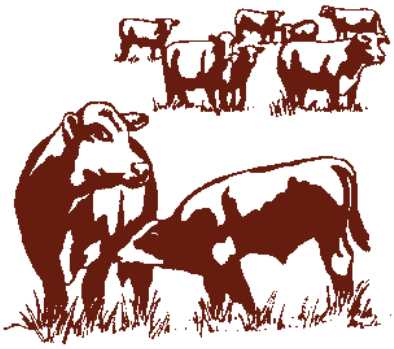
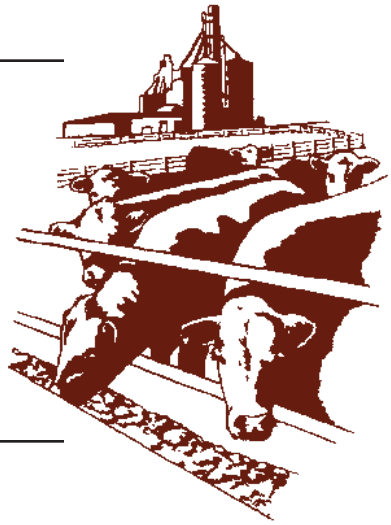


Beef Cattle Handbook



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Formulating Supplements

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A proper nutrition program for the cow herd or grass yearling (stocker) enterprise is essential for successful, profitable beef cattle production. Today's costs of production demand efficient utilization of forages. Supplemental feeding programs must be designed to meet the nutritional needs of the cow herd, while allowing effective utilization of available forage supplies. Because the nutrient requirements of cattle change with age, stage of lactation, sex, environmental conditions and the type of production being accomplished in a particular operation, a knowledge of animal nutrient requirements is a necessary step in formulating supplements. Grazing situations require supplemental feed during some periods, such as when native range and pasture forages decrease in protein and energy content due to increasing maturity. Such mature forage may not support adequate gains or adequate nutrition for a cow-calf operation without supplemental feed. Stocker cattle on grass also often need supplemental feed to make the most efficient gains.

Building a supplement

The steps in formulating supplements are: 1) knowing what nutrients the cattle require, 2) estimating the amount of nutrients the cattle will consume from forage; 3) and providing the nutrients necessary in the supplement to fill the gap between the forage and the requirements, while maximizing use of the forage or roughage.

The most difficult step is estimating how much roughage the animal will consume. Feeding a supplement often changes the amount of roughage the animal will consume. The direction and the extent of change depend on the palatability of the roughage and the type of supplement fed. In general, high-protein supplements fed in relatively small quantities increase roughage intake and digestibility. Rarely will high-protein supplements decrease forage intake. High-energy supplements usually decrease forage intake and may also decrease roughage digestibility. The depression in forage intake will be more pronounced with more mature and less palatable roughages. The practical application is that slightly more supplement per day may be needed with mature roughages to achieve a given gain or level of production. Table 1 is an estimate of the amount of forage that animals will consume. After determining the forage or roughage intake, the nutrients supplied can be calculated and a determination made of nutrient levels necessary in the supplement to enable desired levels of performance.

The nutrients generally necessary in supplements are energy, protein, minerals and vitamin A.

Energy

Energy, or Total Digestible Nutrients (TDN), is a major component of all cattle rations. Energy for cattle is usually measured in pounds of TDN or Megacalories of Metabolizable Energy (Mcal ME).

The bulk of energy for cattle comes from the rumen digestion of forages and roughage products. When proper amounts of protein and minerals are present, rumen activity is capable of releasing energy from a wide variety of feeds that are useless to non-ruminants.

Table 1. Daily Forage Intake and AUMs of Cattle Grazing Rangeland[abc]

	Season				
	Spring % of Body Wt.	Late Spring Early Summer % of Body Wt.	Late Summer % of Body Wt.	Fall % of Body Wt.	Winter % of Body Wt.
Cow (lbs. Forage per Month	2.7-2.9 (810-870)	2.4-2.9 (720-870)	1.8-2.4 (540-720)	1.7-2.2 (510-660)	1.4 (420)
Yearling Cattle (Ave. Wt. 700 pounds) (lbs. Forage per Month)	2.7-2.9 (567-609)	2.4-2.7 (504-567)	1.8-2.4 (378-504)	1.7-2.2 (357-462)	1.4 (294)

[a] *Intake data include dam and offspring from spring through early summer. At 150-day age, intake of calf is one-half of cow. For example, intake by a lOOO-pound cow and calf during late summer: 1000 pound x 2.1 percent x 1.5 = 31.5 pounds daily x 30 days or 945 pounds per month.*

[b] *Mature male animal's consumption will be approximated at 1.2 times the female's consumption.*

[c] *Intake figures do not account for physical damage or beneficial impacts of the grazing process.*

Protein

Proteins are large chemical units containing hundreds of smaller units called amino acids. Amino acids, in turn, are organic compounds that contain nitrogen along with carbon, oxygen and sometimes sulfur. Specific amino acids are used by the animal for synthesis of muscle, blood proteins and other body components. In cattle the microflora of the rumen break down most dietary proteins and synthesize bacterial proteins. The bacterial proteins contain the essential amino acids and are digested in the small intestine to release the amino acids for the animal. The bacteria themselves also must have adequate protein to function in digesting roughages and proteins. Protein requirements for cattle will vary with the animal's stage of production.

Protein supplements are difficult to evaluate because it is necessary to distinguish between natural protein and non-protein nitrogen (NPN), by-pass and degradable protein and dry versus liquid. Urea, biuret and other forms of NPN do not equal protein feed value from natural protein sources. The extent to which NPN is utilized depends on a number factors, including dietary energy level and source, forage quality, form of NPN (liquid or dry).

Table 2 is an estimate of the utilization of NPN based on these factors.

The cost per unit of protein for natural protein sources can be determined, as shown in Table 3. The cost of supplements containing a combination of natural protein and non-protein nitrogen can be determined by using Tables 2 and 3, as shown in the following example: Supplement A is 30 percent dry, all-natural protein at $150 per ton and Supplement B, a 30 percent dry with 15 percent NPN at $120 per ton.

Table 2. Thumb Rules for NPN Utilization

	Utilization, %	
Conditions	Dry Supplement	Liquid Supplement
Weathered grass Crop residues Poor-quality hay	0-25	50
Medium-quality hay Silages Summer pasture	40-60	80
High-energy rations	90-100	90-100

WARNING:
.13-.23 grams urea per pound body weight = toxic
.45-.68 grams urea per pound body weight = lethal

Assume that the cows are consuming low-quality forage and cows require .6 pounds of additional protein per head per day.

Supplement A: 2 pounds all-natural equals .6 pounds protein (2 pounds x 30 percent = .6 pounds). This will cost 15 cents per head per day ($150 divided by

Table 3. Prices for Protein In Various Feeds

Feed	Cost per Ton	% Protein	Cost per Cwt Protein
Alfalfa Hay	$ 50	15	$ 16.67
Corn Silage	15	2	37.50
Bromegrass Hay	50	11	22.73
Barley Grain	80	12	33.33
Oats Grain	100	12	41.67
Wheat Grain	170	15	56.67
Wheat Grain	180	15	60.00
Wheat Grain	190	15	63.33
Corn Grain	70	7	50.00
Soybeanoil Meal	200	50	20.00
Cottonseed Meal	130	41	15.85

2000) x 2 = 15 cents).

Supplement B (15 percent all-natural protein + 15 percent NPN): 15 percent NPN x 25 percent utilization (Table 2) = 3.75 percent. 15 percent + 3.75 percent = 18.75 percent protein. .6 divided by 18.75 = 3.2 pounds of Supplement B. ($120 divided by 2000) x 3.2 = 19.2 cents per head per day.

The amount of NPN to use is determined by the TDN content of the diet. Table 4 gives guidelines recognized by the National Research Council for determining the amount of protein that can be supplied by NPN.

By-pass protein refers to protein that, because of its physical or chemical characteristics, escapes degradation by microorganisms within the rumen. Protein supplements promoted as containing by-pass proteins are usually higher priced than the more traditional sources of supplemental protein. There may be an economical way of providing supplemental by-pass protein, but only if less supplement can be fed to meet the animal's requirement and maintain the same level of performance. If, for example, you must supplement two pounds of all-natural protein to meet the animal's protein needs, but by feeding a high by-pass protein supplement it is only necessary to feed 1.5 pounds per head per day, it may be cost-effective to feed the by-pass protein. By-pass technology should allow use of less protein and, hence, should lower supplemental protein. By-pass protein is not cost-effective if it costs more per head per day than the traditional supplementation programs.

Table 4. Upper Limit for NPN Utilization

% CP in DM before NPN	% TDN in DM					
	55-60	60-65	65-70	70-75	75-80	80-85
	(% CP after NPN addition)					
8	No	10.0	10.5	10.9	11.2	11.4
9	No	10.4	10.9	11.3	11.6	11.8
10	No	10.8	11.3	11.7	12.0	12.2
11	No	11.2	11.7	12.1	12.4	12.6
12	No	No	12.1	12.5	12.8	13.0

Minerals

Minerals are divided into the macro or major minerals, and the minor or trace minerals.

Phosphorus is a major mineral and is the single most commonly deficient mineral for cattle on high levels of roughage or forage.

Early research suggested that calcium-to-phosphorus ratios of 1:1 or 2:1 were best because the body absorbed or used and stored these elements in about these ratios. More recently it has been shown that ratios as high as 8:1 had no ill effect on weight gains of calves or cow reproductive rates or longevity as long as adequate levels of calcium and phosphorus were present.

Researchers at Utah State University fed 96 growing Hereford heifers a hay diet containing either 66 percent or 172 percent of the NRC phosphorus requirement with recommended levels of all other nutrients. The two-year study showed that average daily gain, feed efficiency, age at puberty, pregnancy rate and calf survival were not adversely affected by phosphorus level and that a calcium-phosphorus ratio as high as 8.96:1 had no influence on these production factors.

Research at New Mexico State University found no negative influences from lack of phosphorus supplementation on calving interval, weaning weight, suckling gain or percent calf crop, under normal range conditions, but low phosphorus during drought conditions did influence these measures of performance.

Researchers at North Dakota started two herds of heifer calves, one with and one without phosphorus supplementation. After three years on summer range and winter silage feeding, supplemented and unsupplemented heifers showed no difference in weight gain from weaning to breeding. Calf birth weights and calving interval also showed no difference. However, milk production was 10-20 percent higher for phosphorus-supplemented cows.

This issue is controversial, and until a consensus is reached, the logical solution is to follow the NRC recommendations. In some instances, however, practical experience may be a better rule of thumb.

The value of a phosphorus supplement is based on

the price per unit of phosphorus and the biological availability of the phosphorus.

Table 5 is a guide to the relative biological value of various phosphorus supplements, using tricalcium

Table 5. Comparative Value of Phosphorus Supplements

	Biological Value	P %
Tricalcium phosphate	100	20
Phosphoric acid	120	24
Mono-diammonium phosphate	120	25
Dicalcium phosphate	110	21
Sodium tripolyphosphate	98	25
Soft rock phosphate	30	14

phosphate as the standard.

The following hypothetical example may serve as a guide for pricing phosphorus supplements.

Dicalcium phosphate (21 percent P) at $350 per ton

420 pounds P per ton at a biological value of 110 percent

$350 divided by 420 pounds = 83 cents per pound phosphorus

Phosphoric acid (24 percent P) at $440 per ton

480 pounds P per ton at a biological value of 120 percent

$440 divided by 92 cents per pound phosphorus

.10 (difference in biological value) x 83 cents per pound = 8 cents per pound difference

8 cents + 83 cents per pound = 91 cents per pound

We can pay up to 91 cents per pound for phosphoric acid.

Supplemental calcium is usually not necessary for cattle consuming high levels of forage. Calcium does become limiting for cattle in feedlots on high levels of concentrates, so supplementation is necessary.

Salt is deficient in all forage diets. Salt is inexpensive and is usually fed free-choice.

Other macro minerals, such as magnesium or potassium, may need to be supplemented at times, but are usually not a problem in range areas. Trace minerals include cobalt, iron, iodine, copper, magnesium, zinc and selenium. Deficiencies of these generally do not occur under normal grazing and feeding conditions in the Great Plains region. However, under certain conditions supplementation may be necessary.

Vitamins

Vitamins are classified as either fat-soluble (A, D, E and K) or water-soluble (the B vitamins and vitamin C). The microflora in the rumen synthesize many of the vitamins. Therefore, with the exception of vitamin A, most vitamins do not need to be supplemented. Carotene (vitamin A) is practically devoid in mature, weathered forages, grains and other crop residues, and deficiencies can exist during winter and droughts.

The Calculations

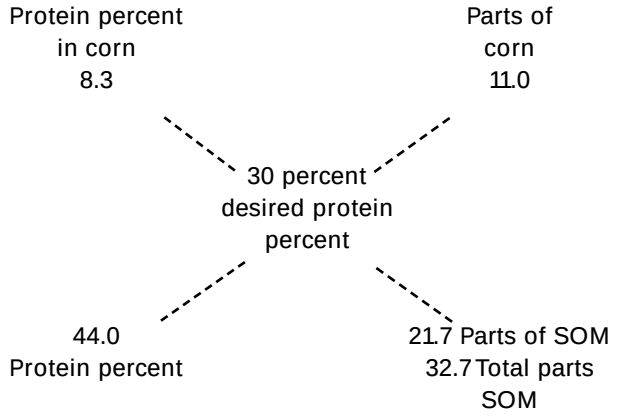
Consider the hypothetical case of grazing dry cows on a dry, weathered range. For purposes of this example, suppose the range tests 5 percent protein, .7 Mcal of ME per pound, .45 percent Ca and .15 percent P on an as-fed basis. Assuming the cows are eating 20 pounds of range daily, the amount of nutrients needed in the supplement

Table 6. Nutrients Required for Range Example

	Protein lb.	Energy Mcal	Ca g	P g
Requirement	1.3	14.5	15	15
Supplied by range (20 pounds)	1.0	14.0	40	13
Needed in Supplement	.3	.5	0	2

can be computed as shown in Table 6.

Since protein is the major need in the supplement (.3 pounds daily), if one pound of supplement is provided per head per day, the supplement must contain 30 percent protein (1 pound x 30 percent = .3 pounds). Since most grains contain 12 percent or less protein, it will be necessary to include enough soybean oil meal (SOM) or cottonseed meal to obtain a 30 percent protein supplement. An example of the Pearson Square method



of calculating the percent of corn and SOM to obtain a 30 percent supplement is shown below.

To find the percent of corn and SOM:

11.0 divided by 32.7 = 33.6 percent corn
21.7 divided by 32.7 = 66.4 SOM

Since the ration is only .5 Mcal deficient in energy, there is little danger that the diet will be lacking in energy.

The energy in the supplement is calculated as follows:

1 pound x 33.6 percent
corn x 1.5 Mcal per pound = .50

1 pound x 66.4 percent
SOM x 1.38 Mcal per pound = .92

Energy in supplement 1.42 Mcal pound

The range provides ample calcium but is two grams deficient in phosphorus. The conversion to a percentage basis for phosphorus is as follows:

2 grams divided by (1 pound x 454 grams per pound) = .44 percent

This can be provided by the phosphorus in the ingredients in the supplement or by adding phosphorus supplements shown in the minerals section.

The supplement will contain: 30.0 percent protein, 1.42 Mcal of ME per pound and .44 percent P.

Do You Need a Computer?

Computers are indispensable when the nutritionist must deal with many possible ingredients and many rations. The computer can calculate least-cost formulations quickly and efficiently. Most range cattle producers, however, deal with a limited number of ingredients.

Usually one or two grains, a roughage, a protein source and minerals. If only a few rations or supplements are formulated each year, a computer is probably not justified. A hand calculator can easily handle calculations needed for most simple rations and supplements.

Novice ration and supplement formulators are often unsure of their arithmetic. It is easy to incorrectly place a decimal point. By comparing hand-calculated rations with a similar example (as shown in this paper), the producer can see if any gross errors have been made. An Extension specialist or county agent should be consulted if there is any doubt. Computer programs are often available in specialist or county agent offices as well.

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