Table 2. Summary of potential sources of ruminally inert fat for milking cows[1].

Product	Company	Ingredient Composition	Fat %	Palatability	Rumen Inertness	Amount of Research	Cost per lb. of fat cents/cow/day
Megalac	Church & Dwight Co.	Calcium Salts of Palm Oil Fatty Acids.	82	-	+	++	40-55
Energy Booster	Milk Specialties Co.	Relatively Saturated Free Long-Chain Fatty Acids - Prilled Fat.	98-99	?+	+	++	40-55
Booster Fat	Balanced Energy Co.	Tallow plus Soybean Meal Treated with Sodium Alginate.	95	?+	?	-	40-55
Alifet	Alifet U.S.A.	Hydrogenated Tallow Mixed with Wheat Starch and Crystallized.	95	?+	?+	-	40-55
Dairy 30	Morgan Mfg.	Hydrogenated Tallow - Prilled. Contains some Phospholipid, Flavor and Coloring Agents.	92	++	?+	-	40-55
Carolac	Carolina Byproducts	Hydrogenated Tallow - Prilled.	98	?+	?+	-	40-55

1 + = positive characteristic. - = negative characteristic. ? = questionable characteristic.

Table 3. Characteristics of potential "bypass" protein sources for milking cows[1].

Ingredient	Palatability TMR	Palatability Topdress	Protein Content[2] CP	Protein Content[2] UIP	Protein Content[2] Amino Acids	Ingredient Quality	Cost per unit CP and UIP
Brewers Grains	++	+++	-	+	?	?	?
Distillers Grains	++	+++	-	++	?-	?	?
Corn Gluten Meal	0	?-	++	++	?-, +	?	?+
Soybean Meal, Expeller	+	+	+	++	++	?	?
Soybeans, Cooked	+	++	+	++	++	?	?
Blood Meal	?	?-	++	++	++	?-	?-
Feather Meal	?-	-	++	++	?-	-	+
Fish Meal	?	-	+	++	+++	?-	?-
Meat & Bone Meal or Meat Meal	?0	?-	+	++	++	?-	+

1 + = positive characteristic. - = negative characteristic. 0 = neutral characteristic or no effect. ? = variable or questionable characteristic.

2 CP = Crude Protein. UIP = Undegradable Protein as a percent of CP.

Table 4. Crude protein content and fraction of undegradable protein of potential animal and plant by-product sources of "bypass" protein for milking cows as compared to solvent extracted soybean meal.

Ingredient	% Crude Protein[1] DM Basis	Fraction of Undegradable Protein[2]
Soybean Meal, 44 or 48 solvent extracted	50.0-54.5	.35
Brewers Grains	25.4	.50
Distillers Grains	25.0	.55
Corn Gluten Meal	67.2	.55
Soybean Meal, 44 Expeller	50.0	.55
Soybeans, Cooked[3]	42.2	.45
Blood Meal	87.2	.65
Feather Meal	90.0	.65
Fish Meal[4]	66.7	.65
Meat and Bone Meal	54.1	.65
Meat Meal	54.8	.65

1 Source: NRC 1989 Update and 1989 Feed Industry Red Book.

2 Source: NRC 1989 Update and Satter 1986. Values for many of these feeds were from only a few measurements and variation across research trials was considerable. Fraction of undegradable protein in by-product feeds is highly variable because of variation in source of raw materials and (or) processing conditions at different locations and at different times.

3 Fraction of undegradable protein in cooked soybeans can vary from .35 to .55 depending on time and temperature of heating and post-heating holding method (Faldet 1989).

4 Fraction of undegradable protein in fish meal can vary from .30 to .70 depending on processing conditions. These include the length of time the raw fish are stored before processing, type of dryer used, duration of heating, and extent of solubles add-back (Stern and Mansfield 1989).

Table 5. Amino acid content and estimated amount of "bypass" lysine and methionine for potential animal and plant by-product sources of "bypass" protein as compared to solvent extracted soybean meal[1].

Ingredient	% CP	UIP-CP	as fed lb. to supply 1 lb. CP	% of CP[2]		grams bypass per lb. CP consumed[3]	
				Lys	Met	Lys	Met
Soybean Meal, 44 solvent	50.0	.35	2.3	6.45	1.45	10.3	2.3
Brewers Grains	25.4	.50	4.3	3.77	1.93	8.6	4.4
Distillers Grains	25.0	.55	4.4	3.13	2.17	7.8	5.4
Corn Gluten Meal	67.2	.55	1.7	1.88	2.91	4.7	7.3
Soybean Meal, 44 Expeller	50.0	.55	2.3	6.45	1.45	16.1	3.6
Soybeans, Cooked	42.2	.45	2.5	6.32	1.42	12.9	2.9
Blood Meal	87.2	.65	1.3	8.60	.93	25.4	2.7
Feather Meal	90.0	.65	1.2	2.10	.56	6.2	1.7
Fish Meal	66.7	.65	1.6	7.91	2.97	23.3	8.8
Meat and Bone Meal	54.1	.65	2.0	5.75	1.29	17.0	3.8
Meat Meal	54.8	.65	2.0	6.30	1.37	18.6	4.0

1 CP = Crude Protein. UIP - CP = Undegradable Protein as a fraction of CP. Lys = Lysine and Met = Methionine.

2 Source: 1989 Feed Industry Red Book and 1982 U.S. Canadian Feed Tables.

3 grams of "bypass" lysine and methionine per pound of CP consumed calculated as: (one lb. CP x % lys or met x UIP - CP) x 454.

Table 6. Influence of animal protein by-products on dry matter intake and milk yield and composition.

Reference	Ration description	Protein Supplement	DM Intake lb/day	Milk Yield and Composition: Yield lb/day	Fat %	Protein %
Wisconsin	Alfalfa haylage (62% DM), corn silage, and corn grain. 15% CP rations.	Urea	55.9	72.4[a]	3.5	3.2
		Soybean meal	55.7	71.7	3.4	3.3
		Meat meal	54.3	73.5	3.4	3.1
		Soybean meal/Meat meal	54.8	72.4	3.5	3.2
Wisconsin	70% alfalfa silage (39% DM) and 30% concentrate. 20% CP rations. Approximately 1.5 lb. fish meal fed per cow per day.	Soybean meal	50.4	79.2[a]	3.3	2.8
		Fish meal	51.0	81.6	3.3	2.9
Brigham Young	Alfalfa silage, earlage, rolled barley, and whole cottonseed. Rations formulated to be equal in CP and energy. Approximately .5 and 1.0 lb. feather meal fed per cow per day.	Meat and Bone Meal	No significant differences.	82.7[b]	---	---
		Feather meal-50% of Supp. CP		80.5	---	---
		Feather meal-100% of Supp. CP		78.5	---	---

a Unadjusted milk yield.

b 3.5% fat-corrected milk yield.

Table 7. Relative feed value of potential animal and plant byproduct sources of "bypass" protein for milking cows.

Ingredient	Soybean Meal 44%, ($/ton)									
	175	200	225	250	275	175	200	225	250	275
	$/ton value (CP basis)[a]					$/ton value (UIP basis)[b]				
Brewers Grains	116	127	139	150	161	134	152	170	187	205
Distillers Grains	129	139	148	158	167	151	169	186	204	221
Corn Gluten Meal	198	233	268	303	338	271	333	396	458	520
Soybean Meal, Expeller	170	194	219	243	267	221	264	308	351	394
Soybeans, Cooked	168	187	207	226	245	188	215	241	268	294
Blood Meal	214	263	313	362	411	362	466	570	674	778
Feather Meal	231	283	334	389	437	385	494	603	711	820
Fish Meal	258	294	329	365	400	367	443	519	595	671
Meat & Bone Meal	299	328	358	387	416	389	452	515	577	640
Meat Meal	272	301	331	360	389	363	426	489	551	614

[a] Feed value relative to corn (energy), soybean meal (crude protein), limestone (calcium) and dicalcium phosphate (phosphorus). Corn was priced at $2.75/bushel for this analysis. Feeds should be considered a good purchase if priced lower than the feed value listed in the table. Tends to underestimate the value of soybeans when fed to high producing cows for a source of supplemental fat.

[b] Feed value relative to corn, soybean meal (undegradable protein), limestone and dical. Feed value that should be used when purchasing "bypass" protein supplements to balance rations for high producing, early lactation cows. Use the feed value calculated on a crude protein basis when rations do not need extra "bypass" protein.

Source: W. T. Howard, UW-Madison, FEEDVAL Spreadsheet.

RECOMMENDED NUTRIENT CONTENT OF DAIRY DIETS

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Cow Weight (lb)	Milk Fat %	Weight Gain lb/Day	Lactating Cow Diets — Milk Yield lb/day							
			Late Lact.		Mid Lact.		Early Lactation		1st 4-6 Weeks Dry Pregnant Cows	Last 2 Weeks Dry Pregnant Cows
880	5.0	0.5	15	29	44	57	73	Early Lact. (Weeks 0 - 3)		
1100	4.5	0.6	18	37	55	73	90			
1320	4.0	0.7	22	44	66	88	110			
1540	3.5	0.8	26	53	79	106	132			
1760	3.5	1.0	29	59	88	117	147			

Nutrient	Late Lact.	Late Lact.	Mid Lact.	Mid Lact.	Early Lactation	Early Lact. (Weeks 0 - 3)	1st 4-6 Weeks Dry Pregnant Cows	Last 2 Weeks Dry Pregnant Cows
Energy:								
NE-L, Mcal/lb	0.65	0.69	0.74	0.78	.78-.81	0.76	0.57	.63-.68
TDN, % of DM	63	67	71	75	75-78	73	56	63-66
Protein Equivalent:								
Crude Protein (%)	12.0	15.0	16.0	17-18	18-19	19.0	12.0	13-14
UIP (%)	4.5	5.4	5.7	6.0	6.3-7.0	7.2		
DIP (%)	7.9	8.8	9.7	10.4	10.4	9.7		
Fiber Content (Minimum)								
Crude Fiber, %	17	17	17	15	15	17	22	22
Acid Detergent Fiber, %	21	21	21	19	19	21	27	27
Neutral Detergent Fiber, %	28	28	28	27-28	27-28	28	50	40
NDF % in D.M. From Forage	21	21	21	21	21	21	45	35
Ether Extract (Minimum) %	3	3	3	3	3	3	3	3
Added Fat, Maximum %	3 - 4	3 - 4	3 - 4	3 - 4	3 - 4	3 - 4		
Minerals:								
Calcium, %	0.55	0.60	0.65	0.70	0.80	0.80	0.45-.90	0.45-.90
Calcium, With Added Fat, %	0.65	0.70	0.75	.80-.90	.90-1.1	.90-1.10		
Phosphorus, %	0.35	0.35	0.38	.41-.50	.50-.60	.50-.60	.26-.32	.26-.32
Magnesium, %	0.20	0.20	0.20	0.25	0.25	0.25	.16-20	0.20
Magnesium, With Added Fat %	0.25	0.27	0.30	.30-.35	.30-.35	0.30		
Potassium, %	.9-1.0	.9-1.0	.9-1.0	1.0-1.2	1.0-1.2	1.0-1.2	.65-.80	0.80
Sodium, %	0.18	0.18	0.18	0.18	0.18	0.18	0.10	0.10
Chloride, %	0.25	0.25	0.25	0.25	0.25	0.25	0.20	0.20
Salt, %	0.48	0.48	0.48	0.48	0.48	0.48	0.25	0.25
Sulfur, %	.20-.22	.20-.22	.20-.22	.20-.22	.20-.22	.20-.22	.16-.18	0.18
Iron, ppm	50-70	50-70	50-70	50-70	50-70	50-70	50-70	50-70
Cobalt, ppm	.10-.12	.10-.12	.10-.12	.10-.12	.10-.12	.10-.12	.10-.12	.10-.12
Copper, ppm	10-12	10-12	10-12	10-12	10-12	10-12	10-12	10-12
Manganese, ppm	40-50	40-50	40-50	40-50	40-50	40-50	40-50	40-50
Zinc, ppm	40-60	40-60	40-60	40-60	40-60	40-60	40-60	40-60
Iodine, ppm	0.60	0.60	0.60	0.60	0.60	0.60	0.25	0.25
Selenium, ppm	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Vitamins:								
Vitamin A, IU/lb	1,450	1,450	1,450	1,450	1,450	1,800	1,800	1,800
Vitamin D, IU/lb	450	450	450	450	450	450	540	540
Vitamin E, IU/lb	7	7	7	7	7	7	7	7

Adapted from 1989 NRC Nutrient Requirements of Dairy Cattle

Projecting Laction Yields and Grouping Cows for TMR Feeding

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Monthly Lactation Persistency Factors - First Lactation and Older Cows

Month of Lactation	Days in Milk	Persist. Factors		Factors to Predict Lactation Total	
		First Lact. Heifers	2nd Lact & Older	First Lactation Heifers	2nd Lactation & Older Cows
				% of Lact Total/Day	
	(Mid Point in Month)				
1	16	1.00	1.00	0.326%	0.342%
2	46	1.25	1.20	0.408%	0.410%
3	77	0.98	0.96	0.399%	0.393%
4	107	0.96	0.95	0.383%	0.374%
5	138	0.95	0.94	0.364%	0.351%
6	168	0.95	0.94	0.346%	0.330%
7	199	0.94	0.93	0.325%	0.307%
8	229	0.93	0.92	0.303%	0.283%
9	260	0.92	0.91	0.278%	0.257%
10	290	0.91	0.90	0.253%	0.231%
11	320	0.87	0.85	0.220%	0.197%

Multiply factor for the month times expected lactation total to estimate average milk/day

For example, a cow in her 4th month predicted at 23,000 lb milk should be producing: 85.1 lb/Day = (0.37%/100) X 23000 lb lactation total

Expanded Lactation Projection Factors First Calf Heifers and Older Cows

Days in Milk	First Calf Heifers			Days in Milk	Older Cows		
	Factor	Days	Factor		Factor	Days	Factor
46	0.408%	180	0.344%	46	0.408%	182	0.303%
60	0.407%	195	0.344%	60	0.408%	197	0.290%
75	0.399%	210	0.308%	75	0.393%	212	0.279%
90	0.399%	229	0.308%	90	0.390%	227	0.266%
105	0.399%	244	0.308%	107	0.372%	242	0.251%
120	0.399%	260	0.308%	122	0.358%	257	0.238%
135	0.362%	275	0.308%	137	0.343%	272	0.221%
150	0.362%	290	0.308%	152	0.329%	287	0.203%
165	0.344%	305	0.224%	·167	0.315%	302	0.190%

Divide lactation total factors into daily milk to estimate lactation milk yield from daily milk yield

For example: a 1st lact. heifer @ 55 lb milk in her 5th month, estimated laction total is: 15,320 lb Lactation total lb = 55 lb/day / (0.359 / 100)

Prepared for: Marsfield Dairy Day, Nov. 30, 1989