UTILIZING AND PRICING ALTERNATIVE FEEDSTUFFS FOR BEEF CATTLE DIETS (1993-1994)

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Alfredo DiCostanzo, Extension Animal Scientist
Jay C. Meiske, Professor of Animal Science
University of Minnesota, St. Paul

Hugh Chester-Jones, Animal Scientist
Southern Experiment Station, Waseca

Factors Affecting Nutritional Value of Feedstuffs

For ruminants, the microbial population existing in the rumen breaks down feed ingredients offered to the animal. This population must be healthy and viable to permit maximum utilization of feed ingredients. Because ruminants evolved mainly as forage feeders, factors that disrupt population of cellulolytic microorganisms will result in reduced utilization of nutrients -- primarily, energy and protein, but also reduced production of vitamins and utilization of minerals. Factors that affect nutritional value of feedstuffs are discussed below.

Nutritional variation. Let us assume that a diet is formulated solely on the average composition of a feedstuff that contains an average CP value of 21.5% with a coefficient of variation of 24%. During a year, several batches of this feedstuff were purchased to formulate a ration throughout that year. Crude protein content derived from that feedstuff would vary as much as 24%. Thus, if the ration contained 50% of that feedstuff, CP content of the total diet would vary as much as 12%. This is equivalent to offering CP levels between 10.6 and 13.4% during this period.

Variation in batches of alternative feedstuffs is dependent mainly on the process that it used to produce that feedstuff. Although some of this variation may be reduced by purchasing from the same source, changes in processing do occur due to changes in demand of main process end products. Thus, as for any feedstuff used in feedlots, chemical analyses of alternative feedstuffs is strongly encouraged.

Spoilage and toxicity. Chemical analyses of feedstuffs must include moisture content analyses to determine whether a feedstuff may be safely stored for any length of time. Moisture levels above 15% may reduce storage time and increase the probability of mold growth and mycotoxin production.

Other potential toxicity problems associated with the use of alternative feedstuffs is the presence of pesticides (especially with fruit and vegetable processing wastes), heavy metal or antibiotic contamination (which may occur with some poultry litter), and salmonellosis (sometimes found in vegetable processing waste).

Supplemental needs. Utilization of certain feedstuffs may increase the supplemental needs of various minerals or vitamins. Utilization of corn gluten feed, which contains high amounts of phosphorus, will require additional supplementation with calcium. Diets with calcium-to-phosphorus ratios lower than 1.5 to 1 may cause urinary calculi.

Also, some poultry litter may contain excessively high amounts of copper, which may interfere with utilization of iron and molybdenum. High sulfur content of some feedstuffs obtained from extraction procedures may reduce thiamine utilization. Reduced thiamine utilization may lead to polioencephalomalacia (PEM). Similarly, utilization of potato screenings and peels may lead to high sodium intakes which interfere with monensin action and reduce DM intake.

Observing limits on feeding alternative feeds, and carefully testing limits when utilizing feedstuffs that have not been thoroughly researched are strongly recommended practices when incorporating alternative feedstuffs in a feeding program. Additionally, gradual incorporation of the alternative, or any "new" feedstuff, in the diet to adapt cattle and ruminal microbes is a sound practice that justifies the additional effort.

Utilization of Alternative Feedstuffs

The initial decision to utilize a feedstuff must take into consideration the factors described above and a price per unit of nutrient provided evaluation. Listed in Table 1 are chemical compositions of various alternative feedstuffs. This table should be utilized as an initial approach to determine whether a specific feedstuff may fit a specific feeding program. The final decision to utilize a feedstuff must include an analysis of the chemical composition of the feedstuff from the source where it will normally be bought, determination of its opportunity price given the prices of other feedstuffs available to the feeder, evaluation of its potential contribution or detriment to the feeding program, consideration made about any added value gained from including a specific feedstuff (utilization of positive associative effects).

Table 1. Nutrient composition of various by-product and non-typical feedstuffs (DM basis)

Feedstuffs	DM	ME	NE_m	NE_g	CP	Ether extract	Ash	Calcium
	%	----------- Mcal/lb -----------			--------------------------------------- % ----			
Animal fat	99	2.91	2.16	1.60	0.0	99.5	0.0	0.00
Apple pomace	40	.92	.54	.28	5.6	5.2	3.5	.13
Bakery waste	95	1.55	1.06	.73	11.2	12.7	4.4	.14
Barley	88	1.38	.94	.64	13.0	2.1	2.6	.05
Beet pulp	91	1.22	.80	.52	9.7	.6	5.4	.69
Blood meal	92	1.08	.64	.37	86.0	1.4	5.8	.32
Brewers grains	23	1.09	.69	.41	27.0	6.5	4.8	.33
Brewers grains	91	1.09	.69	.41	27.2	7.2	3.9	.33
Broiler litter	89	1.091.2	.69	.41	24.5	3.0	22.0	3.16
Canola meal	90	5	.83	.54	36.5	7.9	7.5	.72
Carrots	12	1.38	.94	.64	9.9	1.4	8.2	.40
Cookie meal	90	1.52	1.05	.73	7.0	14.0	4.4	.14
Corn	87	1.48	1.02	.70	9.5	4.2	1.4	.02
Corn cobs	90	.82	.44	.19	3.2	.7	1.7	.12
Corn gluten feed	40	1.36	.92	.62	26.2	2.4	7.5	.36
Corn gluten feed	92	1.36	.92	.62	26.2	2.4	7.5	.36
Corn gluten meal	90	1.46	1.00	.69	67.2	2.4	1.8	.08
Corn silage	35	1.15	.74	.47	8.0	3.1	4.5	.23
Cottonseed hulls	91	.69	.31	.07	4.1	1.7	2.8	.15
Cottonseed meal	90	1.31	.83	.54	44.0	1.6	7.1	.18
Cottonseeds	93	1.58	1.10	.77	23.9	23.1	4.8	.16
Cull beans	90	1.38	.94	.64	25.3	1.5	5.2	.18
Distillers grain	93	1.41	.96	.66	23.0	9.8	2.4	.11
Feather meal	93	1.15	.74	.47	91.3	3.2	3.8	.28
Fish meal	90	1.22	.76	.48	67.0	8.0	21.0	5.90
Hay	89	.90	.52	.26	13.0	2.3	8.4	.30
Hominy feed	90	1.55	1.02	.75	11.5	7.7	3.1	.05
Meat/bone meal	93	1.09	.65	.40	50.4	10.4	31.5	11.06
Molasses	78	1.30	.87	.58	8.5	.2	11.3	.17
Oat hulls	92	.58	.19	0.00	3.9	1.8	.6	.15
Oat screenings	90	1.26	.78	.54	12.9	4.6	2.5	.08
Potato by-products	53	1.43	.99	.68	5.3	.4	3.4	.04
Soy hulls	90	1.08	.65	.39	8.0	2.1	5.1	.49
Soybean meal	89	1.38	.94	.64	44.0	1.5	7.3	.33
Sunflower meal	93	1.07	.67	.40	49.8	3.1	8.1	.44
Sweet corn waste	32	1.18	.77	.49	7.7	5.2	4.9	.30
Thin stillage	5	1.45	.99	.68	29.7	9.2	7.8	.35
Vegetable fat	100	2.91	2.16	1.60	0.0	99.9	0.0	0.00
Whole soybeans	92	1.50	1.03	.71	42.8	18.8	5.5	.27

Adapted from Rust, 1991.

Opportunity price. This is the price a feedstuff acquires given the price and composition of a reference feedstuff. Usually, the reference feedstuff is one that is available at the farm. Thus, a feeder may already own several thousand tons of corn silage priced at harvest cost plus a reasonable profit to his farming operation. Given this situation, this farmer may require additional energy, or protein from feedstuffs he does not own. The opportunity price of energetic feedstuffs would be referenced to his corn silage price, if the alternative feedstuff substitutes part, or all of silage. Also, this feeder will need to finish his cattle at some time. At this point, corn, or barley could become his reference feed, depending on whether he owns any of these feedstuffs, or one of these feedstuffs is readily available at a local elevator. Given this situation, any other feedstuff he may consider will be referenced to corn or barley.

Because alternative feedstuffs vary in their protein and energy composition, opportunity prices must take into consideration the nutrient they will substitute a basic ingredient for (usually energy), but also any other major nutrient (usually protein) they may provide, or limit, depending on whether they have a greater, or lower concentration of the latter than the reference feed.

The following tables (Tables 2 and 3) are based on a paper by Rust (1991), but are adapted to diets based on corn silage, hay, corn grain, or barley. Additionally, an attempt was made to rank feedstuffs based on their fermentation rate and effects on fiber digestion to understand limitations. Later in the paper, reference will be made to these traits to optimize blending these feedstuffs to promote rumen health and improved feedlot performance.

Listed in Table 2 are ruminal characteristics of feedstuffs utilized in formulating growing rations and opportunity prices for various protein supplement price conditions. Corn silage and hay are the reference feeds for this table. Therefore, to facilitate interpretation of effects of alternative feedstuffs on fiber digestion, corn silage was given a value of zero. Thus, when a feedstuff is given a positive value on any of the traits evaluated, it represents a higher value (fermentation rate), or a positive effect (effect on fiber digestion) relative to corn silage. For instance, fermentation rate of corn gluten feed is similar to that of corn silage. Also, when corn gluten feed is fed within limits described here, fermentation of corn gluten feed in the rumen provides a healthy environment for microbial activity, and the overall effect is to enhance fiber digestion relative to corn silage. It is apparent from this table that although fermentation rates may be fast (oat screenings), fiber digestion may be affected negatively. Similarly, a slow fermentation rate (corn cobs), may have a positive effect fiber digestion.

Opportunity prices were calculated as follows: first, corn silage, or hay, as the base ingredients, were priced at $24 and $40/ton. Hay was considered to have 55% TDN, and 13% CP. Opportunity prices that only consider differences in energy between alternative feedstuffs and reference feeds were calculated. Diets to be formulated were to contain 13% CP. Supplemental nitrogen was obtained from soybean meal, priced at $240/ton, and urea, priced at $230/ton. Because urea may not be fed as the sole nitrogen source in these diets, due to the high protein requirement simulated here, a soybean meal:urea blend containing 83% and 17% from each ingredient, respectively, was formulated. Therefore, supplemental protein cost per unit of protein was derived by dividing cost of supplement per ton (as-fed basis) by CP content (as-fed basis). For soybean meal, this cost would be 5.4 ($240/.44).

Therefore, if a feeder is formulating a .51 Mcal NE_g/lb and 13% CP using corn silage as the base ration and wants to add dry corn gluten feed when soybean meal price is $240/ton, dry corn gluten feed may be worth as much as $140.85/ton. This same person could consider using broiler litter for as much as $113.67/ton, but it is not clear whether broiler litter will not affect fiber digestion due to possible interactions with heavy metals and antibiotics the litter may contain. Here is a situation where a person needs to make a careful decision to evaluate a feedstuff further, before using it.

The other scenario that may be generated here is that of a feeder who uses hay-based diets. Given that situation, and because hay contains more protein than corn silage, opportunity price for dry corn gluten feed drops to $128.72, relative to the example based with corn silage.

Another table was generated (Table 3) listing ruminal characteristics of feedstuffs utilized in formulating finishing rations and opportunity prices for various protein supplement price conditions. Corn grain and barley were the reference feeds for this table. Therefore, to facilitate interpretation of effects of alternative feedstuffs (including barley) on fiber digestion, corn grain was given values of zero. Thus, when a feedstuff is given a positive value on any of the traits evaluated, it represents a higher value (fermentation rate), or a positive effect (effect on fiber digestion) relative to corn grain. For instance, fermentation rate of molasses is greater than that of corn grain. Also, when molasses is fed within limits described here, fermentation of molasses in the rumen provides a healthy environment for microbial activity, and the overall effect is to enhance fiber digestion relative to corn grain. It is apparent from this table that although fermentation rates may be fast (potato byproduct), interaction with microbes, and fiber digestion may be affected negatively. Similarly, a slow fermentation rate (corn cobs), may have a positive effect on rumen environment and fiber digestion.

Opportunity prices were calculated as follows: first, corn grain, or barley, as the base ingredients, were priced at $88.88 ($2.50/bu) and $85.11/ton ($2.04/bu). Opportunity prices that only consider differences in energy between alternative feedstuffs and reference feeds were calculated. Diets to be formulated were to contain 13% CP. Supplemental nitrogen was obtained from soybean meal, priced at $240/ton, and urea, priced at $230/ton. Urea may be fed as the sole nitrogen source in these diets and is thus considered ($230/2.81). Also, a soybean meal:urea blend containing 61% and 39% from each ingredient, respectively, was formulated.

In this example, a feeder considering animal fat inclusion in corn-based diets may pay as much as $191.63/ton (9.6 cents/lb) when the supplemental nitrogen source is urea, or as little as $148.46/ton (7.4 cents/lb) when the supplemental nitrogen source is soybean meal. However, if the diet is based on barley, then animal fat is only worth $132.33/ton when the supplemental nitrogen source is soybean meal.

It is interesting that when corn grain is priced at $2.50/bu, a person may purchase barley for as much as $2.14/bu when using urea, or for as much as $2.49/bu when using soybean meal. In contrast, a person that is offered barley at $2.04/bu can pay only $2.45/bu of corn when urea is the supplemental protein, or as little as $2.06/bu when soybean meal is the supplemental protein.

These tables assume that feedstuffs evaluated are to be fed within the limits specified, on an ad libitum basis, and with appropriate feedbunk management practices. Also, the values for this table will contribute to formulating least cost rations. Least cost rations minimize feed cost but do not optimize performance relative to cost. A more detailed evaluation of both least cost and least cost of gain ration analyses should be conducted with a computer program before deciding on how feedstuffs may substitute basic ingredients for improved performance.

Optimization of feedstuff combinations. An attempt was made to rank feeds of known fermentation rates that may be used under feedlot conditions in the upper Midwest. Table 4 depicts these rankings for various feeds grouped under the categories: fats, grains, high energy byproducts, low energy byproducts, and forages. Feedstuffs are ranked in the rows, within groups, relative to the speed of fermentation in the rumen. Therefore, feeds can be compared only for their fermentation rate within a column.

Table 2. Value of various feedstuffs in growing rations for beef cattle

										Sup
					Max dietary limit			Relative to		C
Feedstuff	FR[a,c]	FD[a,d]	DM[e]	CP[f]		ECFI[g]	ECFII[h]	CS[i]	Hay[j]	2.6
			------------ % ------------					-------------------------- Value[k],		
Apple pomace	+	B	40	5.6	25	.80	1.01	21.94	18.40	19.45
Beet pulp	0	+	91	9.7	25	1.06	1.34	66.14	55.46	70.17
Broiler litter	0	0	89	24.5	35	.94	1.19	57.84	48.44	84.50
Carrots	0	+	12	9.9	20	1.20	1.52	9.87	8.28	10.47
Corn cobs	B	+	90	3.2	15	.72	.91	44.43	37.26	33.20
Corn gluten feed	0	+	40	26.2	90	1.18	1.51	32.44	27.17	46.19
Corn gluten feed	0	+	92	26.2	50	1.18	1.51	74.61	62.48	106.23
Corn silage	0	0	35	8.0	90	1.00	1.27	24.00	20.13	24.00
Hay	B	+	89	13.0	90	.79	1.00	47.67	40.00	59.11
Cottonseed hulls	B	+	91	4.1	40	.60	.76	37.44	31.40	28.21
Cull beans	+	+	90	25.3	90	1.20	1.52	74.06	62.10	102.84
Oat hulls	B	+	92	3.9	20	.50	.63	31.54	26.45	21.74
Oat screenings	+	B	90	12.9	40	1.10	1.39	67.89	56.93	79.35
Soy hulls	0	+	90	8.0	80	.91	1.15	56.16	47.09	56.16
Sweet corn waste	0	0	32	7.7	80	1.03	1.30	22.60	18.95	22.35
Thin stillage	0	0	5	29.7	10	1.26	1.59	4.32	3.62	6.49
Whole raw soybeans	0	B	92	42.8	25	1.30	1.64	82.01	68.77	153.29

[a] + = greater than; 0 = equal to; B = less than corn silage.
[b] $/protein content for a mixture (83:17) of soybean meal ($240/ton) and urea ($230/ton, 2.6), or soybean meal (5.4).
[c] Ruminal fermentation rate, ranked as faster or slower than corn silage.
[d] Effects on fiber digestion, ranked as positive or negative.
[e] Dry matter.
[f] Crude protein, % of DM.
[g] ECFI = energy conversion factor relative to corn.
[h] ECFII = energy conversion factor relative to barley.
[i] CS = corn silage ($24/ton); comparison between feedstuff and corn silage on energy value alone.
[j] Hay = comparison between feedstuff and hay ($40/ton) on energy value alone.
[k] Value calculated from formula for feedstuffs with CP < reference feed [(price reference feed DM basis H ECF) + [(CP feeds (supplemental protein cost)]] H (DM feedstuff / 100), or for feedstuffs with CP > dietary CP desired [(price reference feed D feedstuff B diet CP) H (supplemental protein cost)]] H (DM feedstuff / 100).

Table 3. Value of various feedstuffs in finishing diets for beef cattle.

Feedstuff	FR[a,c]	FD[a,d]	DM[e]	CP[f]	Max dietary limit	ECFI[g]	ECFII[h]	Relative to Corn[i]	Relative to Barley[j]	Supplem Corn .8	Supplem Corn 1.7	
			----------- % -----------					------------------------------------- Value[k], $/t				
Animal fat	**B**	**B**	99	0	5	1.97	2.11	199.2	201.83	191.63	183.26	14
Bakery waste	+	**B**	95	11.2	20	1.05	1.12	4	103.23	103.21	104.65	11
Barley	+	**B**	88	13.0	90	.93	1.00	101.9	85.11	89.04	91.87	10
Beet pulp	**B**	+	90	9.7	25	.82	.88	1	76.37	75.54	75.70	7
Brewers grains	**B**	+	23	27.0	30	.74	.79	86.46	17.61	20.00	22.869	3
Brewers grains	**B**	+	91	27.0	30	.74	.79	75.39	69.69	79.26	0.76	13
Carrots	**B**	+	12	9.9	20	.94	1.01	17.39	11.67	11.56	11.61	11
Cookie meal	+	**B**	90	7.0	25	1.03	1.10	68.80	95.93	92.88	90.88	8
Corn	0	0	87	9.5	100	1.00	1.07	11.52	90.03	88.88	88.88	8
Corn cobs	**B**	+	90	3.2	15	.56	.60	94.70	52.16	46.90	41.85	2
Corn gluten feed	0	+	40	26.2	90	.92	.98	88.88	38.08	41.87	46.57	6
Corn gluten feed	0	+	92	26.2	50	.92	.98	51.49	87.59	96.31	107.11	15
Cull beans	0	+	90	25.3	25	.94	1.01	37.60	87.55	95.39	105.25	14
Distillers grains	0	+	93	23.0	60	.96	1.03	86.47	92.39	98.74	107.02	141
Hominy feed	+	**B**	90	11.5	30	1.05	1.12	86.43	97.79	98.00	99.60	10
Molasses	+	+	78	8.5	20	.88	.94	91.21	71.03	69.49	68.80	6
Oat screenings	+	0	90	12.9	40	.86	.92	96.54	80.10	81.55	84.27	9
Potato byproduct	+	**B**	53	5.3	15	.97	1.04	70.12	53.20	50.72	48.74	4
Potato byproduct	+	**B**	33	5.3	15	.97	1.04	79.07	33.07	31.44	30.21	2
Thin stillage	0	0	5	29.7	10	.98	1.05	52.52	5.0720	5.68	6.43	
Vegetable fat	**B**	**B**	100	0.0	5	1.97	2.11	32.57	3.87	193.56	185.11	14
Whole raw soybeans	0	**B**	92	42.8	25	1.01	1.08	5.01	96.16	117.13	141.54	24
								201.2				
								6				
								94.93				

[a] + = greater than; 0 = equal to; **B** = less than corn.

[b] $/protein content for urea ($230/ton, .8), a mixture (61:39) of soybean meal and urea (1.7), or soybean meal (5.4).

[c] Ruminal fermentation rate ranked as faster or slower than corn.

[d] Effects on fiber digestion, ranked as positive or negative.

[e] Dry matter.

[f] Crude protein, % of DM.

[g] ECFI = energy conversion factor relative to corn.

[h] ECFII = energy conversion factor relative to barley.

[i] Comparison between feedstuff and corn on energy value alone.

[j] Comparison between feedstuff and barley on energy value alone.

[k] Value calculated from formula for feedstuffs with CP < reference feed [(price reference feed DM basis H ECF) + [(CP feedstu
(supplemental protein cost)]] H (DM feedstuff / 100), or for feedstuffs with CP > dietary CP desired [(price reference feed DM basis
CP) H (supplemental protein cost)]] H (DM feedstuff / 100).

Table 4. Fermentation rates categorized for feeds within feed group[a]

Fermentation rate	Fats	Grains	High energy byproducts	Low energy byproducts	Forages
FASTEST	Vegetable	Wheat	Bakery waste	Apple pomace	Early vegetative
		Barley	Cookie meal	Soy hulls	
FAST	Yellow	HM[b] corn[c]	Potato byproduct	Corn silage	
	Tallow	SF[d] corn	Molasses	Sweet corn waste	Early bloom/ pre-boot
MODERATE		HM[b] corn[e]	Hominy feed	Beet pulp	Mid-bloom
		R[f] corn	Carrots	Broiler litter	
SLOW	Oilseeds	SF[d] milo	Distillers grains	Cottonseed hulls	Boot stage/
		M[g] milo	Wet gluten feed	Oat hulls	Late bloom
		W[h] corn	Brewers grains	Corn cobs	Dough stage
SLOWEST		R[f] milo	Dry gluten feed	Rice hulls	Straw

[a] Comparison of fermentation rates can be done only within groups of feeds (columns). However, even within columns feeds may not vary significantly (low energy byproducts), or they may vary dramatically (grains).
[b] High moisture.
[c] From bunker (ground).
[d] Steam flaked.
[e] From upright (whole).
[f] Rolled.
[g] Reconstituted.
[h] Whole.

Within each of the categories, a feed listed at the top will have a greater ruminal fermentation rate than those in the middle or bottom of the list. However, for high energy byproducts, differences in fermentation rate for feeds below the level of hominy feed may not differ significantly. Similarly, for grains, differences among fermentation rates of rolled corn, reconstituted or steam flaked milo may not differ significantly.

Thus, when a diet is being formulated, or analyzed, consulting this table may provide an indication of performance, rumen health and the degree of caution to exercise at feed bunk management. For instance, a diet composed of 65% barley, 20% ground high moisture corn and 15% corn silage (DM basis) is probably balanced for fast gains during the finishing phase. However, all feeds utilized in this diet are rapidly fermented in the rumen. Therefore, this diet will require more conscious efforts at feedbunk management. On the other hand, a diet composed of 50% rolled corn and 50% dry corn gluten feed will ferment slower than the one described previously. Thus, although feedbunk management should not be totally ignored with this diet, the diet may permit more flaws in our management.

Another utilization for Table 4 is as an indicator of performance. Diets balanced heavily to the bottom right of this table will not cause rumen upsets but will support slow weight gains. Diets thus formulated are appropriate for growing cattle. On the other hand, diets balanced heavily to the upper left of Table 4 will support faster rates of gain, but will require careful feedbunk management.

By combining information of opportunity prices (Tables 2 and 3), and fermentation rates (Table 4), a feeder may devise his own feeding program. For instance, a feedlot operator may have large amounts of corn silage, and some whole high moisture corn. Regardless of what type of cattle will be fed, protein will need to be supplemented. If calves are going to be supplemented with soybean meal and urea, corn silage (a fairly fast digesting feed) may be combined with dry corn gluten feed (a slower digesting feed) to provide the desired rate of gain. This strategy would permit saving high moisture corn for the finishing period. Under these conditions, dry corn gluten feed is worth as much as $106.23/ton. For the finishing period, the diet could be balanced with high moisture corn, corn gluten feed and corn silage, if sufficient high moisture corn is available for a 50:50 combination with corn gluten feed. However, if additional energy feeds need to be purchased, whole shelled corn (max. $2.50/bu), dry distillers grain (max. $107.02/ton), or whole soybeans (max. $141.54/ton) may provide adequate energy and a moderate rate of rumen fermentation. If prices of moderate fermenting rate feedstuffs are higher than opportunity prices, fast fermenting feeds (barley max. at $2.20/bu) may complement diet adequately, providing careful bunk management is exercised.

Value added feed combinations. Prior discussion on blending feed ingredients based on opportunity prices and fermentation rates centered on the need to manage diets adequately to obtain desired performance. Fast fermenting feeds will provide maximum amount of energy per unit time, but need to be managed so that rumen microbes are not overwhelmed. Utilization of slower fermenting feeds that provide equal or similar amount of energy over time will aid in diminishing the rumen digestive load. Apparently, this concept is applicable not only to protecting the rumen and to promoting animal health, but also to maximizing energy utilization.

Table 5 summarizes a few papers published on effects of combining fast and slow fermenting grains on feedlot performance. An article by Byers et al. (1976) is listed to demonstrate that combining ingredients with different digestibility rates can lead to negative effects also. In this case, diet DM digestibility was decreased by the presence of corn in the diet. Apparently, a rumen microbe population accustomed to digesting fiber may change to digesting starch (from the corn) when corn is made available. This would reduce fiber and total overall digestion. From data reported, Byers et al. (1976) indicated that DM digestibility depression would be overcome when corn grain in the diet increased to 80 to 90% of diet DM.

Of special interest are results from the University of Nebraska (Britton and Stock, 1987; Stock, 1988) indicating that when fast and slow fermenting starch sources are combined (67 to 75% high moisture corn and 33 to 25% dry rolled corn or milo), feed efficiency is actually 2.3 to 4.7 units greater than when high moisture corn is fed alone. This indicates that the energy value of high moisture corn, when fed with dry rolled corn or milo, is greater than that described in feed value tables. This would permit paying a greater price for these feedstuffs when fed in this combination.

Similarly, the value of dry corn gluten feed approaches that of corn when dry corn gluten feed is fed with corn at a 50:50 ratio to finishing steers (DiCostanzo et al., 1990). Also, recent data indicate that the energy value of wet distillers grains may be greater than that of corn (Klopfenstein and Stock, 1993). Under these conditions, wet distillers grains (31.4% DM) may be worth as much as $51.85/ton, with corn priced at $2.50/bu and using a urea:soybean meal supplement for a 13% CP diet.

These concepts are described here to demonstrate that cattle feeding is an art as well as a science. However, for it to become an art, it is necessary to draw from the science of nutrition. As more research is conducted on alternative feedstuffs, it will be an easier task to develop a system to rank feedstuffs based not only on their price, but their contribution, or detriment to feeding growing and finishing cattle.

Table 5. Effects of feeding combinations of fast and slow fermenting feedstuffs on feedlot performance

Basic ingredient	Alternative feedstuff	% DM[a]	Response[b]	Reference
Corn silage	Dry corn	35	-4.8[c]	Byers et al., 1976
	Dry corn	67	-6.2[c]	
High moisture corn	Dry milo	25	4.7	Britton and Stock, 1987
		50	.7	
		100	1.1	
Dry corn	Dry corn gluten feed	30	-12.6	DiCostanzo et al., 1990
		50	.9	
		75	-12.5	
Dry corn	Wet distillers grains	5	3.1	Klopfenstein and Stock, 1993
		13	7.0	
		40	14.5	
High moisture corn	Dry milo, or dry corn	25 to 33	2.3	Stock, 1988
		50	.6	
		66 to 75	-2.8	
		100	-8.0	

[a] Contribution alternative feedstuff.

[b] Feed efficiency response relative to control (100% basic ingredient) diet, except for the Byers study.

[c] Dry matter digestibility response relative to a 100% corn silage control.

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