

**CALCULATION OF COMPLETE DIETS FOR BEEF CATTLE,
CHECKING FOR NUTRIENT BALANCE
AND ESTIMATING GAIN
(OSUNRC2006)**

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For years nutritionists balanced rations using the trial and error technique. With the advent of the microcomputer and spreadsheets, this time consuming chore can be easily and quickly accomplished. The spreadsheets described herein can be obtained from the OSU Animal Science web site at www.ansi.okstate.edu. Most of the software available at this site was designed using Microsoft Excel, a commercially available spreadsheet program. These programs combine the OSU program for "Calculating Livestock Rations" (RATION) and the nutrient requirements for energy, protein, calcium and phosphorus for beef cattle in dry lot derived from the Nutrient Requirements of Beef Cattle (NRC) published by the National Academy of Sciences in 1984 and 1996.

OSUNRC2006 is written so that the user can select either "as is" moisture basis, or a dry matter basis to develop or check a ration formulation. For the non-skilled nutritionist, this program may be used to check a feed mixture to see if it meets the NRC recommendations for a given weight and class of growing-finishing cattle. This program allows the user to maintain a library of up to 103 feeds while being able to use up to 20 feeds in a formulation matrix formulation.

The software is divided into four different worksheets (or pages) in order to simplify the ration evaluation process. The tabs shown at the bottom of the screen display the different tabs. They are **FORMULATION, FEED LIST, MIXING SHEET, and NUTRIENTS**.

The first worksheet is used for formulation; this is where the user inputs specific feeds and the amount or percentage of each feed for the ration that is being evaluated. The second worksheet contains the **FEED LIST**, which is a "library" or large table containing various feeds and their nutrient concentrations. An example is shown in Table 1. The **FEED LIST** can be customized to include different feeds and the nutrient concentrations (or coefficients) for each feed can be changed to reflect the appropriate values specific to each producers feed resources. The user scans the list of feeds in the library, selects those he wishes to use and jots down their feed number found at the left of the ingredient names. Any changes in nutrient composition and/or prices must be made in the **FEED LIST**. Remember that **cost and dry matter** are entered on an "as fed" basis. All other nutrients must be entered on a dry matter basis. The feeds listed in the **FEED LIST** were chosen because they are familiar to most Oklahoma producers. The coefficients may not be correct for your feeds and analysis of your feeds is suggested. The data for the trace minerals in this table were taken from the 1996 NRC publication except in cases where better data were available in Oklahoma. It is very important that the correct dry matter content of any feed be entered. **Serious errors will occur if dry matter is not correct.** When nutrient

composition and prices in the **FEED LIST** are correct, the user should click the **FORMULATION** tab.

TABLE 1. EXAMPLE FEED LISTING FOR THE INGREDIENT LIBRARY

FEED NAME	D.M.%	NEM	NEG	PROT	K%	CA%	PHOS	COST	MG	S	CO	CU	FE	MN	SE	ZN	TDN%	FAT
1 ALFALFA HAY EXC	88.00	66.01	37.72	20.00	2.71	1.56	0.30	4.25	0.35	0.41	0.17	9	119	41	0.28	24	63.00	3.00
2 ALFALFA HAY GOOD	88.00	59.54	33.63	19.00	1.92	1.89	0.29	4.25	0.35	0.36	0.16	10	112	41	0.28	27	60.00	2.60
3 ALFALFA HAY FAIR	88.00	56.00	30.91	18.30	2.06	1.50	0.27	4.25	0.33	0.28	0.15	11	127	42	0.28	25	58.00	1.80
4 ALFALFA HAY POOR	88.00	47.00	22.27	14.00	2.15	1.52	0.26	4.25	0.32	0.28	0.16	10	135	44	0.28	21	52.00	1.30
5 BERMUDA HAY	88.00	37.72	13.18	9.80	1.53	0.47	0.17	4.00	0.21	0.23	0.12	7	106	140	0.12	22	46.00	2.00
6 BERMUDA HAY GOOD	88.00	42.27	17.72	6.00	1.55	0.51	0.24	4.00	0.22	0.21	0.12	6	125	145	0.05	17	49.00	3.80
7 COTTONSEED HULLS	90.00	47.00	10.00	4.00	0.90	0.15	0.09	4.00	0.14	0.09	0.02	13	131	119	0.30	22	47.00	1.70
8 COTTON BURRS	92.00	34.09	10.00	11.00	2.73	0.90	0.12	2.00		0.05						10	44.00	2.70
9 PRAIRIE HAY	90.00	45.45	20.45	5.80	1.08	0.43	0.15	3.00	0.29	0.07	0.13	7	129	110	0.05	34	69.00	2.40
10 SUDAN HAY GOOD	91.00	54.00	26.00	8.50	1.87	0.40	0.26	4.00	0.51	0.06	0.13	37	193	91	0.12	38	58.00	2.60
11 SUDAN HAY FAIR	91.00	52.00	24.00	4.80	1.87	0.45	0.20	3.00	0.51	0.06	0.13	37	193	91	0.12	38	52.00	2.40

The program has two functions. The first is to calculate the nutritional composition of a feed mixture on an "as fed" or "dry matter" basis depending on the basis selected in **cell F3** at the top of the **FORMULATION** page (Table 2). The user selects **1** if the formulation is to be entered on an "as fed" basis, and **2** if the formula is to be entered on a dry matter basis. The second is to generate the nutritional requirements of growing and finishing cattle. Using the two functions together, it is possible to develop a ration, which is correctly balanced for a specific weight and type of animal. The feed numbers of desired feeds are entered beginning in cell A7 and continuing down column A26. A **Zero** placed in column A, rows 7-26, will blank out the feed name and data on rows not used, permitting the user to only see feeds used in a given formulation. It is not necessary for the total amount of feed entered in the C column to add to 100. This program can calculate the nutrient composition on any amount of feed (for example 13.5 lbs, 100 lbs, or 2500 lbs).

In order to generate accurate requirement data, the user must enter the proper information about cattle, sex, weight and type. The animal weight is entered in cell D30, the body and sex type in cell D31 and the daily amount of feed the animal is expected to eat is entered in cell D29. Six combinations of sex and animal type are available and are listed below. When a number from 1-6 is entered, the description of that type is listed on the screen.

1. LARGE-FRAME BULL CALVES AND COMPENSATING LARGE-FRAME YEARLING STEERS.
2. LARGE-FRAME HEIFER CALVES AND COMPENSATING MEDIUM-FRAME YEARLING HEIFERS.
3. LARGE-FRAME STEER CALVES AND COMPENSATING MEDIUM-FRAME YEARLING STEERS.
4. MEDIUM-FRAME BULLS.
5. MEDIUM-FRAME HEIFER CALVES.
6. MEDIUM-FRAME STEER CALVES.

A sample of selection for animal weight, sex and type follows:

FEED PER DAY	13
ANIMAL WEIGHT LBS.	400
BODY TYPE	3

A realistic estimate of feed intake is required for this program to be useful. Dry matter intakes usually range from 2-3 percent of body weight for growing-finishing cattle. Note that the "as fed" intake is converted to dry matter in cell I29. This is the case if you are formulating on an as fed basis. If you use the dry matter basis for formulation enter the dry matter intake in cell D29 and the "as fed" intake will be displayed in I29. If your values are out of range, the ration will not be correct. With experimentation, the user will discover that the appropriate ration formulation will need to change with changes of any of the following: feed intake, animal weight, and body type. This is particularly true with lightweight cattle.

Table 2. FORMULATING WITH OSUNRC2002

OKLAHOMA STATE UNIVERSITY COMPLETE BEEF CATTLE RATION CALCULATOR 2002.

Formulation basis 1= As Fed, 2= Dry matter basis----->: 1

ID	TARGET FOR GAIN OF:	2.89	NUTRIENT	COMPOSITION		REQUIREMENT	
	FEED NAME (17)			AMOUNT	AS FED	DRY	NRC
24	CORN DENT NO 2	48.400	NEm Megcal/CWT.	71.68	80.88		+
7	COTTONSEED HULLS	15.000	NEg Megcal/CWT.	42.98	48.50		+
3	ALFALFA HAY FAIR	25.000	TDN %	67.39	76.03		+
49	SOYMEAL 47.7	10.400	Fat	2.51	2.83		+
64	SALT	0.300	Crude Fiber	14.78	16.67		+
61	LIMESTONE 38%	0.650	ADF	18.72	21.12		
60	DICAL	0.200	NDF	26.32	29.70		
54	VITAMIN A-30,000	0.017	eNDF	50.59	57.08		
55	VITAMIN E-50%	0.017	Crude Protein %	13.64	15.39	15.29	ADEQUATE
57	RUMENSIN 80	0.014	Potassium %	0.96	1.08	0.65	EXCESSIVE
77	ZINC SULFATE	0.002	Calcium %	0.68	0.77	0.76	ADEQUATE
			Phosphorus %	0.30	0.34	0.33	ADEQUATE
			Magnesium %	0.18	0.20	0.1	ADEQUATE
			Sulfur %	0.18	0.20	0.1	EXCESSIVE
			Cobalt ppm	0.07	0.08	0.1	ADEQUATE
			Copper ppm	8.17	9.2	8	ADEQUATE
			Iron ppm	102.00	115.1	50	EXCESSIVE
			Manganese ppm	34.16	38.5	40	ADEQUATE
			Selenium ppm	0.18	0.20	0.2	ADEQUATE
			Zinc ppm	28.57	32.2	30	ADEQUATE
TOTAL & DM COMP		100.000	Cost / cwt.	4.91	\$5.54		

CALCULATED DRY MATTER % 88.6
AS FED FEED/DAY 13 **FEED DRY MATTER PER DAY** 11.5
 ANIMAL WEIGHT LBS. 400 CALCULATED GAIN / DAY 2.89
 BODY TYPE 3 FEED / # GAIN **AS FED** 4.50
 FEED ONLY COST OF GAIN 22.11
 LARGE-FRAME STEER CALVES AND COMPENSATING MEDIUM-FRAME YEARLING STEERS.

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The animal requirements for energy (NEm and NEg), protein, calcium and phosphorus were calculated from the 1984 NRC requirements of beef cattle and these equations are placed in a lookup table at cells O38...T43. The units in this table are for gain "GAIN, pounds per day" protein "PROT, pounds per day" calcium "CA, grams

per day" and phosphorus "PHOS, grams per day". The expected gain (shown twice in cells C4 and I30) is calculated by using the NEm and NEg values calculated in cells G6 and G7 for the body weight (cell D30) the expected dry matter feed intake (either cell D29 or I29) and the body type (cell D31).

The user must use caution and only evaluate rations which will lead to gains between 0.5, and 3.5 pounds per day to stay within the valid weight ranges for which the prediction equations were developed. Body weight should be between 300 and 1000 pounds for medium frame animals and between 300 and 1100 pounds for large frame animals. The calculated nutrient composition of the diet is shown on an as fed basis and on a dry matter basis. To the right of these calculated values are the NRC recommendations for the animal described. The status of each nutrient is shown in the last column.

In this program the NRC requirements for energy, protein, calcium and phosphorus are calculated by mathematical formula. The user need only get protein percentage within 0.05 percentage units of the requirement to avoid the "deficient" status label. Calcium percentage has a tolerance of 0.02 and phosphorus 0.01 to avoid the deficient status label. It is occasionally possible for the protein requirement (determined by the animal's weight and rate of growth) to drop below the protein requirement of the rumen microorganisms. This most often occurs with finishing cattle weighing over 800 pounds. In order to avoid this problem, this program contains an "IF" statement that displays "deficient" status the percent of protein in the diet to drop below 10.5 percent crude protein on a dry matter basis. Mineral requirements are derived from a table (Table 3) reproduced from the 1996 NRC bulletin. The NRC suggests an acceptable range for minerals. Mineral levels below this range are labeled (**DEFICIENT**), within the range (**ADEQUATE**) and above the range are labeled (**EXCESSIVE**). Because most of the minerals when used in excess are toxic, this range is identified (**TOXIC**). There is also a **SUGGESTED** value and this is also shown in the table.

TABLE 3. NRC MINERAL REQUIREMENTS AND MAXIMUM TOLERABLE LEVELS FOR BEEF CATTLE

Mineral	Requirement		Maximum Tolerable Level
	Suggested Value	Range	
Cobalt, ppm	0.10	0.07 to 0.11	5
Copper, ppm	8	4 to 10	115
Iodine, ppm	0.5	0.20 to 2.0	50
Iron, ppm	50	50 to 100	1000
Magnesium, %	0.10	0.05 to 0.25	0.40
Manganese, ppm	40	20 to 50	1000
Potassium, %	0.65	0.5 to 0.7	3
Selenium, ppm	0.20	0.05 to 0.30	2
Sulfur, %	0.10	0.08 to 0.15	0.40
Zinc, ppm	30	20 to 40	500

UNDERSTANDING NUTRIENT RECOMMENDATIONS

A deficiency of any mineral can lead to reduced performance, and in cases of prolonged deficiency, to any number of disorders. Adding appropriate minerals or substituting different feed ingredients should remedy deficiencies.

Users inexperienced in nutrition may be surprised at how frequently formulations involving common feeds and forages will elicit an **EXCESSIVE** label. For example, if the diet contains a large percentage of alfalfa hay, the amounts of potassium and calcium will be above the recommended levels and labeled **EXCESSIVE**. This is usually not serious if the minerals like calcium and potassium largely come from natural feeds such as soybean meal or alfalfa hay. If, on the other hand, the excess of calcium comes from an oversupply of limestone or the potassium comes from potassium chloride, then there could be serious nutritional problems. In many cases it will not be possible or wise to formulate rations without one or more nutrients labeled **EXCESSIVE**. Beware, however, of rations in which any nutrient is detected near the **TOXIC** range. When in doubt about the safety of any ration, inexperienced users should consult a qualified animal nutritionist.

Once the ration composition is complete, the user can recheck the animal data. The most important input/output is the "FEED DRY MATTER PER DAY" because this number is used with the energy values of your ration to calculate daily gain. This is calculated or taken from your input feed per day. The animal's sex, weight, type and gain are used to determine its nutritional requirements. Because gain is calculated using only the energy values, the calculated gain might not occur if the ration is not adequate in protein, potassium, calcium, phosphorus, and other minerals.

There are additional nutrient requirements other than those described in this program. Among these are salt, vitamins A and E. Cattle also have requirements for roughage and are very sensitive to the rates at which various nutrients in the diet become available within the digestive tract. **If the user has no training in nutrition, use of this program should be limited to checking proven formulas to verify that they are adequate for the class of cattle being fed. Simply meeting requirements calculated by this program does not guarantee that the ration is safe to feed.**

Feed intake and the energy content of the diet determine the rate of gain and thus the other calculated requirements. The cost of gain contributed by feed can easily be calculated. This calculation is useful to experienced nutritionists, but without extensive knowledge of ration formulation and cattle management, could cause some users to overestimate feed intake or develop diets, which could lead to founder or acidosis.

Table 4. Ration mixing sheet.

RATION DEVELOPED FOR: [High Energy Grower Ration](#)

ORIGINAL FORMULATION ON **AS FED BASIS**

FEEDING SHEET FOR --->>> LB. BATCH

2000

FEED NAME	FEED NO	% AS Mixed	POUNDS	CUMULATIVE POUNDS
CORN DENT NO 2	24	48.4000	968.00	968.00
COTTONSEED HULLS	7	15.0000	300.00	1268.00
ALFALFA HAY FAIR	3	25.0000	500.00	1768.00
SOYMEAL 47.7	49	10.4000	208.00	1976.00
SALT	64	0.3000	6.00	1982.00
LIMESTONE 38%	61	0.6500	13.00	1995.00
DICAL	60	0.2000	4.00	1999.00
VITAMIN A-30,000	54	0.0169	0.34	1999.34
VITAMIN E-50%	55	0.0170	0.34	1999.68
RUMENSIN 80	57	0.0140	0.28	1999.96
ZINC SULFATE	77	0.0020	0.04	2000.00
			2000.00	

THIS RATION FORMULATED FOR AN ANIMAL WITH THE FOLLOWING SPECIFICATIONS.

AS FED FEED/DAY	13	FEED DRY MATTER/DAY LBS	11.52
ANIMAL WEIGHT LBS.	400	CALCULATED GAIN / DAY	2.89
BODY TYPE	3	FEED / # GAIN	4.50

LARGE-FRAME STEER CALVES AND COMPENSATING MEDIUM-FRAME YEARLING STEERS.

Once the ration composition is complete, the user can tab to the **MIXING SHEET** (Table 4) to view the final ration. Ingredients are listed as percentages on "as fed" basis, "dry matter" basis, and pounds per batch. The user can change batch size from the keyboard. The last column is the cumulative scale reading for the indicated batch. To prevent errors in the cumulative scale reading do not leave gaps between the feeds.

WHEN TO USE 'AS FED' OR DRY MATTER BASIS FOR FORMULATION.

If all potential ingredients contain about the same percentage of moisture (i.e. grains, dry hays, protein meals etc.) the "as is" basis is usually the easiest to use. However, if rations will contain feeds with varying contents of moisture (i.e. silages or high moisture grains) formulations should be done on a dry matter basis. Each ingredient in the feed formula usually contributes at least one nutrient. Many ingredients contribute to all nutrients. There are two boxes on the sheet called by the **NUTRIENTS** tab. The upper box shows the nutritional coefficients for the feeds in the selected ration. These should be checked for accuracy. If changes are necessary the changes are made in the feed list (**FEED LIST**) tab. The lower box shows some very important information. Here the nutrient contribution from each ingredient in the mix is shown. Look at Table 5. Note that the Soybean Meal provided almost half the total protein in this diet. This might lead the user to be sure and check the protein content of the Soybean Meal being fed. Likewise Cottonseed Hulls contributed so little protein

to the diet that checking it for protein would be unnecessary. The cost contribution to the ration for each ingredient is shown in the table.

HINTS FOR FIRST TIME USERS.

Keep the rations simple. The program easily shows for example how much an animal might gain if the diet were only one feed i.e. Number 1 Alfalfa Hay Exc. Enter the amount as 100 implying that the ration was 100 percent alfalfa. Enter the amount fed as 3 percent of body weight or 12 pounds for the animal in the example. If you want more gain you might add some corn. See what happens when you make the diet 50 percent corn and 50 percent alfalfa. Don't be reluctant to use your computer's speed to balance nutrients by trial and error. For example if the calculated diet was low in Selenium add .01 of Selenium 600. If that is too much Se cut the amount you entered in half, etc. Don't worry about the fact that your ration adds up to 101.5 percent. When you get very close you can remove 1.5 percent of some ingredient to bring the total to an even 100 percent if you desire.

Table 5. NUTRIENTS

OKLAHOMA STATE UNIVERSITY RATION CALCULATOR 2002 COMBINATION

NUTRIENT COMPOSITION OF FEEDS INCLUDED IN FORMULA.

(EXPRESSED ON A DRY MATTER BASIS EXCEPT FOR COST)

FEED NAME (17)	AMOUNT	D.M.%	NEM	NEG	PROT	K%	CA%	PHOS	COST	MG	S	CO	CU	FE	MN	SE	ZN	TDN%	FAT%	FIBER	ADF	NDF
CORN DENT NO 2	48.400	88.00	103.0	67.0	9.2	0.40	0.02	0.29	4.50	0.13	0.14	0.07	4.00	26	6	0.15	16	94.2	4.2	2.2	3.0	9.0
COTTONSEED HULLS	15.000	90.00	47.0	10.0	4.0	0.90	0.15	0.09	4.00	0.14	0.09	0.02	13.00	131	119	0.30	22	47.0	1.7	47.8	68.0	87.0
ALFALFA HAY FAIR	25.000	88.00	56.0	30.9	18.3	2.06	1.50	0.27	4.25	0.33	0.28	0.15	11.00	127	42	0.28	25	58.0	1.8	32.0	35.0	45.0
SOYMEAL 47.7	10.400	90.00	97.7	67.3	55.1	2.30	0.29	0.70	8.00	0.32	0.48	0.07	22.00	148	41	0.11	61	87.0	1.0	3.7	6.0	9.0
SALT	0.300	97.00							2.25													
LIMESTONE 38%	0.650	99.60				0.09	39.40	0.09	1.85	0.17	0.01		33.00	542	281		39					
DICAL	0.200	97.00					22.00	19.30	17.00	0.59	1.14		10.00	14400	330		100					
VITAMIN A-30,000	0.017	90.00							140.00													
VITAMIN E-50%	0.017	90.00							500.00													
RUMENSIN 80	0.014	90.00							536.00													
ZINC SULFATE	0.002	99.00							30.20								360000					

NUTRIENT CONTRIBUTION FROM EACH OF THE FEEDS INCLUDED IN THE FORMULA. (below)

(EXPRESSED ON A DRY MATTER BASIS EXCEPT FOR COST)

FEED NAME (17)	AMOUNT	% of DM	NEM	NEG	PROT	K%	CA%	PHOS	COST	MG	S	CO	CU	FE	MN	SE	ZN	TDN%	FAT	FIBER	ADF	NDF
CORN DENT NO 2	48.40	48.0562	49.50	32.20	4.42	0.19	0.01	0.14	2.46	0.06	0.07	0.03	1.92	12	2.88	0.07	7.69	45.29	2.02	1.06	1.4	4.3
COTTONSEED HULLS	15.00	15.2320	7.16	1.52	0.61	0.14	0.02	0.01	0.58	0.02	0.01	0.00	1.98	20	18.13	0.05	3.35	7.16	0.28	7.28	10.4	13.3
ALFALFA HAY FAIR	25.00	24.8224	13.90	7.67	4.54	0.51	0.37	0.07	1.20	0.08	0.07	0.04	2.73	32	10.43	0.07	6.21	14.40	0.45	7.94	8.7	11.2
SOYMEAL 47.7	10.40	10.5608	10.32	7.10	5.82	0.24	0.03	0.07	0.94	0.03	0.05	0.01	2.32	16	4.33	0.01	6.44	9.19	0.11	0.39	0.6	1.0
SALT	0.30	0.3283							0.01													
LIMESTONE 38%	0.65	0.7305				0.00	0.29	0.00	0.01	0.00	0.00		0.24	4	2.05		0.28					
DICAL	0.20	0.2189					0.05	0.04	0.04	0.00	0.00		0.02	32	0.72		0.22					
VITAMIN A-30,000	0.02	0.0172							0.03													
VITAMIN E-50%	0.02	0.0173							0.10													
RUMENSIN 80	0.01	0.0142							0.08													
ZINC SULFATE	0.00	0.0022							0.00								8.04					
RATION DRY MATTER PERCENT-->	100.0000	80.88	48.50	15.39	1.08	0.77	0.34		5.54	0.20	0.20	0.08	9.22	115	38.54	0.199	32.23	76.03	2.83	16.67	21.1	29.7

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