



# Current Report

Cooperative Extension Service • Division of Agriculture • Oklahoma State University

## Spreadsheet Programs for Calculating Complete Diets for Beef Cattle, Checking for Nutrient Balance and Estimating Gain (AUTONRCA & AUTONRCD)

D. R. Gill, K. S. Lusby and F. N. Owens

Animal Science Department  
Oklahoma State University  
Stillwater, Oklahoma

### Introduction

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 computer programs AUTONRCA and AUTONRCD combine the OSU program for "Calculating Livestock Rations" (RATION) and the nutrient requirements for energy, protein, calcium and phosphorus for beef cattle in drylot derived from the Nutrient Requirements of Beef Cattle (NRC) published by the National Academy of Sciences in 1984.

The non-skilled nutritionist may use AUTONRCA or AUTONRCD to check a feed mixture to see if it meets the NRC recommendations for a given weight and class of growing-finishing cattle. Either of these programs allows the user to maintain a library of up to 79 feeds while being able to formulate up to 16 feeds in a formulation matrix.

Pressing the **Alt** and **S** keys simultaneously accesses you to the feeds library for selection of feeds in the program. A few feed ingredients in the library are shown in Table 1. The nutrient composition of these feeds, including trace mineral content, would be shown on the computer screen. You may scan the list of feeds in the library, select those you wish to use, and jot down their feed numbers at the left of the ingredient names. You must make any changes in nutrient composition and/or prices in the library. When nutrient composition and prices are correct, you press the "**HOME**" key on the computer. This places the cursor back to cell A1,

the upper left-hand corner of the formulation matrix. You enter the feed numbers of desired feeds in cell A2 and continue down column A. A **Zero** placed in column A, rows 2-17, will blank out the feed name and data on rows not used, permitting you to see feeds used in a given formulation only.

**Table 1. Example Feed Listing for the Ingredient Library**

FEED NAME
0
1 ALFALFA EXCEL
2 ALFALFA GOOD
3 COTTONSEED HULLS
4 PRAIRIE HAY
5 CORN DENT NO 2
6 MILO, ROLL, GRND
7 WHEAT MIDDS
8 WHEAT
9 CANE MOLASSES
10 COTTONSEED MEAL
11 SOYMEAL 44
12 LIMESTONE 38%

The next important Macro function after the feeds are selected is the **FORMULATE** command. To activate, press the **Alt** and **F** keys simultaneously. This command will place the cursor in cell C1 of the formulation matrix and will place a title lock on the feed names. As you scroll to the right to

check nutrient composition of the feeds selected, the feed name will be locked in the left column. If you decide to change a nutrient value or price for an ingredient during formulation, you must make the changes in the feed library. To edit the library, use the **EDIT** function (**Alt E**). This command will move the cursor to the place where you want to make changes.

If you need to add a feed to the library, first use the **SELECT** command and type the new feed name next to an unused number. Then use the **EDIT** command to enter the nutrient coefficients. Use the **FORMULATE** command to place the cursor in column C2 of the formulation matrix and enter amounts of each feed selected for your ration in the appropriate row in column C.

AUTONRCA is written for those who wish to formulate or evaluate on an "as is" moisture basis, while AUTONRCD is for formulation on a dry matter basis. The examples discussed in this report are all from the AUTONRCA version of the program. If you can use AUTONRCA, you should have no problem with AUTONRCD, the dry matter version.

## Formulating with AUTONRCA - "As Fed" Version

The program has two functions. The first is to calculate the nutritional composition of a feed mixture on an "as fed" basis. The second is to generate the nutritional requirements of growing and finishing cattle. Using the two functions together, you can balance a ration accurately for type of animals with specific weight.

The formulation matrix will hold up to 16 feeds and their nutrient composition. You enter the "as fed" composition of the ration in the "C" column. If you desire to use the dry matter version (**AUTONRCD**), you will enter the ration composition on a dry matter basis. This is the only difference between the two programs. You do not need to add the total amount of feed to 100 to enter in the C column. This program can calculate the nutrient composition on any amount of feed (for example 13.5 lbs, 100 lbs, or 2500 lbs). Remember that you enter **cost** on an "as fed" basis.

There are a large number of calculations hidden to the right of the screen. This portion of the program contains nutrient totals. In the example ration supplied with the program (AUTONRCA), you can see 10.19 percent protein in the ration, of which 6.27 units came from corn and 0.88 units from soybean meal. You should never alter these cells because they contain necessary steps for computing the ration. Any cell that should not be changed is protected to prevent inadvertent removal of an equation.

The formulation matrix can contain a maximum of 16 feeds so that you can see the nutrient names at the top of the screen and the computed composition and requirement values at the bottom of the screen. Moving the cursor to the top left hand cell on the screen (use the "**HOME**" key) will provide the best positioning of the formulation matrix for viewing.

In order to generate accurate requirement data, you must enter the proper information about cattle, sex, weight, and type. From the **HOME** position (cell A1), you can enter this information easily by pressing the **Page Down** key. You enter the animal weight in cell D24, the body and sex type in cell D25, and the daily amount of "as fed" feed the animal is expected to eat in cell D23.

Six combinations of sex and animal type are listed below. After entering a number from 1-6, you see the description of the animal type 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.

This program requires a realistic estimate of feed intake. 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 I23. If your values are out of this range, the ration is unlikely to be correct. With experimentation, you will discover that the "correct nutrient composition" of a diet will change with changes of any of the following: feed intake, animal weight, and body type. These changes will be quite large with light weight cattle. A sample of selection for animal weight, sex and type follows:

AS IS FEED PER DAY 19  
ANIMAL WEIGHT LBS. 650  
BODY TYPE 6

You calculate the animal requirements for energy (NEM and NEg), protein, calcium and phosphorus based on the 1984 NRC requirements of beef cattle. These equations are placed in a lookup table at cells N31...R36. 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." Calculate the expected gain (shown twice in cells D20 and I23) by using the NEM and NEg values in cells E19 and F19, the body weight in cell D24, the expected feed intake in cell D23, and the body type in cell D25.

You should only evaluate rations which will lead to gains of over 0.5 and less than 3.5 pounds per day to stay within the valid weight ranges for which the prediction equations were developed. Animal weight should be between 300 and 1000 pounds for medium frame animals and between 300 and 1100 pounds for large frame animals. You will see the computed values for protein, calcium, and phosphorus in row 20 of formulation matrix to help you develop the ration.

You will find the calculated nutrient composition of the diet below the animal sex, weight, and type. To the right of these are the National Research Council (NRC) recommendations for the animal described. The status of each nutrient is shown in column D (see Table 2).

**Table 2. SAMPLE SCREENS AND OUTPUT FROM AUTONRCA**

FEED NAME	AMOUNT	D.M.%	NEM	NEG	PROT	K%	CA%	PHOS	COST
ALFALFA GOOD	5.00	90.00	57.0	27.0	16.0	1.50	1.25	0.22	4.00
COTTONSEED HULLS	4.00	90.00	47.0	10.0	4.0	0.90	0.15	0.09	3.00
CORN DENT NO 2	77.41	88.00	103.0	67.0	9.2	0.40	0.02	0.29	5.00
CANE MOLASSES	5.00	75.00	77.3	49.1	5.8	3.84	1.00	0.11	3.90
SOYMEAL 44	2.00	90.00	87.0	59.0	48.9	2.52	0.15	0.81	8.50
WHEAT MIDDS	5.00	89.00	76.4	45.5	18.4	1.37	0.13	1.18	5.00
LIMESTONE 38%	0.83	99.60				0.09	39.40	0.09	2.25
SALT	0.30	97.00						2.25	
RUMENSIN 60	0.03	90.00						402	
TYLAN 40	0.01	90.00						428	
VITAMIN A-30,000	0.02	90.00						140	
UREA	0.40	99.00			288.0			9.00	
TOTAL & AI COMP	100.00	87.79	82.28	52.14	10.19	0.62	0.45	0.28	5.05
TARGET FOR GAIN OF:		3.41	LBS/DAY —>		10.12	0.57	0.44	0.22	

AS IS FEED FED PER DAY                      19 DRY MATTER FEED/DAY    16.68  
ANIMAL WEIGHT LBS.                            650 CALCULATED GAIN / DAY    3.41  
BODY TYPE    6 AS FED FEED / # GAIN    5.58  
MEDIUM-FRAME STEER CALVES.

NUTRIENT	COMPOSITION		NRC RECOMMENDATION	
	AS FED	D.M.	DM %	STATUS
NEm Megcal/CWT.	82.28	93.73	*****	
NEg Megcal/CWT.	52.14	59.39	*****	
TDN %	75.58	86.10	*****	
Crude Protein %	10.19	11.61	11.53	ADEQUATE
Potassium %	0.62	0.71	0.65	ADEQUATE
Calcium %	0.45	0.51	0.50	ADEQUATE
Phosphorus %	0.28	0.32	0.26	ADEQUATE
Magnesium %	0.15	0.17	0.1	ADEQUATE
Sulfur %	0.15	0.17	0.1	EXCESSIVE
Cobalt ppm	0.19	0.22	0.1	EXCESSIVE
Copper ppm	7.8	8.8	8	ADEQUATE
Iron ppm	55.3	63.0	50	ADEQUATE
Manganese ppm	22.2	25.3	40	ADEQUATE
Selenium ppm	0.15	0.18	0.2	ADEQUATE
Zinc ppm	19.8	22.5	30	ADEQUATE
Cost / cwt.	\$5.05	\$5.75		

CALCULATED MOISTURE OF "AS IS" MIXTURE IS >>> 12.21 PERCENT

DEVELOPED AT OKLAHOMA STATE UNIVERSITY; BY D. R. GILL & F. N. OWENS  
FILE NAME IS —>>> AUTONRCA (MSDOSLOTUS123)  
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## National Research Council (NRC) Requirements

In this program the NRC requirements for energy, protein, calcium, and phosphorus are calculated by formula. You only need to get protein 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 will not allow the percent of protein in the diet to drop below 10.5 percent crude protein on a dry matter basis.

Mineral requirements are “looked up” in Table 3 reproduced from the 1984 NRC bulletin (cells N39...V52). The NRC suggests an acceptable range for minerals. Mineral levels below this range are labeled DEFICIENT, within the range ADEQUATE, and above the range EXCESSIVE. Because most of the minerals when used in excess are toxic, this range is identified as TOXIC. A SUGGESTED value is also shown in Table 3.

**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; a prolonged deficiency will result in any number of disorders. You should remedy deficiencies by adding appropriate minerals or substituting different feed ingredients.

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 such as calcium and potassium largely come from natural feeds such as soybean meal or alfalfa hay. On the other hand, if the excess of calcium comes from an oversupply of limestone or the excess of 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.

We chose these feeds in the example because most Oklahoma producers are familiar with them. The coefficients may not be correct for your feeds; analysis of your feeds is suggested. You can replace any of these feeds with a feed useful to you. The data for the trace minerals given in this table were taken from the 1984 NRC publication except in cases where better data were available in Oklahoma.

## User Hints

In order to speed operations, especially if you have a slow computer, you may want to set the program to “manual recalculation”. The keystroke sequence is **/WGRM**. Then you may make any number of changes in feeds and nutrients before the program calculates the ration. When you are ready to calculate the ration, press the “**F9**” function key. The program will flash “wait” in the upper right hand corner of the screen while it is calculating. If you have faster computers, you may want to use the “automatic” default and let the computer recalculate after each keyboard entry. To reset to automatic recalculation, the keystroke sequence is **/WGRA**. Often this spreadsheet is more readable if you use the zero suppression option (**ALT Z**).

## Calculating a Ration Using Autonrca— ”As Fed” Version

Rations are calculated by trial and error. Although this may seem crude, the fast speed of the computer makes this relatively efficient.

First, press **Alt F** keys to move the cursor to the top left hand corner of the screen. Next, check the nutrients in the selected feeds. If you need to change the feeds, press **Alt E** to EDIT. You can add new feeds by using the **SELECT (ALTS)** option. Be sure to enter new nutrient data for the new feed. You enter the cost of each ingredient in terms of **\$/hundred weight on an “as fed”, or wet basis**, the way most feeds would be quoted from a feed store.

Next, enter your initial “guesses” for percentages of each ingredient in the ration. You do not need to add the total to 100 for calculating the ration, but keeping the total at 100 may make it easier to visualize the proportions of each feed as you make first entries. Nutrient values in this program (**AUTONRCA**), except amount, dry matter, and cost on “as fed” basis, must be on a “dry matter” basis. You may see the percentage of protein, calcium, and phosphorus required for the indicated animal and feed intake in the bottom line of the

formulation matrix on an "as fed" basis.

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

Cattle require additional nutrient requirements other than those described in this program, such as salt, vitamins A and E. Cattle also require "roughage factor" and are very sensitive to the rates of various nutrients in the diet which become available within the digestive tract. **If you have no training in nutrition, please use this program only to check 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 other calculated requirements. You can calculate the cost of gain contributed by feed easily. This

calculation is useful to experienced nutritionists; however, if the users do not have extensive knowledge of ration formulation and cattle management, this calculation may cause them to overestimate feed intake or develop diets which could lead to founder or acidosis.

Once the ration composition is complete, you can scroll down to the Feeding Sheet (Table 4) to view the final ration. Ingredients are listed as percentages on "as fed" basis, "dry matter" basis, and as pounds for two batch sizes. The user can change batch sizes from the keyboard for the two batch columns to produce desired batch sizes for mixing. If the program is running in the manual mode, you must press **F9** each time a change is made in order to recalculate the new batches.

### When to Use AUTONRCA or AUTONRCD

If all potential ingredients contain about the same percentage of moisture (i.e. grains, dry hays, protein meals etc.), the "as fed" version AUTONRCA is usually the easier one to use. However, if rations contain feeds with varying contents of moisture (i.e. silages and grains), AUTONRCD is the program of choice with formulations done on a dry matter basis.

**Table 4. Sample Feeding Sheet From AUTONRCA**

RATION DEVELOPED FOR—>> Your Name				
DATE	Address			
01/06/91	Town			
FEEDING SHEET FOR —>>>LB. BATCH——>>>			1000	2000
FEED NAME	% D.M.	% AS FED	POUNDS	POUNDS
ALFALFA GOOD	5.1260	5.00	50.00	100.0
COTTONSEED HULLS	4.1008	4.00	40.00	80.00
CORN DENT NO 2	77.5969	77.41	774.1	1548.
CANE MOLASSES	4.2717	5.00	50.00	100.0
SOYMEAL 44	2.0504	2.00	20.00	40.00
WHEAT MIDDS	5.0690	5.00	50.00	100.0
LIMESTONE 38%	0.9417	0.83	8.300	16.60
SALT	0.3315	0.30	3.000	6.000
RUMENSIN 60	0.0256	0.03	0.250	0.500
TYLAN 40	0.0128	0.01	0.125	0.250
VITAMIN A-30,000	0.0226	0.02	0.220	0.440
UREA	0.4511	0.40	4.000	8.000
<b>TOTALS</b>	<b>100.00</b>	<b>100</b>	<b>1000</b>	<b>2000</b>

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