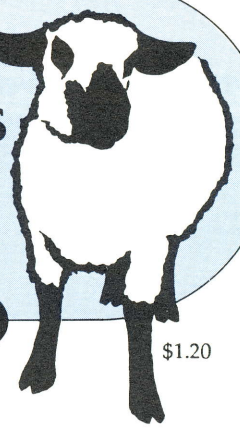
SHEEP NUTRITION

Determining the Equivalent Nutritive Values of Feedstuffs used in Sheep Diets



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Sixty to 70 percent of the total cost of producing slaughter lambs can be attributed to feed costs for both the ewe and her lambs. At a time when economic efficiency in livestock enterprises is of utmost importance, producers must strive for improvement in this area. This bulletin will compare the equivalent nutritive feeding values of various feedstuffs used in ruminant rations. In addition, it will illustrate how to convert available data on these feedstuffs into practical economic values so producers can compare, evaluate and identify alternative feed sources that will produce maximum economic efficiency.

Equivalent Nutritive Values of Concentrates

Equivalent nutritive feeding value can be defined as the proportional value of one feedstuff compared to another, based on the feedstuffs' content of a particular nutrient.

Shelled corn provides more utilizable energy, or *digestible energy (DE)*, for sheep than the other common energy sources except fat. For this reason, shelled corn is routinely given an index value of 100. The equivalent nutritive value (ENV) of other energy feeds is

TABLE 1: Equivalent nutritive value (ENV) of commonly used concentrate (energy) feeds for sheep (pound for pound as fed).

Energy source	ENV[1] percent	lb required to provide equivalent energy in each lb corn[2]	Average bushel weight (lb)
Shelled corn	100	—	56
Barley	99	1.01	48
Oats	88	1.14	32
Wheat[3]	101	0.99	60
Ground ear corn[4]	94	1.06	70[5]
Liquid molasses[6]	78	1.28	—
Fat[7]	252	0.40	—

[1]For energy feeds, ENV is based on shelled corn.

$$\text{ENV} = \frac{\text{Digestible energy (DE) content of energy feed}}{\text{DE content of shelled corn}} \times 100$$

DE values can be found in Table 6.

[2]Calculated as follows:

$$\frac{\text{1 lb corn}}{\text{ENV of energy feed}} \times 100$$

[3]Feed at no more than 50 percent of total grain in diet.
[4]95 percent ground ear corn (corn and cob) plus 5 percent liquid molasses.
[5]Unprocessed ear corn (corn and cob).
[6]Feed at no more than 10 percent of total diet.
[7]Feed at no more than 5 percent of total diet.

TABLE 2: Equivalent dollar values of some concentrate (energy) feeds.

	When shelled corn costs ($/bushel):					
	$1.50	$2.00	$ 2.50	$ 3.00	$ 3.50	$ 4.00
Equivalent value ($/bushel) of:[1]						
Barley	1.27	1.70	2.12	2.55	2.97	3.39
Oats	.74	1.00	1.26	1.51	1.76	2.01
Wheat[2]	1.62	2.16	2.70	3.25	3.79	4.33
Equivalent value ($/cwt)						
Ground ear corn (processed)[3]	2.52	3.36	4.19	5.04	5.88	6.71
Corn gluten feed	2.60	3.46	4.33	5.20	5.69	6.92
Liquid molasses[4]	2.09	2.78	3.48	4.18	4.88	5.57
Fat[5]	6.75	9.00	11.24	13.51	15.75	17.99

[1]Calculations adjusted for differences in weight/bushel and equivalent energy values (Mcal DE/lb).
[2]Feed at no more than 50 percent of the total grain in ration.
[3]Includes cost of grinding and addition of 5 percent liquid molasses (added for improved palatability).
[4]Feed at no more than 10 percent of the total ration.
[5]Feed at no more than 5 percent of the total ration. May be either vegetable or animal fat.

expressed as a percentage of this value (see Table 1). The values for wheat, ground ear corn, molasses and fat are valid only when fed according to the recommendations listed at the bottom of Table 1. Since these values are based on digestible energy (energy that the animals can utilize), different amounts of the various feedstuffs must be fed to provide the equivalent energy of shelled corn.

Dollar value comparisons of energy sources are important when you are considering alternative energy feeds. The cost of energy feeds is usually expressed on a bushel basis, so bushel weights must be known in addition to ENVs (see Table 1) in order to calculate the comparative costs of these feeds (Table 2).

Table 2 summarizes the equivalent dollar value of various energy sources, based on shelled corn prices ranging from $1.50 to $4 per bushel. Values are determined from ENVs and bushel weights in Table 1. For example, if shelled corn is $2 per bushel, barley will be a more economical source of energy if it can be purchased for less than $1.70 per bushel. Ear corn is marketed by the bushel, but it must be ground and have 5 percent liquid molasses mixed with it to attain the ENV of 94 percent that is expressed in Table 1.

Table 3 can help you determine the total processing cost for ear corn. This table incorporates the costs of grinding and molasses supplementation into one value for each bushel of ear corn. For example, if molasses costs 6 cents per pound and the cost of grinding is 25 cents per hundredweight (cwt), then the total cost for processing each cwt of ear corn will be 55 cents × [molasses + grinding costs = (5 pounds molasses × 6 cents/ lb) + 25 cents/cwt = 55 cents].

Once you establish the cost of processing and the cost of unprocessed ear corn, you can compare the total cost of ground ear corn per cwt with the cost of shelled corn per bushel (Table 2). For example, if unprocessed ear corn costs $2.20 per bushel ($3.14/cwt), liquid molasses costs 6 cents per pound and the cost of grinding is 25 cents per cwt, then processed ear corn will cost $3.53/cwt ($2.98 corn + $.55 processing).

You can then compare this value with that of shelled corn to determine the most economical energy source, based on the equivalent dollar values listed in Table 2.

Note that any time the price of processed ear corn is less than the corresponding value for shelled corn (ex., $3.36, if corn costs $2 per bushel), ear corn is the more economical buy, even though 1.1 pounds of processed ear corn must be fed to provide the same amount of energy as 1 pound of shelled corn (Table 1).

Therefore, in this particular example, shelled corn at $2 per bushel is the more economical energy feedstuff. However, if ear corn costs and processing expenses remained the same and shelled corn was $2.50 per bushel, then processed ear corn would be more economical ($3.53/cwt is less than the table value of $4.19/cwt).

Equivalent Nutritive Values of Common Forages

Table 4 illustrates the ENVs of some common forages compared with values of shelled corn. Like the concentrate feeds discussed earlier, the values for forages are calculated from the digestible energy content of each forage.

Table 5 compares the values of alfalfa and grass-legume hay used in a ewe's ration. Although alfalfa hay costs more per ton, equal amounts of each hay plus 1 pound of shelled corn provide enough digestible energy (DE) to meet the ewe's daily nutrient requirements. The greatest difference between the composition of the two diets is in crude protein (CP) content. Alfalfa hay contains more protein than the grass-legume hay, but both rations provide

TABLE 3: Processing and molasses costs necessary to improve ear corn to 94 percent of the energy value of shelled corn ($/cwt).

Molasses—($/lb)	$ .04	$ .06	$ .08	$ .10	$ .12
Grinding costs—($/cwt)	Total processing cost ($/cwt)[1]				
$ .20	.40	.50	.60	.70	.80
.25	.45	.55	.65	.75	.85
.30	.50	.60	.70	.80	.90
.35	.55	.65	.75	.85	.95
.40	.60	.70	.80	.90	1.00
.45	.65	.75	.85	.95	1.05
.50	.70	.80	.90	1.00	1.10

[1]Includes grinding of 95 lb ear corn plus the addition of 5 lb liquid molasses/cwt.

TABLE 4: Equivalent nutritive value (ENV) of commonly used forages, compared with shelled corn, as energy feeds (pound for pound as fed).

Energy source	ENV[1] percent	lb required to provide equivalent energy in each lb corn[2]
Shelled corn	100	—
Alfalfa hay—midbloom	66	1.52
Birdsfoot trefoil hay	70	1.43
Bromegrass hay	65	1.54
Corn silage[3]	30	3.33
Red clover hay	71	1.41

[1]ENV based on shelled corn.

$$\text{ENV} = \frac{\text{Digestible energy (DE) content of energy feed}}{\text{DE content of shelled corn}} \times 100$$

DE values can be found in Table 6.

[2]Calculated as follows: $\frac{1 \text{ lb corn}}{\text{ENV of energy feed}} \times 100$

[3]33 percent dry matter.

adequate protein to meet the ewe's requirements. The extra protein in the alfalfa diet—that above the ewe's requirement— will not improve productivity of the ewe, but will be used only as an energy source. Performance of ewes on both diets should be similar, provided all other nutrient requirements (e.g., minerals) are met. Note that Diet 2 is cheaper, and ewes on this diet should perform equally to those consuming Diet 1.

Providing Energy through Forages or Grain

The decision of whether to provide energy to the ewe through a high quality forage or through grain should be made only after you determine the cost of DE for each feedstuff. To determine the cost per Mcal[1] of DE, use the following equations:

$$\$/\text{lb of feed} = \frac{\text{price of feed (\$/bushel)}}{\text{lb/bushel}}$$

$$\$/\text{Mcal of DE} = \frac{\text{cost/lb of feed (\$/lb)}}{\text{energy content (Mcal of DE/lb)}}.$$

The following example illustrates this comparison[2]:

Example 1A: Assume shelled corn costs $2.25 per bushel, weighs 56 lb/bushel and contains 1.53 Mcal of DE/lb:

$$\frac{\$2.25/\text{bushel}}{56\ \text{lb/bushel}} = \$.0402/\text{lb}.$$

$$\frac{\$.0402/\text{lb}}{1.53\ \text{Mcal/lb}} = \$.0263/\text{Mcal of DE from shelled corn.}$$

Example 1B: Assume orchard grass-red clover hay costs $60 per ton and contains 1.02 Mcal of DE/lb:

$$\frac{\$60/\text{ton}}{2{,}000\ \text{lb/ton}} = \$.03/\text{lb}.$$

$$\frac{\$.03/\text{lb}.}{1.02\ \text{Mcal of DE/lb}} = \$.0294/\text{Mcal of DE from orchard grass-red clover hay.}$$

The result: DE is more economically provided by shelled corn than orchard grass-red clover hay at the specified prices in this example. Traditionally, forages have been the most economical source of energy in ewe diets. However, as the above example illustrates, this is not always the case.

Most forages (Table 6) fed to sheep have similar DE contents, regardless of the forage type. The major difference among them is the crude protein (CP) content. Therefore, there may be times when the consumption of certain forages alone (orchard grass, timothy, bromegrass, corn silage) may result in protein deficiencies. These deficiencies are most likely to occur during late gestation (four weeks prior to lambing) and lactation. At

[1] Mcal, or megacalorie, is a unit of energy commonly used when referring to feed measurements. One Mcal is equal to 1,000 Kcals, or kilocalories. One Kcal is equal to 1,000 calories.

[2] Based on figures from Table 6.

TABLE 5: Comparison of the value of alfalfa hay and a grass-legume hay in a diet for a 175-lb ewe during the last four weeks of gestation.

	Daily feed[2]	DE[3]	CP[4]	Cost/ewe per day	Cost/ewe per month
Ewe requirements[1] daily	**4.4 lb**	**4.7 Mcal**	**0.49 lb**		
Diet 1					
Shelled corn at $2.25/bushel	1.0	1.53	0.09	$.04	$1.12
Alfalfa hay at $80/ton	3.5	3.54	0.53	.14	3.92
TOTAL	4.5	5.07	0.62	$.18	$5.04
Diet 2					
Shelled corn at $2.25/bushel	1.0	1.53	0.09	$.04	$1.12
Grass-legume hay at $60/ton	3.5	3.43	0.40	.105	2.94
TOTAL	4.5	4.96	0.49	$.145	$4.06

[1]Requirements as given in the "Nutrient Requirements of Sheep," National Research Council, 1985.
[2]As fed basis.
[3]Digestible energy.
[4]Crude protein.

TABLE 6: Digestible energy (DE) and crude protein (CP) content of selected feedstuffs.

Feedstuff	% DM	DE (Mcal/lb) DM	DE (Mcal/lb) As fed	CP (percent) DM	CP (percent) As fed
Concentrates:					
Barley	88	1.72	1.51	13.5	11.9
Corn—shelled	88	1.74	1.53	10.1	8.9
Corn—ground ear	87	1.66	1.44	9.0	7.8
Corn gluten feed	90	1.66	1.49	25.6	23.0
Corn gluten meal	91	1.76	1.60	46.8	42.6
Oats	89	1.52	1.35	12.8	11.4
Sorghum (milo)	89	1.76	1.57	11.3	10.0
Wheat	89	1.74	1.55	16.0	14.2
Liquid molasses	78	1.54	1.20	8.5	6.6
Fat	99	3.90	3.86	0.0	0.0
Soybeans—whole	92	1.88	1.73	42.8	39.4
Forages:					
Alfalfa hay—midbloom	90	1.12	1.01	17.0	15.3
Birdsfoot trefoil hay	92	1.16	1.07	16.3	15.0
Bromegrass hay	91	1.10	1.00	9.7	8.8
Corn silage	33	1.40	0.46	8.1	2.7
Grass-legume hay	89	1.10	0.98	13.0	11.6
Red clover hay—midbloom	88	1.24	1.09	18.1	15.9

SOURCE: "Nutrient Requirements of Sheep," National Research Council, 1985.

these times it may be necessary to supplement protein with a legume hay or soybean meal.

The comparison of forages in Table 6 presents average values of DE and CP but does not illustrate the large variation that may exist in these two nutrients within a given forage. For example, the average shown for alfalfa hay is 1 Mcal of DE/lb and 15.3 percent CP. However, depending on maturity and environmental factors, alfalfa hay may range from 0.8 to 1.5 Mcal of DE/lb and 10 to 23 percent CP.

Two of the primary factors that influence nutritive value of forages are:

- **Stage of maturity at harvest.** As maturity increases, CP and DE contents decrease.
- **Environmental conditions at harvest.** Rainfall after cutting and before baling can leach many nutrients from the crop, and harvesting procedures can drastically lower nutritive value.

Either or both of these factors can greatly alter the nutritive composition of forages. The tables in this bulletin offer general forage value guidelines, but you should rely on composition analyses of forages to accurately predict feeding values. The tables can be very useful for predicting the nutritive value of concentrate feedstuffs. Concentrate feeds are much less variable in nutritive composition than forages.

Equivalent Nutritive Values of Protein Supplements

Table 7 illustrates the ENVs and equivalent dollar values of various protein sources compared with soybean meal. These values are based on the CP content of each source, along with constraints required for their use. Linseed meal, for example, has 86 percent of the equivalent nutritive value of soybean meal as a protein supplement. Alfalfa hay, if it contains 17 percent CP, has 39 percent of the nutritive value of soybean meal as a protein source. Urea, a non-protein nitrogen source, has a high ENV relative to soybean meal (237 percent). However, urea contains no energy and must be used with care in sheep diets. Thorough mixing of the grain portion of a diet that contains urea is essential because larger-than-recommended doses of urea can be toxic and lethal. The total amount of urea included in the diet should never exceed 1.5 percent of the total high concentrate ration.

Table 7 also shows comparative dollar values per ton of various protein sources.

Summary

To attain the goal of maximum economic efficiency, you must identify the feedstuffs that provide the required nutrients for the least cost. When comparing the value (cost) of various energy sources for sheep, follow these basic steps:

1. Convert all sources to the same weight.
2. Consider processing costs for feedstuffs such as ear corn.
3 Determine the cost of each feedstuff per unit of energy supplied.

These steps can also be used in comparing protein sources.

TABLE 7: Equivalent dollar value of protein supplements (as fed).

Protein supplement[1]	ENV[2] percent	When soybean meal costs ($/ton): $140	$160	$180	$200	$220
Soybean meal (44%)	100					
Equivalent value ($/ton of):[3]						
Linseed meal (38%)	86	120.40	137.60	154.80	172.00	189.20
Alfalfa hay (17%)	39	54.60	62.40	70.20	78.00	85.80
Urea (281%)[4]	237	331.80	320.00	426.60	474.00	521.40
Soybeans (39%)	89	124.60	142.40	160.20	178.00	195.80
Corn gluten feed (23%)	52	72.80	83.20	93.60	104.00	114.40
Dehydrated alfalfa (17%)	39	54.60	62.40	70.20	78.00	85.80

[1]Values in parentheses indicate crude protein (CP) content or crude protein equivalent on an as-fed basis.
[2]ENV, or equivalent nutritive value, of protein supplements is based on soybean meal (44% CP).

$$\text{ENV} = \frac{\text{CP content of supplement}}{\text{CP content of soybean meal}} \times 100$$

[3]Values adjusted for differences in ENV for protein.
[4]Must be thoroughly mixed with ground grain portion, and must not exceed 1.5 percent of total daily ration.

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