
Dairy Update

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Alternative Feeds For Dairy Cattle In Northwest Minnesota: An Update

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Feed is the major cost associated with dairy production. One way to reduce or control feed costs for dairy farms is to maximize the use of high quality forages in rations. High quality legumes and grasses provide dairy cows and heifers with a good source of protein, energy, fiber and minerals. Corn silage is a high energy feed that supplies fiber as well as grain. However, poor growing, harvesting and/or drying conditions often result in a low supply of high quality forages. If all low quality forages are fed to dairy cows, decreases in intake often result, and milk production decreases because of insufficient nutrients. When dairy producers are forced to feed low quality forages, one option is to look for low cost alternative or byproduct feeds to substitute for some of the low quality forages in the ration.

In Northwest Minnesota, several energy feeds, protein supplements, and byproducts can be used as alternative feeds for dairy cows. They can be substituted in the dairy ration to compensate for energy and protein, and improve intake and milk production. The rate of substitution will depend on palatability, nutrient composition, wetness, metabolic problems associated with high intake, price and availability.

Nutrient values for the feeds discussed below are listed in Table 1.

A. Protein Supplements

Soybean Meal: Soybean meal is the most common plant protein supplement. The 44% crude protein soybean meal is the most common. Two other sources of soybean meal also are available: a dehulled soybean meal at 48% crude protein, and expeller or old processed soybean meal (42% crude protein and 5% oil). Soybean meal is highly palatable and has a moderate level of rumen

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undegradable protein (RUP). The most limiting amino acid to milk protein synthesis in soybean meal is methionine (Maiga et al., 1996).

Canola Meal: Canola is grown for its oil. The meal, a byproduct remaining after the oil is pressed from the seed, is used as a protein supplement for livestock. The nutritive value of canola meal compares favorably to soybean meal, being just slightly lower in protein and energy but higher in fiber. Research has demonstrated its value as a very satisfactory protein and mineral source for all classes of dairy animals (Marx, 1996). Canola meal protein is degraded relatively fast in the rumen.

The new canola meal, as opposed to the older rapeseed meal, is much safer to feed, much lower in glucosinolates, and has no adverse effects on feed intake. Canola meal is becoming more available with a substantial market being developed in Canada.

Sunflower Meal: Sunflower meal is a byproduct of the sunflower seed after oil is extracted from the seed. Sunflower meal has been around a few years, but it is now more readily available because of several new sunflower-processing plants in the Midwest. Protein and fiber content of sunflower meal varies depending on the amount of hull removed from the meal during processing. Most sunflower meal available commercially is a partially dehulled byproduct at 34% crude protein, but a lower quality (28% protein) product also is sold. A higher protein (40%) meal is sometimes available. The total digestible nutrient (TDN) content of the most readily available 34% protein sunflower meal is lower than soybean meal because of its higher hull or fiber content. The fiber in sunflower meal is low in digestibility and may be a disadvantage when balancing rations for high milk production or for calves.

Sunflower meal is less palatable than soybean meal, but palatability has not been a problem in studies conducted at the University of Minnesota, Crookston (Marx, 1993). This may be more of concern at high levels of feeding. A rule of thumb is to have no more than 20 to 25% of the grain ration as sunflower meal (15% for the 28% sunflower meal). Additionally, sunflower meal has a less desirable amino acid profile than soybean meal. The most limiting amino acid in sunflower meal is lysine.

Sunflower meal is very suitable in mineral content, particularly calcium and phosphorus, compared to other meals. There have been no problems with goitrogenic substances or nutritional toxins from feeding sunflower meal.

Linseed Meal: Linseed (flax) meal is a byproduct of the flax industry and is a good protein supplement. Linseed meal is obtained by grinding the cake or chips that remain after removing the oil from flaxseed, and it must not contain more than 10% crude fiber. Linseed meal is an excellent protein supplement for dairy cattle and aids in producing bloom and making the hair soft (Harris and Staples, 1988).

Cottonseed Meal: Cottonseed meal contains less available protein and energy than soybean meal. Some caution is suggested when using both cottonseed meal and whole cottonseed in dairy rations for high producing cows because of the presence of gossypol, which can be toxic at high levels of intake.

Dried Distillers Grains: Dried distillers grains are the byproduct from distillers or alcohol manufacturers. Corn and barley are the most common ingredients in the fermentation and production of commercial alcohol. Most of the starch of the kernel is taken out when making alcohol; thus, the remaining protein of the kernel, including the protein from microbial fermentation, is concentrated in the byproduct. Dried distillers grains are a moderate source of protein (25 to 32%). They are a good source of RUP (55% of the crude protein). Lysine is low. Production response, milk fat, feed intake, and digestibilities are suitable for livestock feeding (Marx, 1993).

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Brewers Grains: Both wet and dry forms are byproducts of beer production. Wet brewers grains are the most readily available form. They are not suited to extended storage, particularly in the summer, and can be expensive to transport long distances because of the high water content (70 to 80%). Producers located near a brewery may be able to obtain wet brewers at a reasonable cost. Wet (pressed) brewers grains are intermediate in protein content and similar to corn silage in fiber and energy value. There can be considerable variability in moisture (70 to 80%) and nutrient content, so the buyer should beware and buy on a guaranteed analysis. On a dry matter basis, brewers grains are high in protein and a fair source of energy. Brewers grains are very palatable and are also very high in RUP. Brewers grains should not exceed 25% of the ration dry matter or 40 to 50 lb of wet feed per cow.

Wet brewers grains deteriorate quite rapidly during hot weather and should be fed within 2 to 3 days. During cool weather, the feeding period can be extended to 5 or 6 days. Placing wet material on a concrete slab, under plastic or shade, and covering with salt (10 to 25 lb/ton) will delay spoilage during hot weather (Harris and Staples, 1988).

Corn Gluten Meal: Corn gluten meal (CGM) is produced from wet milling of corn for starch and syrup. Two products are produced, a 40% (also known as corn germ meal) and a 60% crude protein supplement with the 60% being the most common. Both types have high RUP content. Energy content of CGM is only slightly less than corn grain. Because of palatability problems, limit amounts to 5 lb/cow/day.

Corn Gluten Feed: Corn gluten feed (CGF) is the major byproduct of the wet milling process after the extraction of the oil and starch. This product is sold wet or dry and is an excellent feed for the ruminant animal. Protein content of corn gluten feed is variable (20 to 25% dry matter basis) and should be purchased on protein content if used as a supplement. CGF is also high in digestible fiber, which is concentrated in the feed because of the removal of most of the starch and fat. The higher fiber content may help in reduction of potential rumen acidosis. Milk fat percentage has been demonstrated to be easier to maintain and sometimes increased with CGF in the diet. This feed is low in calcium but has relatively high levels of phosphorus and potassium.

Wheat Midds (Middlings): Wheat midds are a byproduct of the flour milling process. This product consists of several grades of granular particles containing different proportions of endosperm, germ, and bran. Just over 20% of the original wheat kernel ends up as wheat midds. Wheat midds are sometimes pelleted and can vary in composition. On average, wheat midds contain 18 to 20% crude protein. Energy is considered medium or mid-range. Effective fiber is also low as compared to beet pulp or soy hulls fiber.

Intake of midds should be restricted to 8 lb/cow/day or 15% of the total ration. Overfeeding wheat midds could decrease dry matter intakes, leading to a negative energy balance, which would decrease milk production (Marx, 1997).

Wheat Bran: Bran is included to add bulk and fiber to the diet. It is relatively high in protein and phosphorus, improves ration palatability, and functions as a laxative. Limit to 15% of diet dry matter.

Field Peas: Field peas can be used as a protein source (26% crude protein on dry matter basis) for livestock. Seed yields between 2,500 and 3,000 lb/acre can be produced under good growing conditions. Trapper variety is the most commonly grown field pea in North Dakota. Field pea may be grown as a forage, hay (difficult to dry down in the Midwest), pasture or silage. Field pea grown in a mixture with oat, barley or triticale yields more dry matter per acre than a straight pure pea. A mixture of 2/3 field pea and 1/3 oat can be seeded with alfalfa or clover as a companion crop.

Edible Beans: Culls and splits of edible beans are a good source of crude protein (25%). These byproducts, if clean and free of foreign materials, can be fed to dairy animals at 2 to 3 lb/cow/day.

Fish Meal: Fish protein sources are primarily of two types. Those from fish caught for making meal and those made from fish residues remaining after processing for human food or other industrial purposes. Anchovy, herring, and menhaden provide a majority of the meals made from whole fish. Crude protein ranges from 35 to 70% depending on type of product (whole fish or cuttings). Excellent protein quality and source of B-vitamins. Excellent source for limiting amino acids: tryptophan, lysine, and methionine. Limit the amount of fish meal in dairy cow diets to 1 lb/cow/day or about 100 grams of fish oil.

Malt Sprouts: Malt sprouts consist of dried sprouts and rootlets produced during the malting (germination or sprouting) of barley for beer manufacturing. The sprouts are separated from the malted barley and pelleted. Malt sprouts are low in energy, somewhat bitter and should be mixed with other feeds before feeding. Maximum feeding amount is 5 lb/cow/day.

B. Oil Seeds and Energy Feeds

Soybeans: Raw unprocessed soybeans are a good protein supplement for dairy cattle. They contain 18% fat. Roasting or extruding soybeans can increase palatability, stability, and RUP. Feeding rates of raw soybeans should be limited to 5 lb/cow/day or 20% of the grain mix. Heat processed soybeans may be fed at a 1 to 2 lb/cow/day higher feeding rate than raw soybeans.

Canola: Canola is grown for its high-quality oil content (42%). The seeds are very small and black or brownish colored and look like mustard seeds. Canola seeds should be processed before being fed to cattle; otherwise, many of the seeds pass through the intestinal tract undigested. The seeds can be coarsely ground, crushed, cracked or popped.

Feeding recommendations suggest a rate of 6.5% of the total ration dry matter or 3 to 4 lb/day.

Whole Sunflower Seeds: Two types of sunflower are grown: 1) The oil seed varieties, which may be either linoleic or oleic type, and are black-seeded with a thin hull that adheres to the kernel. Oilseed varieties contain from 38 to 50% oil and about 20% protein; 2) Non-oilseed types have been referred to as confectionery sunflower, have gray stripes, and are large-seeded. The confectionery seed hybrids generally are larger than those of the oilseed types and have a lower oil percentage and test weight (Berglund, 1994).

Sunflower seeds are quite palatable and are an excellent energy source. Feed at a rate equal to 1 lb of fat intake for lactating dairy cows (Park et al., 1997).

Whole Cottonseed: Whole cottonseed is a high fat (20 to 24%), high energy (1.02 Mcal/lb) and good protein (24%) feed. Whole cottonseed is white and fuzzy, while delinted cottonseed is black and smooth. The amount fed should not exceed 7 lb/cow/day.

Fat: Animal fat obtained from the tissues of mammals and or poultry in the commercial processes of rendering or extracting. Fat contains 2.25 more calories than carbohydrate. Fat is added to feed mixtures to increase the energy value, decrease dustiness, and improve texture and palatability. Tallow is the most common animal fat used in dairy rations. Fat can be added at levels up to 5% in ruminant diets.

Potato Wastes: Cull potatoes, screening and byproducts are high in water content (75 to 80%) and must be mixed with drier feeds for best response (Marx, 1997). Potato processing wastes such as

culls, peelings and other residues can be mixed with chaff, chopped hay or haylage and preserved as silage or can be dried and preserved as potato meal. Potato byproducts are high in energy, very palatable, medium to low in protein, and can be incorporated into properly balanced dairy rations.

Grains: Grains supply mainly energy. Oats and barley are moderately high in crude protein. Processing grain (rolling, cracking, or grinding) increases its digestibility. About 30% of the whole grain will pass through the digestive tract if not processed before feeding. Breaking the seed coat increases digestion. Coarse-textured, processed grain enhances palatability and intake. All finely ground grain in a ration is not recommended as it can cause rumen acidosis. Because young animals can chew their feed more thoroughly than adults, whole grains can be fed up to 12 months of age.

- ◆ Shelled Corn is the most common grain fed to dairy cows. It is one of the highest energy feeds available for use in dairy rations. Because of its high caloric density, good management (determining the amount to feed, frequency of feeding, mixing with other feeds, etc.) is needed to obtain maximum consumption without causing digestion disturbances. High moisture corn is highly palatable. High moisture shelled corn should be stored at 25 to 32% moisture. High moisture ear corn and shelled corn should be ground before storing in conventional silos. In oxygen limiting silos, the shelled corn can be stored whole and rolled upon removal from the silo. Propionic acid can be used to treat and preserve high moisture corn.
- ◆ Barley is a good source of energy and protein. Rolling barley is superior to fine grinding for palatability.
- ◆ Oats contain 15% less energy but 20 to 30% more crude protein than shelled corn. Oats add fiber and bulk to dairy rations, and may help maintain rumen function.

Molasses: Cane and beet molasses supply energy and are primarily used to enhance palatability of the ration. More varieties of molasses products are now available to dairy producers. Among these are citrus molasses, Masonex, and a number of products resulting from alcohol production.

Hominy Feed: Is a byproduct from the manufacturing of pearl hominy, hominy grits or table meal from corn. It has slightly more energy and protein than ground corn, and is similar in appearance and feeding characteristics (Harris and Staples, 1988). Hominy feed is very palatable to dairy cattle and may be fed up to 16 lb/cow/day.

Whey: Whey is the residue from cheese production and consists primarily of lactose, minerals and water. It can be fed dry or as a liquid. The liquid is termed sweet whey or acid whey. Sweet whey comes from the manufacture of cheddar and mozzarella cheese. Acid whey results from the production of cottage cheese and is less palatable than sweet whey. Liquid whey contains only 6 to 7% solids and must be fed rather soon after being produced or it will spoil. The pH of sweet whey (pH 6.0) is higher than the pH of acid whey (pH 4.5), but both will drop to about pH 3.5 or lower within 2 days. Cows will consume about 20 gallons of liquid whey daily and will increase their output of urine. Cows require a period of up to about 4 weeks to become accustomed to liquid whey. Liquid whey is corrosive; therefore, suitable containers such as plastic, stainless steel, glass and wood must be used to contain it (Harris and Staples, 1988).

Dried whey products are considered energy feeds and contain 37 to 72% lactose, which is readily fermented in the rumen (Schingoethe, 1991). Typical dried whey contains about 13% protein. Dried whey can be added to the diet to increase ruminal fermentation and microbial protein synthesis (Maiga et al., 1996). However, dried whey is usually a more expensive feed ingredient than feed grains. Rate of feeding recommended is about 2 to 3 lb/cow/day.

C. Fiber Byproducts

Sugarbeet Pulp: Beet pulp can replace either part of the grain or part of the forage in a dairy ration. Compared to corn, beet pulp contains 85 to 90% energy, similar crude protein, but a much higher and more digestible fiber. Sometimes beet pulp contains molasses (about 3%), which adds to its energy value and palatability. Dried sugarbeet pulp can be included in up to 30% of diet dry matter.

Straw, Chaff: Not all dairy animals need top quality forage all of the time. Dry cows and yearling heifers can be fed lower quality forages if their rations are properly supplemented. On a dry matter basis, wheat chaff may contain up to 11% crude protein, 3% fat, 35% fiber, and 39% readily available starch and sugars. Sunflower chaff (combine wastes and head particles) is most useful for dry cows and yearling heifers.

Soybean and Sunflower Hulls: These byproducts contain 50 to 55% ADF. Soybean flakes, soyhulls, and soybean hulls are all similar feeds and are good sources of highly digestible fiber. They may replace starch in the diet, but not forage fiber. Sunflower hulls are low in digestibility, but can add bulk to diets. They also readily absorb liquids such as molasses.

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Table 1. Nutrient Values of Alternative Feeds and Commonly Accepted Maximum Levels in Dairy Rations

Protein Supplements	DM %	CP %	RUP % CP	FAT %	NEL Mcal/lb	TDN %	ADF %	NDF %	Calcium %	Phosphorus %	MAXIMUM		As fed
											% Conc.	% Diet DM	lb/cow/day
Brewers Grains													
~Dried	93	26	50	6.5	0.71	68	24	46	0.29	0.54	25~35	15~25	6~10
~Wet	22	26	35	6.5	0.74	73	23	42	0.29	0.54		15~25	30~40
Canola Meal													
~Mech~extd	92	38	28	3.0	0.79	72	18	36	0.3	1.0	20~25	10~15	6~8
~Solv. ~extd	91	41	28	1.2	0.71	69	18	36	0.3	1.0	20~25	10~15	6~8
Corn Gluten Feed													
~Dried	90	25	22	2.4	0.85	82	12	34	0.1	0.8	50~100	20~30	12
~Wet	40	25	26	2.4	0.85	82	12	34	0.1	0.8		20~35	25
Corn Gluten Meal	90	66.7	85	2.4	0.88	82	5.0	14	0.1	0.8	5~15	4~8	2~4
Cotton Seed Meal	91	45.6	43	1.3	0.81	76	19	26	0.22	1.21			
Distillers Grains, Corn													
~Dried	93	25	54	10.3	0.92	88	18	44	0.15	0.71	50~100	25~40	9
~Wet	22	25	47	10.3	0.92	88	18	44	0.15	0.71		15~25	30
Edible Beans, Cull Navy	90	25.4	16	1.6	0.87	83	10	15	0.29	0.54	5~10	3~5	2~3
Field Peas, dry	90	25.8	22	1.3	0.86	82	8	12	0.2	0.55			
Fish Meal	92	67	60	10	0.76	73	~	~	5.65	3.16	3	2	1
Linseed Meal 34% Solv.	90	38.3	35	1.5	0.81	78	19	25	0.43	0.89			
Malt Sprouts	94	28.1	~	1.4	0.72	71	18	48	0.23	0.75	20~30	10~15	5~9
Soybeans, heat treated, (roasted)	91	42.2	49	20	0.99	94	10	15	0.28	0.66	25~35	15	6~8
Soybeans, Raw	90	42.8	26	18.8	0.96	91	10	15	0.28	0.66	20~25	10~15	4~6
Soybean Meal 44% CP	89	49.9	35	1.5	0.89	85	10	15	0.3	0.68			

Protein Supplements (continued)	DM %	CP %	RUP % CP	FAT %	NEL Mcal/lb	TDN %	ADF %	NDF %	Calcium %	Phosphorus %	MAXIMUM		As fed
											% Conc.	% Diet DM	lb/cow/ day
Soybean Meal 49% CP	89	55.1	35	1.0	0.88	84	6	8	0.29	0.7			
Soybean Meal, extruded, 140° C	89	46	67	5.5	0.92	87	8	10	0.3	0.68	25~35	10~15	4~5
Soybean Screenings	90	32.5		13	0.92	87	22.4	30	0.34	0.47	25~35	15	6~8
Sunflower Meal without hulls	89	45	26	3.1	0.69	67	15	25	0.44	0.98			
Sunflower Meal with hulls	90	34	26	2.1	0.63	57	33	40	0.23	1.03	10~20	10~15	5~8
Wheat Bran	89	18	29	4.4	0.77	70	15	51	0.12	1.32	25~35	15~25	6~9
Wheat, Middlings	89	19	25	4.9	0.87	83	10	37	0.12	1.0	25~30	15~25	6~12
Grain and Energy Feeds													
Canola Oil Seed	92	21	-	42	1.17	110	12	25	0.38	0.75		6~7	3~4
Barley	89	14	27	2.1	0.88	84	7	19	0.05	0.37	50~100	35~40	16~20
Pearl Barley	89	15	27	3.9	0.78	76	15	25	0.05	0.46	50~100	35~40	16~20
Corn, shelled 15% Moisture	85	10.2	52	4.3	0.92	88	3	9	0.02	0.3			
Corn, shelled High Moisture	70	10.2	70	4.3	0.92	88	3	9	0.02	0.3			
Ear Corn 15% Moisture	85	9.3	52	3.7	0.87	84	11	25	0.04	0.26			
Ear Corn High Moisture	65	9.3	70	3.7	0.87	84	11	25	0.04	0.26			
Cottonseed (fuzzy), Whole with Lint	92	24	45	20	1.02	96	34	44	0.2	0.75	25~35	15	6~7
Cottonseed, Whole without Lint	90	25	45	23.8	1.06	98	26	37	0.12	0.54	25~35	15	5~7

Grain and Energy Feeds (continued)	DM %	CP %	RUP % CP	FAT %	NEL Mcal/lb	TDN %	ADF %	NDF %	Calcium %	Phosphorus %	MAXIMUM		As fed lb/cow/ day
											% Conc.	% Diet DM	
Fat, Animal	98	~	~	100	2.38	182	~	~	~	~		3~5	1~1.5
Hominy Feed	90	12	~	7.7	0.96	92	13	25	0.05	0.57	50~100	20~35	10~16
Molasses													
~Beet	75	9	~	~	0.81	79	~	~	0.17	0.04	5~10	3~5	1~5
~Cane	75	4	~	~	0.74	72	~	~	1.19	0.11	5~10	3~5	1~5
Oats, 32~36 lb/bu	89	13	~	4.5	0.79	76	16	32	0.1	0.32	50~75	25~30	10~12
Oats, over 36 lb/bu	89	14	~	5.4	0.82	80	13	29	0.1	0.32	50~100	25~40	10~15
Potato Wastes	23	6.9	~	8	0.82	79	2	8	0.05	0.14	25	10~15	25
Soybeans, Raw	90	42.8	26	18.8	0.96	91	10	15	0.28	0.66	20~25	10~15	4~6
Sunflower													
- Confectionery	90	18.7	~	28		84	29	35	0.2	0.6	25~35	7~10	3~5
~Oil varieties	90	20	~	42	1.25	95	24	30	0.3	0.6	25~35	7~10	3~5
Whey, dried	7	14		0.7	0.81	78	~	~	0.98	0.81		5~10	2~3
Fiber Byproducts													
Alfalfa													
- 20% CP dehy.	93	21.5		3.1	0.64	62	35	45	1.43	0.29	10~20	10~20	4~10
- 17% CP dehy.	93	18.7		3	0.63	60	31	42	1.3	0.26	5~15	5~15	3~8
~Cubes	93	18.7		3	0.63	60	31	42	1.3	0.26	5~15	5~15	5~15
Corn Cobs, ground	90	3		0.4	0.5	50	35	89	0.1	0.15	15~25	15~25	6~8
Cottonseed, (fuzzy)													
Whole with Lint	92	24		20	1.02	96	34	44	0.2	0.75	25~35	15	6~7
Cottonseed,													
Whole without Lint	90	25		23.8	1.06	98	26	37	0.12	0.54	25~35	15	6~7
Grain Screenings, Variable hulls	90	11				70	41	68	0.1	0.25	10~20	10~15	4~6

Fiber Byproducts (continued)	DM %	CP %	RUP % CP	FAT %	NEL Mcal/lb	TDN %	ADF %	NDF %	Calcium %	Phosphorus %	MAXIMUM		As fed
											% Conc.	% Diet DM	lb/cow/ day
Oat Hulls	93	3.9		1		55	42	62	0.31	0.19	10~20	10~15	4~6
Soy Hulls	91	12	30	2.1	55	78	50	67	0.5	0.2	20~50	15~25	8~12
Sugarbeet Pulp	91	9.5	45	0.6	81	78	28	49	0.75	0.11	30~50	20~30	8~15
Sunflower Hulls	93	5		3	0.4	40	55		0.32	0.12	10~20	10~15	3~4
Wheat													
~Chaff	89	11		3.2	0.44	44	50	80	0.32	0.12			
~Straw	89	4		1.8	0.44	44	54	85	0.32	0.12			

RUP: Rumen Undegradable Protein (same as UIP: Undegradable Intake Protein).

Sources: The data have been summarized from the following:

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