October 1980

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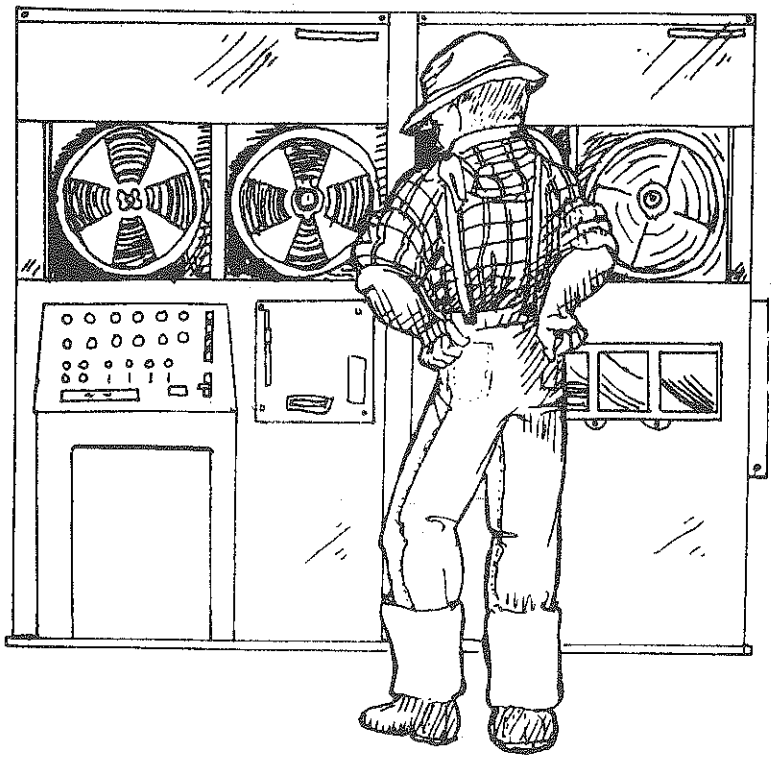
A.S. Mimeo 52

LEAST-COST BALANCED DAIRY RATIONS

NEWPLAN PROGRAM 31

Form 4



A Computer Program Users' Manual

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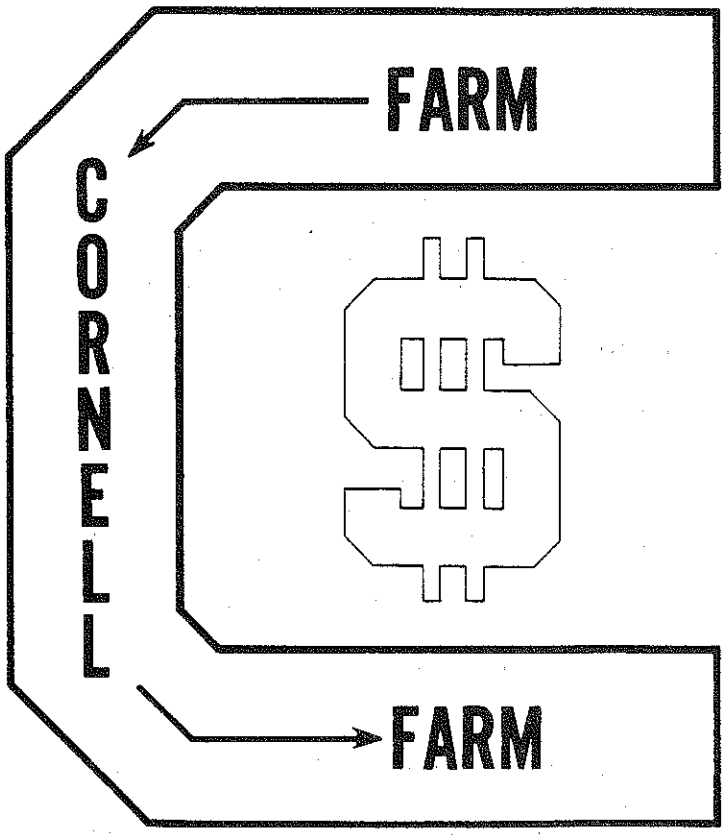

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ACKNOWLEDGMENTS

The authors wish to acknowledge the efforts of several individuals who assisted in the development of the Least-Cost Balanced Dairy Ration Program. Dr. Paul Chandler, author of the dairy ration program available on the Computerized Management Network, consulted with the authors in order that we might fully understand his program. Dr. Roy Black, Dr. William Thomas, Dr. Donald Hillman and others from Michigan State University provided helpful ideas at a meeting in Hamilton, Ontario.

Mary Lou Durfee assisted in early development of the input form and the output format. Numerous extension agents and specialists assisted her in development of the input form and output format.

Jerry Gerner served as a consultant to Bob Milligan regarding programming questions and problems. Dr. Sherrill Nott provided the required assistance to get the program running on the Forward Planning System.

Linda Putnam typed each draft of this manual and all of the supporting materials, assisted in computer input and editing, and persevered all of the crises associated with development of a program of this size.

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INTRODUCTION

Purchased feed is the largest cash expense item on a dairy farm, more than three times greater than the next highest item. Feed costs result, however, not only from purchased but also from farm grown feeds. On most farms, the total cost of purchased and farm grown feeds is 50 to 60 percent of cash expenses and resources required to grow and store crops account for 40 to 70 percent of total farm investment. Formulating dairy rations, therefore, has a tremendous impact on farm costs and resulting profitability and a manager should consider both costs of farm produced and purchased feeds.

To provide an educational tool for cooperative extension agents and specialists and others interested in nutrition and dairy cattle feeding management, the authors have developed an up-to-date least-cost balanced dairy ration program. This program, as was its predecessor, determines a nutritionally balanced least-cost ration composed of the feed ingredients available to the dairymen and considering the restrictions on availability of feeds and prespecified milk production.

The simultaneous determination of the feed formulation and the production level to be fed for maximum profit is an advancement which the authors anticipate incorporating into a program of this type at some future date. At the present time, however, knowledge of the relationship between inputs, particularly feed, and the quantity of milk produced is not sufficiently well defined to be incorporated in a program of this type.

Even though this program is completely new, the input format is very similar to its predecessor; it has been developed for use on the NEWPLAN remote access system. There are three major differences from the previous least-cost balanced dairy ration program (Program 31, Form 2). The first is that the program includes nutritional advances in the last decade. New nutritional concepts incorporated include negative energy balance, lead factors, soluble protein and the balancing for additional minerals and vitamins. The second difference is that the output has been expanded to provide information on the feeds formulated in a form useful to the user, a complete nutritional breakdown of the requirements and the amount contained in the ration, and additional economic information concerning the cost of attaining nutritional requirements and restricting feeds to be included in the ration. The third change is that the program has been developed so that the user can change any feed requirement or feed composition parameter when the situation dictates.

Ration Types

Currently, rations can be formulated for either lactating animals or for dry cows; heifer formulations may be added later. For both lactating and dry cows the ration can be formulated for two feeding systems, the conventional feeding system and a total mixed ration feeding system. In the conventional feeding system, a concentrate mix is formulated with or without a premix and roughages and possibly other feed ingredients are

assumed to be fed separately. In the conventional feeding system, the program essentially balances as though it is balancing for an individual cow. In the total mixed ration feed formulation, the feed is formulated to be fed to a group of animals with all of the ingredients being fed in a complete feed or with all of the feed except the dry hays fed in a complete feed. Because the complete feed is fed to a group of animals, the program is balanced for the group necessitating the introduction of the concept of a lead factor. A lead factor provides feeding for a higher level of production than the average actually being attained by the group.

Nutrient Requirements

The requirements are taken largely from recommendations contained in the National Research Council publication entitled, Nutrient Requirements of Dairy Cattle, fifth revised edition, 1978. The actual requirements are detailed later in Section IV of the input form discussing modifications of nutrient requirements. The program is designed to include the following maximum and minimum requirements.

Maximum and minimum dry matter intake
Minimum energy
Minimum adjusted acid detergent fiber
Minimum adjusted crude protein
Maximum non-protein nitrogen
Maximum protein solubility when urea is included in ration
Minimum calcium
Minimum and maximum phosphorus
Minimum and maximum calcium:phosphorus ratio
Maximum fat
Minimum and maximum sodium
Minimum and maximum magnesium
Minimum and maximum sulfur
Minimum potassium
Minimum chloride
Minimum supplemental vitamin A
Minimum supplemental vitamin D

In addition, the quantities in the ration of iron, zinc, copper, manganese, supplemental iodine, supplemental selenium and supplemental vitamin E are calculated and included in the output. Furthermore, minimum iron, minimum zinc, minimum and maximum copper and minimum manganese restrictions can be included in the program at the user's option.

The nutrients necessary to meet these requirements come from the feedstuffs available to the manager for whom the ration is being formulated. These feeds are taken from the feedbank and coefficients contained in Table 1. The data in Table 1 come from tables included in the National Research Council publication entitled, Nutrient Requirements of Dairy Cattle, fifth revised edition, 1978 and New York Dairy Herd Improvement Association forage testing results (Chase and Sniffen), Summary of NYDHIC Forage Analysis Data. The user is encouraged to change the values in the table to better

reflect the feed ingredients available on the farm; to make maximum use of the program it is essentially mandatory that a forage analysis be used to alter the nutritional nutrient contents of farm-produced forages.

Organization of the Manual

The remainder of this users' manual contains three sections. The first describes the procedures and makes recommendations for entering the data by completing the input form. The second section discusses the output from the program and the third section contains information on using the program including a complete example, a discussion of the use of premix, concentrate and complete feed from the previous analysis and a discussion of the expansion data program. The organization of the first section on entering the data is to start with input line 01 and continue through input line 99 providing considerable detail concerning the background and the types of information that should be entered. As mentioned above, the nutrient requirements of the program are outlined and discussed in Section IV, discussing the modifications of those requirements. In the output discussion, each of the three possible forms of output, error messages, information on problem solutions and an output of a least-cost balanced dairy ration are discussed.

COMPLETING THE INPUT FORM

To obtain a least-cost balanced dairy ration requires first obtaining and organizing the necessary descriptive data such as cow or group characteristics, production level and nutrients contained in feeds. This data is then entered on an input form. The input data is recorded on the appropriate input line which is identified by a line number. Number of digits and placing of decimals in the input data must conform with the spacing indicated for each line of the input form. The number of digits (numbers) cannot exceed the number of spaces available. Decimal points cannot be added or moved. Fractions must be entered in decimal form. Input data (numbers) must be right justified, i.e. entered so that the right-most digit falls in the extreme right-hand space provided and leading zeros are entered. For example the number 1,704 would be entered as 0 1 7 0 4 or 0 1 7 if the input is required in hundreds.

At the top of the input form, space is available to enter the name, address and phone number of the person or farm business for whom the analysis is being made. There also will be questions asked during the entering of the input regarding the name and telephone number of the person for whom the analysis is being run. Inclusion of this information on the input form and in the output should provide a personal touch and reduce the potential for confusion when rations are formulated for multiple farm businesses.

Because it is essential that all entries on the input form be complete, this section follows the input form from line 01 to 99. Where needed, detailed explanations and examples are included. This description is intended as a reference rather than for reading as a novel.

Section I. Animal Characteristics

Production Factors

01.a. Enter type of least-cost ration desired: At this time, there are four options available for the least-cost balanced ration program--two for milking cows and two for dry cows. These are:

2 = conventional feeding for milking cows,
3 = total mixed ration for milking cows,
6 = conventional feeding for dry cows, and
7 = total mixed ration for dry cows.

The selection of a ration type first involves indicating whether the ration is to be formulated for milking or dry cows. The distinction between conventional feeding and total mixed ration depends upon the feeding system present on the farm. Each is discussed below.

Conventional Feeding (Ration Types 2 and 6)

With this option, the output will contain information on a premix if one is requested, a concentrate mix including any premix and the amounts of each of the roughages to be fed. The information on the

premix includes the quantities and proportions of each of the individual ingredients included in the premix and the amount of the premix to be fed or included in the concentrate. The information on the concentrate includes the ingredients in a concentrate batch and the amount of that concentrate to be fed to each animal. The information on the roughages includes the amount of each to be fed. The conventional feeding option should be used whenever a concentrate mix is to be formulated and then fed separately from the roughages. The ration is balanced for an individual animal having the characteristics specified on input lines 01 and 03.

Total Mixed Rations (Ration Types 3 and 7)

The output for this feeding situation is a total mixed ration with all ingredients listed separately followed by the quantity of the complete feed to be fed per animal or per group per feeding. The exception to all ingredients being included in a total mixed ration is that one or more dry hays can be fed separately. This ration type should be used whenever the herd is housed in production groups and each group is fed a complete ration including the minerals, concentrate and roughages except for dry hays fed separately. In this feeding situation, the ration is balanced based on milk production, fat test and body weight averages for the group of cows. To facilitate this ration type inputs in lines 02 are considered.

01.b. Average body weight of cows: Enter estimated average weight in hundredweight of an individual cow or group of cows for which the ration is to be balanced. The lower limit is 800 lbs. and the upper limit 1700 lbs.

01.c. Average milk production level: Enter level of milk production in pounds per cow per day of an individual cow or the group of cows for which the ration is to be balanced. When using a total mixed ration, this should be the actual average production not the production for which the ration for the group of cows is to be balanced. That adjustment is made using the lead factor entered in input 02. The program will accept production levels of up to 130 lbs. although high production levels will normally result in infeasible solutions. For dry cows, a "000" should be entered.

01.d. Butterfat test: For milking cows, enter the average butterfat test in percent for the individual cow, group of cows or the herd. For dry cows, enter "00". For milking cows, butterfat content must be above 2 percent but cannot be greater than 6 percent.

Information for Total Mixed Rations (Ration Types 3 and 7)

In order to tailor the ration for a production group fed a total mixed ration, additional information is required. For a ration balanced for conventional feeding this information is not required and a "0" should be entered for input line 02 and proceed to input line 03. Two types of information are required for the total mixed ration option. The first is a lead factor which facilitates balancing the ration for a production level higher than the average production of the group entered in input 01.c.

The second type of information relates to the number of cows in the production group and the number of feedings per day. This information is used primarily when you wish to develop a ration batch size which is the amount needed to feed the group per feeding. The number of cows input is also included in the output as introductory descriptive information.

02.a. Lead factor: This becomes important when cows are fed in groups. If the cows are fed for the average production in the group then there are approximately half the cows in the group that are underfed. Cows are able to adjust their intake partly as a function of milk production; however, rumen fill can become an important factor especially if the diet formulated restricts dry matter intake to the point where the cow cannot consume enough nutrients in a 24-hour period to meet her needs.

The objective then is to formulate for a production level enough above the average in the group so as to meet the animal's requirement without excessively overfeeding the low cows in that group. In a one group situation, the lead factor is larger due to the greater spread of production levels; conversely, the greater the number of groups the smaller the lead factor. Suggested lead factors are as follows:

Type of Group	Lead Factor
Complete herd	1.20 - 1.30
Two groups	
Top half	1.10 - 1.20
Bottom half	1.15 - 1.25
Three groups	
Top	1.10 - 1.15
Middle	1.12 - 1.17
Bottom	1.18 - 1.23
Four groups	
Fresh	1.10 - 1.25
Peak	1.05 - 1.15
Mid lactation	1.10 - 1.15
Tail end	1.10 - 1.15

Please realize that the lead factor should change as the stage of lactation and body condition varies. Use the average production in the group as a benchmark.

The ration is then formulated as though the cow was producing the amount of milk indicated by the average production in input 01 times the lead factor entered in this input 02.a. As an example, if the average production of the group were 60 lbs. per cow per day and a lead factor of 1.10 were entered in this input 02.a., the total mixed ration for this group would be formulated for a cow producing 66 lbs. of milk.

02.b. Number of cows in production group: As indicated above, the number of cows in the production group is used exclusively for the output in two places, (1) in the descriptive information and (2) in formulating the pounds to be included in the total mixed ration when the total mixed ration is to be tailored to the requirements of the group for each feeding. Enter the number of cows in the group.

02.c. Number of feedings per day: Again, this entry is simply for use in the output and it should be the number of times you are going to feed the total mixed ration per day. It is only used in the situation where you are tailoring the size of the total mixed ration to the amount to be fed per group per feeding.

Characteristics of Cows Needed to Determine Nutrient Requirements

In order to better tailor the ration to be formulated to the cow or group of cows in question, some additional information is required concerning whether negative energy balancing is to be allowed and the age of the animals for which the ration is to be formulated.

03.a. Option to negative energy balance: In most situations, high producing cows cannot consume enough feed to meet their energy needs for both maintenance and milk production in early lactation. The difference between energy intake and energy required comes from body reserves. In order to incorporate this concept into the program, it is possible to introduce an activity which represents the energy coming from body tissue. If this option is selected, the program is designed to allow up to one pound of body weight per cow per day or 2.2 Mcal of energy. If you feel that one pound of body weight per cow per day is either too high or too low, it can be changed in Section IV of the program, Modification of Animal Nutrient Requirements. The program is designed so that energy from body tissue or negative energy balance is used as a last resort. This is accomplished by placing a very high cost on this activity, so that if it is possible, the energy comes from the available feedstuffs rather than from body tissue. If you wish to give the program the option to negative energy balance, enter a "1" in input line 03.a. This option should only be used for cows in early lactation; it should not be used when you are having problems formulating a ration for cows not in early lactation. If you choose to give the program the option to negative energy balance, the Mcal of energy coming from the negative energy balance will be indicated in the output. If you do not wish to use this option, enter a "0" on input line 03.a.

03.b. and 03.c. Age structure of group of cows: In order to accurately formulate rations for first and second lactation animals, a requirement for growth is included. Input items 03.b. and 03.c. are used. In most situations the ration is balanced for a mature cow, which is indicated by entering a "0" in input 03.b. and a "0" in input 03.c. If you wish to balance for a first lactation animal or group of animals, enter a nonzero number in input 03.b., and if you wish to develop a ration for a second lactation cow or group of cows, enter a nonzero number in input 03.c.

Section II. Feed Ingredients Available

All feed ingredients to be considered as a part of the ration to be formulated must be included in this section. This includes roughages, individual concentrate ingredients, commercial concentrates including protein supplements and all minerals and vitamin sources. Several items of information are required for each of the feeds: the feed code, the price and a code indicating how this feed ingredient is to be included in the ration.

The types of feeding ingredients that can be included are coded as follows:

Types of Feeds	Range for the Feed Codes
Roughages	101 - 199
Individual Ingredient Concentrates	200 - 299
Commercial Concentrates and Protein Supplements	300 - 399
Minerals, Mineral Supplement and Vitamin	400 - 440

The feed codes and the ingredients in each of the feeds are in Table 1 on pages 63 to 70. When selecting the feed ingredients to enter in this section, keep in mind that you are able to and in fact it is expected that you will be changing the nutrient content to more precisely tailor the ration to the specific feeds that are being entered. These are entered as nutrient changes in the next input section.

04.a. - 30.a. Feed code: As indicated above, the feed code should be selected from Table 1. It is very important to enter this number correctly. It is also important to utilize a feed code that is included in Table 1. If you accidentally enter a feed code that is not in Table 1, an error message results. The acceptable feed codes are of three types:

a. Feed codes for feed ingredients with the nutrient contents specified in Table 1. Changes in nutrient values for these feeds are made in input Section III.

b. Feed codes that can be used for specifying the total nutrient makeup of a feed not included in the feed matrix. Entries are made in input Section III. These feed codes, their feed name and their feed description are:

191	ROUGH 1	Your Roughage #1
192	ROUGH 2	Your Roughage #2
193	ROUGH 3	Your Roughage #3
194	ROUGH 4	Your Roughage #4
291	CONC 1	Your Concentrate #1
292	CONC 2	Your Concentrate #2
293	CONC 3	Your Concentrate #3
294	CONC 4	Your Concentrate #4

391	COM CON1	Your Commercial Concentrate #1
392	COM CON2	Your Commercial Concentrate #2
393	COM CON3	Your Commercial Concentrate #3
394	COM CON4	Your Commercial Concentrate #4
421	MINERAL1	Your Mineral #1
422	MINERAL2	Your Mineral #2
423	MINERAL3	Your Mineral #3
424	MINERAL4	Your Mineral #4
437	VITAMIN1	Your Vitamin #1
438	VITAMIN2	Your Vitamin #2
439	VITAMIN3	Your Vitamin #3
440	VITAMIN4	Your Vitamin #4

c. Feed codes that are used to include the premix, concentrate mix (conventional feed formulation) or complete feed mix (total mixed ration) formulated in the previous analysis as a feed ingredient in this analysis. The codes are:[1/]

200	COMPLETE	Complete Feed Mix from previous analysis
300	CONCENTR	Concentrate Mix from previous analysis
400	PRE-MIX	Pre-mix Mix from previous analysis

04.b. - 30.b. Price: All feed prices are entered on an as-fed basis (price for ingredient with percent dry matter specified in feed table or as changed). The price entered should reflect the individual farm situation under consideration. For those feed ingredients that are purchased off the farm, determination of the price to be entered should be the purchase price of that feed ingredient. Mixing, hauling and feeding costs for concentrates or premixes are included in input line 98. If there are purchase costs or transportation costs not included in the purchase price of roughages, they should be included in the price entered. If there are additional costs attributable to the feed ingredient being entered beyond those included in the premix or concentrate mix charges, the charges should be added to the price before it is entered on the line. For example, if all of the ingredients are already on the farm for a total mixed ration, except you are going to purchase corn grain from a neighbor and you have to pay a hauling charge, the costs of transporting it to the farm should be added to the price that is entered on this line.

The pricing of farm produced feed ingredients is more difficult. Normally, an opportunity cost principle should be used to price these ingredients; namely, the return that could be obtained from the ingredient if it was not fed to your dairy animals. In other words, the price that you could sell corn to an elevator or roughage to a neighbor. By valuing it at the opportunity cost, you are saying that the cost of feeding the roughage is the income foregone by not selling it. One feature of the output of this program is that the cost of home-produced ingredients and purchased ingredients are reported separately.

[1/] See pages 57 to 58 for more details.

04.c. - 30.c. Unit: In order to lessen the computations required for entering prices, the price of a feed ingredient can be entered on a per ton, per hundredweight or a per pound basis, all as-fed, with the appropriate unit code being indicated. Namely, "1" if the price is $/ton, "2" if the price is $/cwt. and "3" if the price is $/lb. Note that the price is to be entered in unit of 10 cents.

04.d. - 30.d. How fed: In order to incorporate the three ways of feeding a feed ingredient, premix, concentrate and roughage and the split between purchased and homegrown feeds, six how-fed codes are necessary; however, not all options are identical for each of the ration types. The following discussions describe the six codes:

How Fed Codes

0 = roughage or individually fed feed ingredient to be included in conventional ration or a dry hay fed separately from total mixed ration--grown.

1 = grown feed to be included in the premix.

2 = grown feed to be included in concentrate (conventional) or total mixed ration.

3 = roughage or individually fed feed ingredient to be included in conventional ration or a dry hay fed separately from total mixed ration--purchased.

4 = purchased feed to be included in premix.

5 = purchased feed to be included in concentrate (conventional feeding) or total mixed ration.

In a conventional feeding formulation all feeds fed individually, as opposed to being included in the concentrate mix are entered with a "0" or a "3" how fed code. This code is usually used for roughages although any other ingredient fed separately would also be coded with a "0" or a "3". In total mixed ration formulations only dry hays fed separately from the complete feed mix are coded "0" or "3". If selected ingredients are mixed for later inclusion in a concentrate mix or complete feed, they should be coded "1" or "4". A pre-mix containing the proportions of these ingredients required in the ration is formulated. All ingredients to be included in the concentrate or complete feed that are not first included in the premix are coded "2" or "5".

When you have entered the last feed, enter a "0" on the following line and proceed to Section III.1/

1/NOTE OF CAUTION: In several of the input sections, the user enters a "0" to indicate to the computer that this is the end of the information for this section. The user should bear this point in mind when planning for and doing adjusted analyses. For example, if the user wants to drop a feed in the middle of the feed list for an adjusted analysis, the wrong method of doing this would be to enter a "0" on that line since this would indicate to the computer that there are no more feeds and all feeds in Section II which are on lines following the one where the "0" has been entered are ignored. The best method would be to plan ahead and place the feed to be dropped on the end of the feed list and then drop this feed by entering a "0" for the adjusted analysis. However, if the feed to be dropped is in the middle of the list, the feed at the end of the list can be moved up to replace that feed and "0" is entered to drop the feed at the end of the list to avoid duplication of feeds. This technique can also be employed in other sections of the input form.

Section III. Modification of Feed Nutrient Composition

This least-cost balanced dairy ration program is developed with the expectation that the user will want to modify the nutrient composition of feeds, particularly roughages in accord with feed analyses that have been conducted. In addition, it is important for all feeds that the percentage dry matter be representative of the feeds that are actually on the farm. This is the section where these changes are made. Most changes are made in lines 31 through 65; however, in certain cases the restrictiveness of this section with only two digits both to the left and to the right of the decimal point does not allow all changes. Where more digits are required, changes are made in lines 66 through 77. Additional changes can be made using Program 64, the expanded data program (see pages 58 to 60). The discussion turns first to input lines 31 through 65. Particularly if you are not choosing to balance for the micro-minerals, all of your changes can be made in this section.

31.a. - 65.a. Feed nutrient code: The feed nutrient codes are the numbers given to each nutrient or characteristic of the feed ingredients in the feed table. The specific nutrient codes and the unit which that nutrient must be entered are given below. These nutrient codes are also contained in Tables 1, 2 and 3 and on the Code Chart.

Code	Nutrient	Unit
01	dry matter	percent
02	adjusted crude protein	percent of dry matter
03	soluble protein	percent of protein
04	unavailable protein	percent of dry matter
05	NPN	percent of dry matter
07	acid detergent fiber	percent of dry matter
08	adjusted acid detergent fiber	percent of dry matter
09	net energy of lactation	Mcal/lb. dry matter at 1 x maintenance
10	discount factor	percent
11	calcium	percent of dry matter
12	phosphorus	percent of dry matter
13	magnesium	percent of dry matter
14	potassium	percent of dry matter
15	sodium	percent of dry matter
16	chloride	percent of dry matter
17	sulfur	percent of dry matter
18	iron	parts per million of dry matter
19	zinc	parts per million of dry matter
20	copper	parts per million of dry matter
21	manganese	parts per million of dry matter
22	fat	percent of dry matter
23	supplemental iodine	parts per million of dry matter
24	supplemental selenium	parts per million of dry matter
25	supplemental vitamin A	thousands of international units
26	supplemental vitamin D	thousands of international units
27	supplemental vitamin E	international units

Code	Nutrient	Unit
28	index for depression of dry matter intake due to moisture	
29	maximum percent of concentrate mix (conventional feeding only)	percent
30	maximum percent of total ration	percent
31	feeding loss	percent as-fed

31.b. - 65.b. Feed nutrient level: Enter the correct level of the nutrient content or other item being altered from the value contained in Table 1, 2 or 3. All items except the percent dry matter (01), soluble protein (03), the moisture depressant index (28) and the percent feeding loss (31) are on a dry matter basis. Be certain to enter the correct units for each nutrient or feed specification as specified above and in Table 1 (pages 63 to 70). A few of the nutrient values require specific attention as indicated below.

Dry Matter (feed nutrient code 01): It is important that dry matter, particularly on roughages be as accurate as possible since the amount of feed fed is based on the dry matter indicated. Whenever high moisture feeds are to be fed, you should use a feed analysis or at least a moisture tester to determine the dry matter in the feed. If the moisture content of the feed seems to have changed since the last feed analysis, recheck the percentage dry matter.

Soluble and Unavailable Protein (feed nutrient codes 03 and 04): Both of these nutrients are used in this program. When urea is included as a feed ingredient, soluble protein becomes a constraint; otherwise, the soluble protein content of the feeds is used to calculate the soluble protein in the ration which is included in the output. Unavailable protein was used to adjust crude protein to obtain adjusted crude protein by subtracting any unavailable protein in excess of one percent of the dry matter.

Adjusted ADF (feed nutrient code 08): An adjustment in ADF values is made to better reflect the fiber content of feeds that is useable by the cow and promotes improved rumen function. Adjusted ADF is different from ADF only in the concentrates where the adjusted ADF value is much smaller since during the grinding and mixing of concentrates the effectiveness of the fiber is usually diminished greatly through a greater passage or escape from the rumen. It should be pointed out that if the forage has been chopped fine, the effectiveness of the adjusted fiber as a promotant of normal rumen function can be diminished dramatically.

Net Energy (feed nutrient code 09): This value is indicated in Mcals of net energy for lactation per pound of dry matter. The value which is indicated in Table 1 and should be entered whenever changes are made is net energy for lactation at maintenance level. This value will be discounted for increments of maintenance using the discount factor. You must be careful to get the decimal point in the correct place when entering net energy per pound of dry matter. As an example, 0.50 Mcal is entered 0 0.5 0 not 5 0.0 0.

Discount Factor (feed nutrient code 10): Recent nutritional research has shown that as milk production increases the energy actually utilized by the cow from a given feedstuff declines. In order to incorporate this concept into the least-cost balanced ration program, a discount factor is used. This factor discounts the energy available from each feed by the percentage indicated for each increment of maintenance. For example, if the discount factor is 4 percent and the total energy requirement for maintenance, growth and milk production is 3 times that for maintenance, the energy value will be discounted by 2 times 4 percent or 8 percent. At the current time, 4 percent is used as the discount factor for all feeds. In almost all instances, this 4 percent should be left unchanged. If you do choose to change it and you also have negative energy balance, there may be a very slight error in terms of the actual energy utilized by the cow.

Iron, Zinc, Copper and Manganese (feed nutrient codes 18-21): Balancing for these micronutrients is optional. Unless you choose to balance for these nutrients, their contents in the feed is used simply to calculate and include in the output the contents of each of these four micronutrients in the ration that has been balanced. (See Section IV for information on this option.)

Feeding Loss (feed nutrient code 31): You can include feeding losses for groups of feeds such as the complete feed, the roughages included in a conventional feed or the concentrates in input line 99. However, if the feeds included in one of these groups have different feeding losses, such as two roughages having different feeding losses, you can include a feeding loss under the roughages for one of the feeds and then enter the feeding loss for the roughage which is different as a feed nutrient change in this section.

31.c. - 65.c. Feed code: For the first nutrient content change for each feed ingredient, enter the feed code. The same code as appeared for that feed ingredient in Section II must be entered. When you enter all of the changes for a given feed code sequentially, you do not have to enter the feed code for subsequent changes. Simply enter |0 0 0| which results in three less digits to enter on the terminal and proceed to the next line.

As indicated above, whenever you need to change to a number which is greater than 99 or less than .01, you must use lines 66-77. Except for the fact that there are more significant digits allowed, the changes in this section are similar to changes in the previous section.

66.a., 68.a., 70.a., 72.a., 74.a., 76.a. Feed nutrient code: Enter the feed nutrient code from the list that is contained with the discussion of feed nutrient codes above, on the Code Chart and on Table 1, 2 or 3.

66.b., 68.b., 70.b., 72.b., 74.b., 76.b. Feed code: Enter the feed code for the first change to be made for that feed. Again, if you enter the changes for a feed sequentially, you do not need to enter the feed code for subsequent changes.

67.a., 69.a., 71.a., 73.a., 75.a., 77.a. Number of digits: Enter the number of digits to the right of the decimal point entered in part b. As an example, 0.065 would be entered |3|0 0 0 0 0 0 6 5|. As another example, 300,000.0 would be entered |0|0 0 3 0 0 0 0 0|.

67.b., 69.b., 71.b., 73.b., 75.b., 77.b. Feed nutrient level: Enter the level of the nutrient to replace the value in Table 1, 2 or 3. Be certain that your digits are correct. You should see the additional comments in the section above. The major use for this section is to change the micronutrient content of mineral supplements since when using parts per million there will need to be more digits than are available above.

Section IV. Modification of Animal Nutrient Requirements

The Least-Cost Balanced Dairy Ration Program is developed with the assumption that the user is aware of and understands the nutrient requirements used in the model and that the user has the capability to change nutrient requirements if there is a sound nutritional basis for making a change. It is important to remember that the requirements in this program are based on research data and recommendations of nutritionists and that changes should be made only for good and easily-justified reasons. Whenever a requirement is changed that has both a maximum and a minimum, the user must be certain that the minimum is never larger than the maximum.

78.a. - 87.a. Cow requirement code: There are 30 nutritional changes that can be made in the program. The user indicates which of these 30 he or she wishes to change by entering a cow requirement code. The cow requirement codes are listed with a brief description on the Code Chart accompanying the program. The listing below provides more detail concerning what is to be changed and unit of measure of the nutrient.

Cow Requirement Code	Nutrient Requirement	Unit
01	Maximum dry matter intake	pounds
02	Minimum dry matter intake	pounds
03	Minimum adjusted crude protein	pounds
04	Maximum non-protein nitrogen	pounds
05	Maximum NPN in concentrate	percent of concentrate dry matter
06	Maximum protein solubility for inclusion of urea	percent of protein
07	Minimum adjusted acid detergent fiber	percent of dry matter
08	Minimum net energy	Mcal
09	Maximum daily body weight loss from negative energy balance	pounds/day
10	Minimum calcium	grams
11	Minimum phosphorus	grams
12	Maximum phosphorus	grams

Cow Requirement Code	Nutrient Requirement	Unit
13	Minimum calcium:phosphorus ratio	__ to 1.0
14	Maximum calcium:phosphorus ratio	__ to 1.0
15	Minimum magnesium	percent of dry matter
16	Maximum magnesium	percent of dry matter
17	Minimum potassium	percent of dry matter
18	Minimum sodium	percent of dry matter
19	Maximum sodium	percent of dry matter
20	Minimum chloride	percent of dry matter
21	Minimum sulfur	percent of dry matter
22	Maximum sulfur	percent of dry matter
23	Maximum fat	percent of dry matter
24	Minimum iron	parts per million
25	Minimum zinc	parts per million
26	Minimum copper	parts per million
27	Maximum copper	parts per million
28	Minimum manganese	parts per million
29	Minimum supplemental vitamin A	thousands of international units
30	Minimum supplemental vitamin D	thousands of international units

78.b. - 87.b. Scaler or absolute nutrient requirement: For each change that is entered, the user has a choice of whether to enter that change simply as a scaler adjuster, e.g., a 5 percent increase would be 1.05 or to enter the new actual level that is desired to be the minimum or maximum for that nutrient (e.g., 40 lbs. of dry matter). If a scaler change is to be entered, a "1" should be indicated in input b. If the absolute level of the requirement is to be entered, a "2" should be entered.

78.c. - 87.c.: The following discussion is intended to provide a complete specification of the nutrient requirements in this program and a discussion of any additional information that should be helpful to facilitate changes in nutritional requirements.

As was indicated in input line 03, the user has the option to utilize this program to balance least-cost balanced rations for first and second lactation heifers requiring nutrients for growth as well as maintenance and milk production. The growth requirement is included by increasing the maintenance requirement by 20 percent for first lactation animals and by 10 percent for second lactation animals. This growth requirement is only required in the calculations for those nutrients for which an actual level is required and not for those nutrients that are specified as a percent of dry matter. The inclusion of the growth requirement will be indicated in the requirement equations by the presence of the variable, XMNT. This variable is equal to 1.2 for first lactation animals, 1.1 for second lactation animals and 1.0 for mature cows. The variable is simply multiplied by the maintenance requirement in those equations in which it is included.

01. Maximum Dry Matter Intake (pounds)

Lactating Cows: 1.85 * BW + .305 * FCMLF - B * WAT

Dry Cows: 2.00 * BW

BW = body weight in 100 pounds

FCMLF = fat corrected milk in pounds adjusted for lead factor

WAT = pounds of water in the feed formulated in excess of 30 percent of the total as fed feed consumed by the cow

B = Amount dry matter intake is depressed per pound of water above 30 percent
= 20/(2 * DMAX - DMAX/.7) * .01 * BW

DMAX = Maximum dry matter intake excluding moisture depressant term.

The constraint on maximum dry matter intake is a critical part of the least-cost balanced dairy ration program and one for which there are significant herd to herd variations. If accurate dry matter intake data can be obtained for the cows for which the ration is being balanced, it should be used and would be a great asset in tailoring the ration to the user's herd. This is particularly relevant where a group of animals is fed a total mixed ration and a good handle can be obtained on the dry matter intake.

The requirement itself is handled somewhat differently depending on whether a scaler or absolute change is indicated. When a scaler change is indicated, all requirements are multiplied by that scaler. That means that the actual requirement independent of the depressors is multiplied by the scaler and the coefficients on the depressor term in the equation are multiplied by the scaler. For example, if the dry matter intake were decreased by 5 percent, the requirement obtained by multiplying by the body weight and the fat corrected milk for which the ration is being balanced would be multiplied by .95 and the coefficient on the terms of the equation for moisture depression would be multiplied by .95. Whenever an absolute level is entered for dry matter intake that number is entered as the maximum dry matter intake and the depressor is taken from the equation. As an example, if you indicate that the dry matter intake for this group of cows is 42 lbs., the maximum dry matter intake will be 42 lbs. and that will not be depressed based upon the moisture content of the ration. Whenever an absolute dry matter intake is indicated, the depressors are also removed from the minimum dry matter intake equation.

02. Minimum Dry Matter Intake (pounds)

Lactating Cows: .9 * Maximum Dry Matter Intake for Total Mixed Ration formulation. For Conventional feeding programs, Minimum Dry Matter Intake is 0.0.

Dry Cows: .5 * Maximum Dry Matter Intake for Total Mixed Ration formulation. For Conventional feeding programs, Minimum Dry Matter Intake is 0.0.

Minimum dry matter intake is felt to be required for total mixed rations because of the assumption of ad libitum feeding whereby if a ration is developed where the intake is not going to be very close to maximum, the animals will eat more than their requirements. Again, the change is different depending upon whether you enter a scaler or an absolute change. If it is a scaler adjustment, the requirement based on body weight and milk are adjusted as is the coefficient on the depressor. If you enter an absolute level for the minimum dry matter intake, that level is utilized and the depressor does not affect the level.

03. Minimum Adjusted Crude Protein (pounds)

Lactating Cows: XMNT * [0.32 + .06 * BW] + .087 * FCMLF

Dry Cows: XMNT * [0.56 + 0.11 * BW]

XMNT = Increase in maintenance to include growth

= 1.2 for first lactation cows

= 1.1 for second lactation cows

= 1.0 for mature cows

The minimum protein requirement currently in the program is adjusted crude protein with the unit being pounds. The percentage of the protein that is soluble is calculated and a warning message is printed when this percentage is larger than is currently felt to be desirable. It is hoped that soluble and insoluble protein requirements can be incorporated into the program in the not too distant future. The exception to soluble protein only being calculated is when urea is included as a feed ingredient. At that time, the recommended maximum soluble protein is included as a constraint and can only be violated by taking urea out of the list of feed ingredients (see discussion below).

04. Maximum Non-Protein Nitrogen (pounds)

Lactating Cows: 0.5

Dry Cows: 0.2

05. Maximum Non-Protein Nitrogen in Concentrate (Conventional feeding only)

Lactating Cows: 3 percent of concentrate dry matter

Dry Cows: 3 percent of concentrate dry matter

In addition to the non-protein nitrogen restriction in the previous code, non-protein nitrogen is limited to 3 percent of the concentrate mix in conventional feeding formulations.

06. Maximum Protein Solubility When Urea is Included as a Feed Ingredient

Lactating and Dry Cows: 25 + .4 * [100 - FCMLF]

with a maximum of 49 percent of protein and a minimum of 25 percent

Because of the importance of the solubility of protein when urea is considered as a feed ingredient, soluble protein becomes a constraint whenever urea is added. The constraint is based upon the level of milk production with greater percentages protein solubility allowed as production declines. In the program, the percent of the protein which can be soluble protein as determined above is multiplied by the total protein to give a maximum pounds of soluble protein.

Because the requirement is a sliding scale, a scaler change means nothing and only an absolute change is allowed. That absolute change then is the maximum percent solubility and is not adjusted based on production since the production is already entered. Outputs with urea considered as a feed ingredient should be considered very carefully. If urea does not enter into the solution, the total ration may have been affected by the constraint on maximum protein solubility. If urea does not enter and the maximum soluble protein enters as a restriction which is constraining, you should rerun the program via an adjusted analysis without urea and then utilize the two outputs to determine what feeding regime you are going to use because the protein solubility constraint may have altered your feeding program more than an increase in protein solubility would cost you.

07. Minimum Adjusted Acid Detergent Fiber

Lactating and Dry Cows: 15 percent of dry matter

Adjusted acid detergent fiber is the acid detergent fiber values for roughages and a reduced value for the concentrates because the fiber is not very efficient or useful to the rumen after it is ground in a concentrate mix. Adjustments in this restriction should be made with care but in certain instances would be possible.

08. Minimum Net Energy (Mcal)

Lactating Cows: XMNT * [2.1 + 0.58 * BW] + 0.34 * FCMLF

Dry Cows: XMNT * [2.77 * 0.74 * BW]

XMNT = Increase in maintenance to include growth

= 1.2 for first lactation cows

= 1.1 for second lactation cows

= 1.0 for mature cows

This energy requirement is derived from The National Research Council and other data and should almost never be modified. When

attempting to alter the energy balance in the ration, you should change the sources of the energy rather than the requirements. Changes in the source can be introduced through altering the potential amount of negative energy balance or through bringing in higher energy feed ingredients.

09. Maximum Daily Body Weight Loss from Negative Energy Balance

Lactating Cows: Early Lactation = 1 lb.
Mid or Late Lactation = 0

Dry Cows: 0

As described in input line 03, for early lactation cows and groups of cows, the possibility of including the biological fact of negative energy balance or utilizing body tissue to meet the energy requirements is incorporated into the program. The maximum amount that can be used is 1 pound of body tissue per cow per day. This is a relatively conservative maximum and under certain situations where balancing for high-producing cows at the very peak of lactation this maximum could be increased. Since the maximum is 1 pound, the absolute and scaler changes give identical results.

10. Minimum Calcium (grams)

Lactating Cows: XMNT * [4.3 + 1.3 * BW] + 1.7 * FCMLF

Dry Cows: XMNT * [5.1 + 3.0 * BW]

11. Minimum Phosphorus (grams)

Lactating Cows: XMNT * [3.6 + 1.0 * BW] + 0.95 * FCMLF

Dry Cows: XMNT * [3.5 + 1.9 * BW]

12. Maximum Phosphorus (grams)

Lactating and Dry Cows: 1.5 * Minimum Phosphorus Requirement as calculated above

13. Minimum Calcium:Phosphorus Ratio

Lactating and Dry Cows: 1.5 (Calcium content in grams has to be at least 1.5 * Phosphorus content in grams)

When making a change in the minimum calcium to phosphorus ratio, enter either a scaler adjustment which would then multiply the scaler amount entered times 1.5 or an absolute level which would simply be the replacement for 1.5 calcium to 1.0 phosphorus.

14. Maximum Calcium:Phosphorus Ratio

Lactating Cows: 3.0 (Calcium content in grams can be no greater than 3 * Phosphorus content in grams)

Dry Cows: 2.5

Changes are made by either multiplying the scaler times the 3.0 or 2.5 or by replacing the 3.0 or 2.5 by the absolute number entered in this input line.

15. Minimum Magnesium (Percent of Dry Matter)

Lactating Cows: 0.22% of ration dry matter

Dry Cows: 0.2% of ration dry matter

16. Maximum Magnesium (Percent of Dry Matter)

Lactating Cows: 0.50% of ration dry matter

Dry Cows: 0.4% of ration dry matter

17. Minimum Potassium (Percent of Dry Matter)

Lactating and Dry Cows: 0.8% of ration dry matter

18. Minimum Sodium (Percent of Dry Matter)

Lactating Cows: 0.18% of ration dry matter

Dry Cows: 0.1% of ration dry matter

19. Maximum Sodium (Percent of Dry Matter)

Lactating Cows: 0.4% of ration dry matter

Dry Cows: 0.2% of ration dry matter

20. Minimum Chloride (Percent of Dry Matter)

Lactating Cows: .25% of ration dry matter

Dry Cows: 0.1% of ration dry matter

21. Minimum Sulfur (Percent of Dry Matter)

Lactating Cows: 0.20% of ration dry matter

Dry Cows: 0.17% of ration dry matter

22. Maximum Sulfur (Percent of Dry Matter)

Lactating Cows and Dry Cows: 0.30% of ration dry matter

23. Maximum Fat (Percent of Dry Matter)

Lactating and Dry Cows: 6.00% of ration dry matter

24. Minimum Iron (optional)

Lactating and Dry Cows: 100 parts per million in the ration dry matter (.01%)

Iron, zinc, copper and manganese are routinely calculated and the amount in the ration printed on the output. They also can be included as requirements simply by entering a nutritional change for that element. If you wish to accept the 100 parts per million, you simply enter the 100 parts per million as an absolute amount or enter a 1.00 scaler change. The 100 parts per million is stored in the program so scaler changes are allowed.

25. Minimum Zinc (optional)

Lactating and Dry Cows: 40 parts per million in ration dry matter (.004%)

Iron, zinc, copper and manganese are routinely calculated and the amount in the ration printed on the output. They also can be included as requirements simply by entering a nutritional change for that element. If you wish to accept the 40 parts per million, you simply enter the 40 parts per million as an absolute amount or enter a 1.00 scaler change. The 40 parts per million is stored in the program so scaler changes are allowed.

26. Minimum Copper (optional)

Lactating and Dry Cows: 10 parts per million in ration dry matter (.001%)

Iron, zinc, copper and manganese are routinely calculated and the amount in the ration printed on the output. They also can be included as requirements simply by entering a nutritional change for that element. If you wish to accept the 10 parts per million, you simply enter the 10 parts per million as an absolute amount or enter a 1.00 scaler change. The 10 parts per million is stored in the program so scaler changes are allowed.

27. Maximum Copper (optional)

Lactating and Dry Cows: 80 parts per million in ration dry matter (.008%)

Iron, zinc, copper and manganese are routinely calculated and the amount in the ration printed on the output. They also can be included as requirements simply by entering a nutritional change for that element. If you wish to accept the 80 parts per million, you simply enter the 80 parts per million as an absolute amount or enter a 1.00 scaler change. The 80 parts per million is stored in the program so scaler changes are allowed.

28. Minimum Manganese (optional)

Lactating and Dry Cows: 45 parts per million in ration dry matter (.0045%)

Iron, zinc, copper and manganese are routinely calculated and the amount in the ration printed on the output. They also can be included as requirements simply by entering a nutritional change for that element. If you wish to accept the 45 parts per million, you simply enter the 45 parts per million as an absolute amount or enter a 1.00 scaler change. The 45 parts per million is stored in the program so scaler changes are allowed.

29. Minimum Supplemental Vitamin A (thousands international units)

Lactating and Dry Cows: 3.3 * BW

The unit of measure for vitamins is thousands of international units so the minimum is 3.3 times body weight. The minimum is from the supplement. Consequently, in order to run this program you have to enter either a vitamin supplement or a mineral supplement that contains adequate vitamins. If you do not have the information to solve for vitamins and are determined not to, you could simply set the requirement at 0 or scale it to 0 by using a 0 scaler.

30. Minimum Supplemental Vitamin D (thousands international units)

Lactating and Dry Cows: 0.5 * BW

The unit of measure for vitamins is thousands of international units so the minimum is 0.5 times body weight. The minimum is from the supplement. Consequently, in order to run this program you have to enter either a vitamin supplement or a mineral supplement that contains adequate vitamins. If you do not have the information to solve for vitamins and are determined not to, you could simply set the requirement at 0 or scale it to 0 by using a 0 scaler.

Section V. Restrictions on Levels of Feeds to be Included in Balanced Ration

Because balanced ration must reflect the quantities of homegrown feeds available, the quantities of feed ingredients that can be purchased and by nutritional consideration and preferences of the farm manager; some feed ingredients must be limited or minimum amounts introduced into the balanced ration. It is highly desirable that this section not be used in the first analysis. Since this program is being used as an educational tool, the user should be interested in the change in the ration's composition and cost as the restrictions due to on-farm supplies and nutritional desires are incorporated.

88.a. - 97.a. Feed code: The feed code of the feed ingredient to be changed is entered. The feed ingredient and consequently the feed code must have been specified in Section II where the individual feed ingredients are entered.

88.b. - 97.b. Max., exact, or min.: This is where the type of restriction being placed on the feed ingredients is entered. It can be either a maximum, whereby the code is "1"; an exact amount, whereby the code is "2"; or a minimum amount, whereby the code is "3". The use of the exact code should be fairly unusual since normally you either are constrained by a minimum amount due to having to use up on-farm storage to a maximum amount because you have a shortage of on-farm storage or you may have a minimum and a maximum.

88.c. - 97.c. Level type: An attempt has been made to incorporate all of the possible types of constraints that you would be interested in entering. The constraints can be entered either on an as-fed basis or on a dry matter basis. In all cases the percentage is of the

amount fed not of the amount consumed. As indicated on the Code Chart and in the listing below there are 10 level type codes.

0 = lbs./head/day; 100% dry matter basis
1 = lbs./head/day; as fed
2 = % of total ration; 100% dry matter basis
3 = % of total ration; as fed
4 = % of premix; 100% dry matter basis
5 = % of premix; as fed
6 = % of concentrate OR complete feed; 100% dry matter basis
7 = % of concentrate OR complete feed; as fed
8 = % of feed in roughage; 100% dry matter basis
9 = % of feed in roughage; as fed

Level type 0 and 1 limit the amount fed to the specified number of pounds per head per day either on a dry matter basis or on an as-fed basis. Level code 1 would be used most commonly when the restriction is a certain amount of feed, usually a roughage, that is in storage. Level type codes 2 and 3 are for placing restrictions on individual feed ingredients as a percentage of the total ration either on a dry matter or an as-fed basis. Level type codes 4 and 5 are for placing restrictions on feed ingredients as a percentage of all feed ingredients that are included in the premix, again on either a dry matter or an as-fed basis. Level type codes 6 and 7 are as a percent of the concentrate or complete feed. Recall that when balancing for a total mixed ration, the complete feed deviates from the total ration when a dry hay is fed separately. If a percentage of the complete feed is entered, it is a percentage of the ingredients that are in the complete feed excluding the dry hay. Level type codes 8 and 9 are a percentage that feed must be of the roughage mix. In conventional feeding, this entry is used to determine that percentage of all feeds that are coded as roughages. In a total mixed ration this entry can be made for any feed that is coded from 101 to 199 and it is utilized by incorporating this feed as the indicated percentage of all feeds that have feed codes between 101 and 199.

88.d. - 97.d. Level amount: This is the actual restriction that is being entered. The actual form of this restriction will depend upon the code used as indicated below and also on the Code Chart.

If using level type "0", enter desired lbs. dry matter.
If using level type "1", enter desired lbs. as fed.
If using level type "2", "4", "6", or "8", enter desired percentage level (dry matter basis).
If using level type "3", "5", "7", "9", enter desired percentage level (as-fed basis).

Using level type code 0 or 1 simply enter the pounds of dry matter or pounds of the ingredient as fed that you are using as a restriction. If you are entering a percentage which would be all the other codes, 2 through 9, simply enter the desired percentage. For those in which you are working with dry matter (2, 4, 6, 8) it will be a percentage of the total dry matter and for those in which you are working with as fed (3, 5, 7, 9) it will simply be the percentage of the total amount as fed.

Section VI. Additional Feed Information

This section is used to indicate additional information needed to balance the ration and information needed to tailor the output to the user's requirements.

98.a. Premix batch size (cwt.): If a premix is not considered, enter "00" or any other number. If a premix is being considered, two options are available. One is to specify the exact size (quantity) of the premix batch desired. To use this option enter the premix batch size in hundredweight. The other option is to have the premix tailored to meet the needs of preparing a concentrate batch or complete feed. To use this option enter "99" and then all quantities of the ingredients included in the premix are that quantity which adds to the total amount of the premix required in the concentrate or complete feed.

98.b. Premix costs ($/cwt.): Enter the costs of obtaining the premix other than the costs of the ingredients. These costs include mixing costs for the premix and hauling charges. Costs that are directly attributable to the concentrate mix or complete feed should not be entered here as they should be included as concentrate mixing costs. If a premix is not being considered, enter "00" or any other number.

98.c. Concentrate or Total Mixed Ration batch size: If you are using a conventional feeding formulation, simply enter the size desired of the concentrate batch. If you do not have a set size requirement such as 1 ton, it is best to enter a fairly large number, perhaps one which is divisible by 10, such as 100, which is for a 10,000 pound batch size. If you are balancing a total mixed ration, you have two options. You can simply specify a fixed batch size as you would for the concentrate or you can enter "999" in which case the size of the ration is that size which it is estimated would be required to feed a group of cows the size of which you specified under number of cows for one feeding given the number of feedings you specified in input 02.

98.d. Concentrate cost ($/cwt.): Again, this is the non-feed cost of obtaining the concentrate including the premix and should include any mixing charges or hauling charges incurred. If those costs are not for the total concentrate, but are for individual ingredients, they should be added to the price of those individual ingredients.

99.a. Percent feeding losses of concentrate or complete feed: When using a conventional feeding formulation this percentage feeding loss is attributed to all feed ingredients coded to be included in the premix and the concentrate. When balancing a total mixed ration, they are attributed to the ingredients included in the premix and the complete feed. If you wish to consider a feeding loss other than that incorporated here for one or more individual feed ingredients, that feeding loss will be entered in Section III, Modification of Feed Nutrient Composition.

99.b. Percent feeding loss of roughages: The percent feeding loss of roughages is used for all roughages included in a conventional feeding formulation and for any dry hay fed separate from the complete feed in a total mixed ration. Again, if you wish to incorporate different feeding losses for individual ingredients, you have to make the change in Section III. This is certainly a possibility for roughages. There may be a smaller loss for corn silage and hay crop silage than for dry hay. You might then enter the loss for corn silage and hay crop silage as the percentage feeding loss of the roughages and then make a modification for the dry hay to incorporate the higher feeding loss.

99.c. Feed analysis in adjusted analyses: One section of the output which takes time to print is the summary of the feed analysis of each of the individual feed ingredients. This output is always printed in the first analysis. If a "1" is entered here, it is printed in every analysis. If a "0" is entered here, the feed analysis summary is not printed in adjusted analyses. In many instances you will enter a "0" here except that when you come to what you think is the last analysis, you may want to change it back to a "1" to obtain the feed analysis in the output which the farm manager will be using.

99.d. Option to stop output: In some instances, you may determine simply by looking at the feeds included in the output that this output is not what you expect it to be or is no change from the previous run. In that case, you might not want to continue the output. If you want the option of being asked about half way through the output, "CONTINUE?", enter a "1" here. If you do not want this option to stop, enter "0" and there will be no interruption in the printing.

99.e. State code: Enter the state code for New York that is "31".

Adjusted Analyses

Most feeding and ration formulation decisions require one or more adjusted analyses. Adjusted analyses are made by entering new values for each input line in which a change is made. If any part of a line is changed, the entire line must be entered in the adjusted analysis. The line numbers of all lines to be changed in the next analysis are then entered in numerical order.

For example, if the dairyman had a conventional ration formulated for milking cows (1300 lbs. body weight, 60 lbs. milk/day and 3.5% test) in Analysis 1, the input value for line 01 would be |2|1 3.0|0 6 0|3.5|. Then, if he or she wished to formulate the conventional ration for dry cows (1400 lbs. body weight) in an adjusted analysis, the entry for line 01 in Analysis 2 would be |6|1 4.0|0 0 0|0.0|.

It is important to remember that each adjusted analysis builds on the previous one. Thus, if the dairyman in the above example wished to determine the effects of limiting corn silage for the MILKING cows in another adjusted

analysis, he or she would have to change line 01 back to input for milking cows as well as placing limits on corn silage in Section V of the input form. If this were not done, the second adjusted analysis would be for limited corn silage feeding to DRY cows.

Emphasis: As few restrictions as possible should be placed on the feeding of roughages when analyzing a least-cost balanced dairy ration. Of course, when formulating a ration, it is important to anticipate any problems the farmer may have in utilizing it. Thus, if a problem is foreseen in the farmer's utilization of the least-cost ration printed, it may be necessary to run an adjusted analysis with appropriate restrictions on roughage or other feeds.

OUTPUT

There are three types of output that can be obtained. The first is an error message which means that there is a detectable error in the input. In this case the program never tried to solve for the least-cost ration. The second is that the program ran but was unable to find a balanced ration using the requirements and feed ingredients entered. In this case you will be given an output which helps determine what requirements were not able to be met. The third possible output is a least-cost balanced ration.[1/] Each of these three types of output is discussed below.

Error Messages Related to Erroneous Input Data

If an inconsistency is found in the data input for analysis, an error message is printed out and the analysis is stopped. All error messages are the same form. The message will state, ERROR AT INPUT VALUE X, where X is the number of the input line where the error occurs. The following list of error messages for each line or group of lines from the input should be consulted when an error message is received.

[1/] A fourth possibility is that the program was not able to solve at all. It is hoped that this would be very rare. In this case there are three possibilities. One is that an error was detected before the program went to solution. In this case an error was detected in the linear programming routine before it was solved. It is hoped that this would never occur but if it does, there will be a message that says the following, "Program Problem Error in LP Matrix. Please Contact Robert A. Milligan, Cornell University, 607-256-4579". If you should receive this message, do as directed, but you also may want to look at the input to see if you have put in something that you did not intend to put in; if so, correct it and try again, but do call the number indicated because even with a funny input the error messages and checks should prevent this ever happening and we want to help other users keep from getting in this situation. The second possibility is that the program might, again very unlikely, reach an unbounded solution or not be able to find a solution within the number of iterations that we allow. In this case you would get a message which would say, "Program Problem: Error in Solution. Please Contact Robert A. Milligan, Cornell University, 607-256-4579". Again, please contact the author. Again, you may want to look at your input to see if there might be something that you did not intend and if you do, resolve. The third possibility is that there would be an infeasible solution even including the nutrients put in to prevent an infeasible solution and gives you information on where the problems lie. In this case you have probably made an error in the input, you should check it. Again, if you cannot find this problem, do not hesitate to call the author.

Error at Input Line No.	Description
1	Part a must contain a ration type code which represents a currently working ration formulation procedure. Part b must be in the range of 800 to 1800 lbs. (8-18 cwt.). Part c cannot be greater than 130. Part d cannot be less than 2.0 or greater than 6.0.
2	An error message results if a lead factor other than 0 or 1 is entered to reinforce the user that lead factor is not a part of the conventional feeding formulation. For total mixed ration formulations the lead factor cannot be outside of the range 1.0 to 1.40. For total mixed rations, part b cannot be 0 if the size of the complete mix batch is to be tailored to the number of cows in the group (this error will be indicated by an error message in both line 02 and 98). For total mixed ration formulations, part c cannot be 0 when the total mixed ration batch is to be tailored to the group of cows (again, input 02 and 98 will both be indicated as an error).
3	Part a cannot be greater than 1 for milking cows. Part a cannot be non-zero for dry cows. Part b and part c cannot both be non-zero.
4 through 30	Part a must be the feed code of either (1) a feed ingredient included in the feed table (see Table 1), (2) a number set aside to enter the specification for a feed of your choice (see Table 1), or (3) a premix, concentrate or complete feed formulated in the previous analysis (adjusted analyses only). Part a cannot be 200, 300 or 400 in the first analysis. Part a cannot be 200 for a conventional feeding formulation. Part a cannot be 300 for a total mixed ration formulation. Part b cannot be greater than $200 a ton for feed codes 101 through 199. Part b cannot be greater than $400 per ton or $20 per hundredweight for feed codes 200 through 399. Part c cannot be 0 or greater than 3. Part d cannot be greater than 5. For total mixed rations, only dry hays can be coded as roughages.
31 through 65	Part a cannot be 0, 6 or greater than 31. Part c cannot be a feed code that is not included in the list of feed ingredients in part 2 (lines 4 through 30).

Error at Input Line No.	Description
65	Several problems result in an error at this line number. It can be the same problems described in 31 through 65 above for either line 65 or for any of the input lines 03 through 99 used in Program 64. If input line 65 is used to call for expanded data, error messages will result unless Program 64 Form 0 was used to generate the specified data file. The file security code must be correct. If the computer has problems with locating and reading the data file, this error message is generated. In Program 64, the input must specify Program 31 and the correct form.
66,68,70,72,74, 76	Part a and b errors are the same as for part a and c errors in 31 through 65.
78 through 87	Part a cannot be 0 or greater than 30. Part b must be 1 or 2. Part c cannot be greater than 2.00 when part b is equal to 1. When part b is equal to 2, part c has some restrictions on the absolute level of nutrients. These are designed to catch errors in the entries relative to shifting of the decimal point rather than to influence the size of the nutritional change that can be made. The restrictions are: when part a is 01, part c cannot be less than 10.00; when part a is 03, part c cannot be less than 1.00; if part a is 06, 07, 08, 10, 11 or 12, part c cannot be less than 1.00; if part a is 15, part c cannot be greater than 1.00; if part a is 17, part c cannot be greater than 2.00; if part a is 18, 20 or 21, part c cannot be greater than 1.00; if part a is 23 through 28, part c cannot be less than 1.00. when a is 01, 03-14, 16, 19, 22, 23, or 27, c cannot be 0.00.
78	In addition to the possible errors indicated above, error at line 78 could indicate that the minimum dry matter intake is now greater than the maximum dry matter intake.

Error at Input Line No.	Description
79	In addition to the errors indicated above, input 79 is used to indicate that the minimum calcium to phosphorus ratio is greater than the maximum calcium to phosphorus ratio.
80	In addition to the possible errors indicated above, input 80 is used to indicate that the minimum sodium is now greater than the maximum sodium.
81	In addition to the errors indicated above, 81 is used to indicate that the minimum sulfur is now greater than the maximum sulfur.
82	In addition to the errors indicated above, 82 is used to indicate that the minimum magnesium is now greater than the maximum magnesium.
83	In addition to the errors indicated above, 83 is used to indicate that the minimum phosphorus is now greater than the maximum phosphorus.
84	In addition to the errors indicated above, 84 is used to indicate that the minimum copper is now greater than the maximum copper.
88 through 97	Part a cannot be a feed code that is not included in the list of feed ingredients in Section II (input lines 04-30). Part b cannot be 0 or greater than 3. If part c is 4 or 5, the feed ingredient must have a how fed code of 1 or 4. If part c is 6 or 7, the feed ingredient cannot have a how fed code of 0 or 3. If part c is 8 or 9, the feed ingredient must have a how fed code of 0 or 3.
98	For conventional feeding formulations, part c, batch size, cannot be 999 since that is used to indicate that a total mixed ration has been tailored to the group. For total mixed rations, when part c is 999, parts b and c in input 02 must be non-zero.

If an error message is received, the error can be corrected during the next adjusted analysis.

No Balanced Ration Possible

When formulating rations for high-producing cows or in situations where no feed ingredient is high in a required nutrient, it is possible that no combination of the feed ingredients can meet all of the nutrient requirements. In these situations an output with the following message occurs:

INFEASIBLE SOLUTION--ONE OR MORE NUTRIENT REQUIREMENTS CANNOT BE MET WITH THE FEED INGREDIENTS AND RESTRICTIONS ENTERED.

THE NUTRIENT RESTRICTION(S) WHICH COULD NOT BE MET IS(ARE):

This message is followed by a listing of the nutrient or nutrient requirements that are lacking. The requirements that can generate such a situation and thus the potential list of messages are:

MINIMUM ADJ CRUDE PROTEIN
MINIMUM ENERGY
MINIMUM CALCIUM
MAXIMUM CALCIUM
MINIMUM PHOSPHORUS
MAXIMUM PHOSPHORUS
MINIMUM SODIUM
MAXIMUM SODIUM
MINIMUM MAGNESIUM
MAXIMUM MAGNESIUM
MINIMUM SULFUR
MAXIMUM SULFUR
MINIMUM POTASSIUM
MINIMUM CHLORIDE
MAXIMUM FAT
MINIMUM VITAMIN A
MINIMUM VITAMIN D
MINIMUM IRON
MINIMUM ZINC
MINIMUM COPPER
MAXIMUM COPPER
MINIMUM MANGANESE

Whenever any of these messages except MINIMUM ENERGY is received, the reason is almost always because no feed ingredient or combination of feed ingredients is entered that is a good source of that nutrient. Entering such a feed ingredient or ingredients and running an adjusted analysis nearly always results in a balanced ration.

When the requirement that cannot be met is MINIMUM ENERGY, it usually means that problems are being encountered formulating a balanced ration for a high-producing cow or group of cows; however, you should first check to be certain feed ingredients are included to easily meet all other requirements since deficiency in other nutrients can contribute to the inability to meet the energy requirement. Once you are certain the list of feed ingredients is complete, you should carefully

evaluate your input in light of the situation for which you are formulating. The following questions may be of assistance:

a) Are roughage and concentrate ingredients with high energy densities included and not unduly restricted by maximums?

b) Are minimum or exact restrictions on low energy ingredients included? For instance, the high producers may not be the cows to feed low quality hay or oats.

c) For a total mixed ration formulation, is the lead factor too high?

d) Is the average body weight correct? In many situations the high producing cows weigh more than the average for the herd.

e) Is the butterfat test correct? Many times high producing cows have lower butterfat content.

f) Is the negative energy balance option being used? Early lactation cows typically use body tissue to sustain milk production.

g) Are the cows using more body tissue than the one pound per cow per day maximum allowed? Many high-producing cows exceed this level at peak production.

After the above message the PRODUCTION INFORMATION and FEED ANALYSIS sections are printed to help in checking to be certain that the infeasible solution did not result from an input error.

Output of Formulated Ration

The desired outcome of each analysis is a least-cost balanced ration formulated for the specific animal and feed characteristics. As indicated earlier, one of the major differences between Form 4 and the earlier version of least-cost balanced rations, Form 2, is an expanded output. This output is contained in several sections each of which is described below. At the top of each output is the analysis number, an indication that the program was developed by the Departments of Agricultural Economics and Animal Science at Cornell University, the name of the farm manager for which the ration is formulated, and the date of ration formulation.

Production Information

The format for the information included in this section is different for each of the ration types. The following information is included when appropriate: average milk production, lead factor, the pounds of milk for which the ration is balanced (milk production x lead factor for lactating animals fed a total mixed ration); fat test; body weight; number of cows in the group; number of feedings; whether the ration is formulated for

mature cows, first lactation heifers or second lactation heifers; and number of times maintenance for which the ration is balanced. The number of times maintenance the ration is balanced for is the total energy requirement for maintenance, growth (if any) and milk production divided by the energy required for maintenance. This value is used in calculating the available energy of the feeds to be fed.

Feed Analysis

This section is included to provide a summary of the nutrient content of the feed ingredients entered. The output can be used both to detect errors and as a reference when using the analysis in feeding the dairy cows on the farm. This section is an optional output in all but the first analysis (input 99.d.). The format of this section is illustrated below:

FEED ANALYSIS

FEED INGREDIENT	DRY MATTER %	ADJ CR PROTEIN % D.M.	ADJ A D F % D.M.	NET ENERGY MCAL/LB.	CAL-CIUM % D.M.	PHOS-PHORUS % D.M.
130 MMG HAY	88.0	12.5	40.0	0.52	0.71	0.20
121 MML HCS	40.0	14.5	32.0	0.55	1.10	0.26
151 CORN SIL	33.0	3.5	28.0	0.75	0.22	0.20
217 GSHCORN	89.0	10.0	1.4	1.01	0.02	0.30
244 OATS	89.0	12.9	7.0	0.86	0.07	0.39
257 SOY-48	90.0	53.9	2.0	0.92	0.36	0.75
402 DICAL	99.0	0.0	0.0	0.0	21.00	18.00
401 CALSULF	99.0	0.0	0.0	0.0	22.00	0.0
403 LIMESTON	99.0	0.0	0.0	0.0	37.00	0.0
404 MAG OX	99.0	0.0	0.0	0.0	0.0	0.0
410 TMS	99.0	0.0	0.0	0.0	0.0	0.0
419 HICA MIN	99.0	0.0	0.0	0.0	21.00	12.00

The feed content of each of the feeds is in the indicated units with net energy values at maintenance.

Ration Costs/Cow/Day

Information concerning the ration cost is provided in four pieces of information. The first is the total feed cost which is the total cost of all feed ingredients included in the ration calculated by multiplying the feed ingredient cost per unit by the quantity to be fed. The second piece of information is the total ration cost which is the total cost of feeding the ration. This cost includes both the total feed cost just described and any grinding, mixing or transportation costs entered in input line 98. This cost is equivalent to the total cost calculated in Program 31, Forms 1 and 2.

In addition, the total feed cost is divided into purchased feed cost and the value of home grown feeds. Purchased feed cost is the cost of the ingredients that must be purchased which were indicated by how-fed codes 4, 5, and 6. The value of home grown feed is the value of or opportunity cost of the ingredients grown on the farm that are fed and includes the entered costs of all ingredients with how-fed codes 0, 1 and 2.

Quantity of Each Feed Ingredient in Ration

Although the heading is slightly different depending upon whether the ration is formulated as a total mixed ration or a conventional feeding ration, there are four potential types of output in this section. The first is a premix, the second is a concentrate or complete feed, the third is the roughages or dry hays fed separate from the complete feed and the fourth is the information on premix, concentrate and/or complete feed.

The format of the premix is as follows:

QUANTITY OF EACH FEED INGREDIENT IN RATION

PRE-MIX

FEED INGREDIENT	POUNDS IN PRE-MIX	PERCENT OF PRE-MIX
402 DICAL	3.43	2.39
401 CALSULF	8.34	5.72
403 LIMESTON	4.35	29.42
404 MAG OX	0.56	3.42
410 TMS	3.70	22.44
419 MICA MIN	5.96	36.19
TOTAL	16.49	

Three items of information included on each feed ingredient that is to be included in the premix are: the feed number and name of the feed ingredient, the pounds to be included in the premix and the percentage of the premix. The pounds in the premix and the percent of the premix are calculated on an as-fed basis. The total pounds in the premix can either be the amount specified in input 98 or the amount to be included in the concentrate or complete feed.

The next potential portion of the ration fed is the concentrate for a conventional feed formulation or the complete feed for a total mixed ration formulation. The format of the two is very similar. The format for a total mixed ration formulation is illustrated below:

COMPLETE FEED

FEED INGREDIENT	POUNDS IN BATCH	AS FED LBS/COW	AS FED PERCENT OF CMPL FD	AS FED PERCENT OF RATION	DRY MATTER LBS/COW	DRY MATTER % OF RATION
PREMIX	16.5	0.82	1.04	0.98	0.82	2.02
151 CORN SIL	1235.1	61.75	78.11	73.47	20.38	50.54
217 GSHCORN	209.4	10.47	13.24	12.46	9.32	23.11
257 SOY-48	120.2	6.01	7.60	7.15	5.41	13.41
TOTAL	1581.2	79.06		94.05	35.92	89.09

The pounds to be included in the batch can be the pounds to be included in a batch size that was indicated in input line 98 or for a total mixed ration, the total pounds of each feed ingredient that should be fed to the group per feeding. As an example, in the above output, 1581 pounds of feed should be fed to the 40 cows in the group per feeding. The composition of that 1581 pounds should be: 16.5 pounds premix, 1235 pounds corn silage, 209 pounds ground shelled corn and 120 pounds soybean meal. Additional information concerning the concentrate or complete feed is also provided on both an as-fed and a dry matter basis. As-fed information includes the pounds fed per cow per day on an as-fed basis for each feed ingredient, the percent of the complete feed or concentrate and the percent of the total ration. Similarly, on a dry matter basis, the pounds of dry matter of each feed ingredient to be fed per cow and the percent of the total ration is indicated. Two numbers from the row labeled "Total" are particularly important. The as-fed pounds per cow is the pounds of concentrate or complete feed to feed per cow per day. In a conventional feed formulation, the percent of the total ration dry matter in the concentrate can be used to indicate the concentrate to roughage proportions in the total ration.

The third part of the output indicates the quantities to be fed of the feeds that are fed separately. In a conventional feed formulation, this is all of the roughages. In a total mixed ration situation, there may be no output for this section or there may be a dry hay fed separate from the complete feed. This section is illustrated by output from a conventional feed formulation.

CONCENTRATE

FEED INGREDIENT	POUNDS IN BATCH	AS FED LBS/COW	AS FED PERCENT OF CONC	AS FED PERCENT OF RATION	DRY MATTER LBS/COW	DRY MATTER % OF RATION
PREMIX	476.4	0.82	4.76	0.96	0.82	1.99
217 GSHCORN	6051.1	10.47	60.51	12.17	9.32	22.74
257 SOY-48	3472.5	6.01	34.72	6.98	5.41	13.20
TOTAL	10000.0	17.30		20.11	15.54	37.93

ROUGHAGES

130 MMG HAY	5.00	5.31	4.40	10.74
151 CORN SIL	63.73	74.07	21.03	51.33

For each of the ingredients to be fed separately, the pounds per cow and the percent of total ration on both an as-fed and a dry matter basis are indicated.

The final part of this section of output is the summary information on premix, concentrate and complete feed. The type of information available is indicated for the following conventional feed formulation which had both a premix and a concentrate.

PRE-MIX AND CONCENTRATE INFORMATION

FEED INGREDIENT	DRY MATTER %	ADJ CR PROTEIN % D.M.	ADJ R D F % D.M.	NET ENERGY MCAL/LB.	CAL-CIUM % D.M.	PHOS-PHORUS % D.M.
400 PREMIX	99.0	0.0	0.0	0.0	20.33	4.86
PRE-MIX PRICE= 15.81 PER CWT						
300 CONCENTR	89.3	24.7	1.5	0.93	1.20	0.70
CONCENTRATE PRICE= 9.59 PER CWT						

The information includes a summary of the content of the premix, concentrate or complete feed similar to that in the feed analysis above and the as-fed cost per hundredweight of the premix, concentrate or complete feed. When a dry hay is not fed separately from the complete feed, only the per hundredweight cost of the complete feed is included.

The complete nutritional composition for the premix and concentrate or complete feed is stored so that it can be used as a feed ingredient in the next adjusted analysis using the feed ingredient codes 400 for a premix, 300 for a concentrate and 200 for a total mixed ration. If you use the premix, concentrate or complete feed in the next analysis, you must eliminate those feeds which are contained in the premix, concentrate or complete feed in order to avoid small quantities of those feed ingredients entering the ration.1/

Nutrient Composition of Total Ration

This section provdes information concerning the nutrient composition of the ration or similarly the total nutrients that the animal would consume if the ration formulated above were fed and the dry matter intake were predicted correctly. The output of this section is illustrated below.

1/ For more information on the use of this option see pages 57 to 58.

NUTRIENT COMPOSITION OF TOTAL RATION

	NUTRIENT CONTENT		NUTRITIONAL CONSTRAINTS MINIMUM	MAXIMUM
DRY MATTER INTAKE	3.00 % BW	39.0 LBS	0.0 LBS	39.0 LBS
ADJ CRUDE PROTEIN	15.21 % DM	5.93 LBS	5.93 LBS	
NON-PROT NITROGEN	0.0 %PRO	0.0 LBS		0.50 LBS
ADJUSTED A D F	7.42 LBS	19.04 % DM	15.00 % DM	
NET ENERGY(NEL)		23.51 MCAL	23.51 MCAL	
CALCIUM	0.65 % DM	115.5 GRMS	115.5 GRMS	
PHOSPHORUS	0.39 % DM	69.3 GRMS	69.3 GRMS	104.0 GRMS
CAL TO PHOS RATIO		1.67 TO 1	1.50 TO 1	3.00 TO 1
MAGNESIUM		0.220 % DM	0.220 % DM	0.500 % DM
POTASSIUM		0.965 % DM	0.800 % DM	
SODIUM		0.130 % DM	0.130 % DM	0.400 % DM
CHLORIDE		0.944 % DM	0.250 % DM	
SULFUR		0.20 % DM	0.20 % DM	0.30 % DM
FAT		2.96 % DM		6.00 % DM
SUPPLEM. VITAMIN A		42.9 THIU	42.9 THIU	
SUPPLEM. VITAMIN D		42.9 THIU	6.5 THIU	

QUANTITY OF OTHER NUTRIENTS IN RATION:

SOLUBLE PROTEIN	3.32 % DM	25.09 %PROT
ACID DETER FIBER	7.72 LBS	19.81 % DM
IRON	156 PPM	
ZINC	59 PPM	
COPPER	11 PPM	
MANGANESE	41 PPM	
SUPPLEM. IODINE	0.41 PPM	
SUPPL. SELENIUM	0.07 PPM	
SUPPL. VIT. E	42.9 I U	

The above output is a formulation with no negative energy balance, optional micronutrients or urea. The impact on this output of these options is indicated below. The nutrient summary is provided in five columns: the first column giving the nutrient, the second and third columns providing information concerning the nutrient content and the fourth and fifth columns giving the minimum and maximum constraints included in this ration formulation.

In addition to the summary of the nutrients for which the program balances, information is provided on the quantities of other nutrients in the ration. These nutrients are important to a nutritionally balanced ration but are not included as constraints in the least-cost balanced ration program. The first is soluble protein. Although soluble protein is not included as a constraint except when urea is included in the ration (see below), a warning is provided if the level gets above an acceptable maximum. The warning says, "**WARNING** SOLUBLE PROTEIN IS ABOVE RECOMMENDED LEVELS".1/

In order to avoid any possible confusion, the abbreviations used in this section are defined below.

1/ The warning level is the same as the maximum when urea is included. See page 18.

% BW	Percent of the body weight entered as input.
LBS	Total pounds.
% DM	Percent of the total dry matter consumed by the animal as indicated in the first row.
%PRO	Percent of total protein consumed by the animal.
MCAL	Megacalories.
GRAMS	Grams.
THIU	Thousands of international units.
PPM	Parts per million of the total dry matter.
IU	International units.

Several of the options available affect the output of the nutrient composition of the ration. Those discussed below include negative energy balance, including urea as a feed ingredient, balancing for one or more of the micronutrients (iron, zinc, copper, manganese) and changing one or more of the nutritional requirements from the level specified in the program. The first option is negative energy balance. Whenever this option is selected whether any body tissue is actually needed or not, the number of Mcals of negative energy balance used is indicated in a prominent point in the output as indicated below.

ADJUSTED A D F	5.36 LBS	15.00 % DM	15.00 % DM
NET ENERGY(MCAL)		33.92 MCAL	34.30 MCAL
NEGATIVE ENERGY BALANCE		0.38 MCAL	
CALCIUM	0.70 % DM	147.0 GRMS	147.0 GRMS

You will notice that whenever negative energy balance is considered the nutrient content is the energy obtained from the feeds fed; when the negative energy balance is added, the total is the requirement of net energy.

As described in the discussion of the input (page 18), whenever urea is included as a feed ingredient, the maximum soluble protein as a percentage of total protein becomes a constraint rather than simply an output of the formulated level. The output for this situation is illustrated below.

QUANTITY OF OTHER NUTRIENTS IN RATION:

SOLUBLE PROTEIN	3.49 % DM	42.80%PROT	42.80%PROT
ACID DETER FIBER	7.46 LBS	19.33 % DM	

In this case, 42.8 percent of the protein was the maximum soluble protein and urea was included to the maximum allowed. Another adjustment in the output of a conventional feed formulation is the NPN content of the concentrate. Whenever there is NPN in the ration, a row will be added directly below the nonprotein nitrogen indicating the percentage NPN content of the concentrate as compared to the constraint.

Again, as indicated in the input (pages 20 and 21), the micronutrients can be included as nutrients to be balanced for. When this is desired, the micronutrients will be outputted at the same location in the nutrient composition; however, the content will move to the second column and the nutritional constraint that was included will be entered as indicated below.

IRON		189 PPM	100 PPM	
ZINC	60 PPM			
COPPER		10 PPM	10 PPM	80 PPM

In addition, whenever a nutrient is changed, the output will indicate that there has been a change in the nutrient requirements and the nutrient requirements which have been changed. In the example below dry matter intake and calcium-phosphorus ratio were changed.

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**NOTE**  THE FOLLOWING NUTRIENT REQUIREMENTS HAVE BEEN CHANGED:

  MAXIMUM DRY MATTER INTAKE
  MINIMUM CALCIUM:PHOSPHORUS RATIO
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Prices at Which Composition of Ration Will Change

This and the next section provide economic information concerning sensitivity of the ration to price changes and the cost of constraints. The information in this section is useful in determining the sensitivity of the ration to changes in prices of the individual feed ingredients. An example of the output is provided below.

PRICES AT WHICH COMPOSITION OF RATION WILL CHANGE

PRICES AT WHICH INGREDIENTS IN RATION WILL:

INGREDIENT	UNIT	INCREASE	CURRENT VALUE	DECREASE
130 MMS HAY	TON	$ 0.0	$ 50.00	$999.99
151 CORN SIL	TON	$ 0.0	$ 12.00	$ 30.00
217 SHELLCORN	CWT	$ 5.34	$ 3.00	$ 6.95
257 SOY-48	TON	$121.65	$300.00	$344.00
402 DICAL	CWT	$ 0.0	$ 25.00	$ 33.42
401 CALSULF	CWT	$ 0.25	$ 15.00	$ 61.67
403 LIMESTON	CWT	$ 0.0	$ 5.00	$ 23.40
404 MAG OX	CWT	$ 0.0	$ 30.00	$143.57
410 TM3	CWT	$ 0.0	$ 4.00	$999.99
419 HICA MIN	CWT	$ 21.05	$ 30.00	$999.99

PRICE AT WHICH INGREDIENTS NOT IN RATION WILL ENTER:

INGREDIENT	UNIT	ENTER	CURRENT VALUE	CHANGE REQUIRED
121 MML HCS	TON	$ 21.75	$ 25.00	$ 3.25
244 OATS	CWT	$ 5.50	$ 6.00	$ 0.50

For those ingredients that are included in the formulated ration, the price at which the amount that would be included in the ration will increase and the price at which the amount included in the ration will decrease are included on the two columns labeled "INCREASE" and "DECREASE". These values are the values at which the ration will change given that the price of all other ingredients remains constant. As an example, the current price of shelled corn is $6.00. If that price rose to or above $6.95 with all of the other prices remaining constant, a new least-cost balanced ration containing less shelled corn is available. At prices between $6.00 and $6.95 the ration would not change; however, the total cost of the ration would increase slightly. At $6.95 it is not possible to tell how much less shelled corn would be included in the ration, only that less will be included.1/ The units included in this section, lb., cwt. or ton are the same as those in which the price was entered in the input. A 0.00 in the increase column indicates that no matter how much the price fell, the amount of that ingredient would not increase. Conversely, a 999.99 means that the price would have to increase to $1,000 or more before there would be any decrease in the amount of that ingredient included in the ration.

The second part of this section contains information concerning those feed ingredients that did not enter the ration at their current prices. In this case it gives the price at which they would enter and the price change that would be required for them to enter. For example, mixed mainly legume hay crop silage would enter if the price fell $3.25 or more to $21.75 or less and oats would enter if the price fell to $5.50 or less all other prices staying constant.

Restrictions Which are Constraining

This section provides information concerning the cost of altering both nutritional and feed ingredient constraints. The usefulness of this information, particularly for the nutritional constraints, is a guide as to which constraint is the most costly, more for information than from the standpoint that there is any opportunity to alter the restrictions. The following is an example of this section:

1/ When more than one price changes even though none of the prices are outside of the range indicated, a new least-cost balanced ration may be available.

RESTRICTIONS WHICH ARE CONSTRAINING

NUTRITIONAL CONSTRAINTS:

CONSTRAINT	LIMIT	AMOUNT	MARGINAL VALUE	EFFECT OF ONE % LIMIT INCREASE
DRY MATTER INTAKE	MAX	41.0 LBS	-6.6 CTS	-2.7 CTS
ADJ CRUDE PROTEIN	MIN	5.93 LBS	22.9 CTS	1.4 CTS
NET ENERGY(NEL)	MIN	28.51 MCAL	11.8 CTS	3.4 CTS
CALCIUM	MIN	115.5 GRMS	0.1 CTS	0.1 CTS
PHOSPHORUS	MIN	69.3 GRMS	0.3 CTS	0.2 CTS
MAGNESIUM	MIN	0.22 % DM	0.7 CTS	0.1 CTS
SODIUM	MIN	0.18 % DM	0.3 CTS	0.0 CTS
SULFUR	MIN	0.20 % DM	0.9 CTS	0.1 CTS
SUPPLEM. VITAMIN A	MIN	42.9 THIU	0.1 CTS	0.1 CTS
FEED INGREDIENT CONSTRAINTS:				
130 MMG HAY	EXCT	5.00 LBS	0.5 CTS	0.0 CTS

Only constraints which are constraining are included in the output. The nutritional constraints are discussed first although much of the discussion also pertains to the feed ingredient constraints. The constraint that is imposed, whether it is a maximum or a minimum, and the level of the constraint (and consequently the amount in the balanced ration) are contained in the first three columns. The third column is the marginal value or in economic terms is often referred to as the shadow price of the requirement. The value contained in this column is the amount that the total cost of the ration would be altered if the constraint were increased by one. For those constraints that are in pounds, Mcals, grams or thousands of international units, it simply is the change in cost of increasing the requirement one pound, Mcal, gram or thousand international unit. As an example, the cost of increasing the dry matter intake one pound is -6.6 cents, or the total cost of the ration would decrease by 6.6 cents; the cost of increasing the adjusted crude protein requirement one pound would be 22.9 cents. The percent of dry matter constraints are different since the unit of measure in these rows is actually the percent of the feed ingredient or of the total ration and consequently a change in the right-hand side would be equivalent to increasing the constraint by .01 pounds. As an example, the 0.7 cents on the marginal value for magnesium means that increasing the requirement by .01 pounds of magnesium would cost .7 cents.

Because the numbers in the marginal value row are sometimes difficult to interpret, particularly for those constraints that are in percent of dry matter, and because they are not comparable because some are in pounds, some are in Mcals, and some are in grams; an attempt was made to develop a measure that would provide a relative comparison among the nutrient constraints. The solution to this attempt was to calculate the effect of increasing the limit of each of the requirements by 1 percent and calculating the cost of that increase. This value is contained in the final column. This column will probably be the most useful since it provides a relative comparison of the cost of increasing each of the

constraints by 1 percent. In most rations, the dry matter intake and the net energy will have the largest absolute values of numbers. Adjusted crude protein and adjusted ADF may also be relatively large. Whenever the cost of a one percent increase in mineral requirements exceeds about one cent, there probably is a lack of a feed ingredient to efficiently meet that mineral requirement.

The format for the feed restrictions which are constraining is exactly the same as the nutritional constraints. These restrictions include those imposed in the input and also those that are imposed automatically for those concentrate ingredients which have a maximum percent in the concentrate or in the total ration. The limit imposed can be either a maximum, an exact, or a minimum. The restriction is either in pounds (level type code 0 and 1) or in percent (level type codes 2 through 9). The marginal value for the restrictions which are in pounds is the cost of increasing the restriction by one pound. For percentage restrictions, the value is again the cost of increasing the restriction by one pound of dry matter or one pound of as fed depending upon whether the restriction is in dry matter or as fed. In either case, the final column is the effect of increasing the feed ingredient constraint by one percent.[1/]

[1/] A comment on exact restrictions. First of all, we would suggest not using exacts but rather using both a maximum and a minimum. Since the exact is serving as a maximum, whenever the final two columns are negative numbers and a minimum whenever the final two columns are a positive number, if you enter it as a maximum and a minimum only the one which is constraining will be outputted and it will be much easier to explain to others the concept of a maximum or the minimum.

USING THE LEAST-COST BALANCED DAIRY RATION PROGRAM

This section provides additional information designed to assist the user. The first part contains an example of a problem situation, the necessary input and the output of the resulting feed formulation. The example is followed by discussion of two of the new features of this program: using formulations from previous analyses and using the expansion data program.

An Example Problem Situation

John Herdsman owns and operates a 100-cow dairy with a two-group total mixed ration feeding system plus feeding additional dry hay. The farm-produced feed ingredients in inventory include mixed mainly legume hay crop silage, mixed mainly grass hay, corn silage and high moisture shelled corn. All other feed ingredients must be purchased from the elevator. Facilities to mix the feeds on the farm are excellent except that the mineral ingredients are purchased as a premix at the elevator to be included in the total mixed ration.

In this example, the ration is formulated for the high group which is averaging 70 pounds of 3.5 percent milk per cow per day. With the two-group system, John chooses a lead factor of 1.12. He estimates that the 40 animals in this group weight 1300 pounds and are fed twice per day. Since the group is predominately mature cows and since the top producers in the group are mature cows, the ration is balanced for mature cows with negative energy balancing allowed as the cows in this group are in early lactation.

The following table gives the required information for the feed ingredients that John Herdsman is willing to examine for inclusion in the least-cost balanced ration.

Feed Ingredient	Feed Code*	Feed Name*	Unit	Price/ Unit
Corn silage	151	CORN SIL	ton	$ 20.00
Mixed mainly legume hay crop silage	121	MML HCS	ton	28.00
Mixed mainly grass hay	130	MMG HAY	ton	50.00
High moisture shelled corn	218	HMSC	cwt.	4.90
Soybean oil meal-48	257	SOY-48	ton	320.00
40% Dairy concentrate	340	DAIRY40	ton	320.00
Dicalcium phosphate	402	DICAL	cwt.	25.00
Calcium sulfate	401	CALSULF	cwt.	15.00
Limestone	403	LIMESTON	cwt.	5.00
Magnesium oxide	404	MAG OX	cwt.	30.00
Trace mineral salt	410	TMS	cwt.	4.00
High calcium mineral supplement	419	HICA MIN	cwt.	30.00

*See Table 1 on pages 63 to 70 for feed codes and names.

In studying the nutrient specification for these feed ingredients and his forage analyses, John recognizes that some of the specifications must be modified to represent his farm situation. For the corn silage the information is accurate except that forage analysis indicates that the corn silage is 35 percent dry matter rather than the 33 percent included in the stored data file. For the mixed mainly legume hay crop silage, the dry matter must be decreased from 47 to 41, the protein decreased from 14.5 to 14.0 and the net energy decreased from .55 to .53. The mixed mainly grass hay needs two adjustments, namely the dry matter increased from 88 to 90 and the protein content increased from 12.5 to 13.0. In addition, the high calcium mineral mix that he is purchasing has several mineral levels different from the mix specified in the feed table. The differences are calcium is 30 percent of dry matter rather than 21, magnesium is 3 percent of dry matter rather than 4 percent and iron is 1,000 parts per million rather than 2,500.

Mr. Herdsman thinks that it is important to balance for iron and copper, and therefore the appropriate entries are made in Section IV, Modification of Animal Nutrient Requirements to activate balancing for iron and copper at the levels specified in the program. In addition the minimum calcium to phosphorus ratio is increased from 1.5 to 1.8. This change is also made in Section IV.

John believes that it is critical that a minimum of five pounds of dry hay be included in the ration. He therefore makes the indication that feed code 130, mixed mainly grass hay, must be fed at a level of at least (a minimum of) 5 pounds as-fed per cow per day.

The final pieces of information that must be indicated concern the specification of the total mixed ration. John indicates that the premix should be formulated to indicate the pounds of each ingredient and the total premix to include in the complete feed. In addition, he indicates that the quantity formulated of the complete feed should be that amount which is needed to feed the group of 40 cows at each feeding. The mixing costs are $.30 per hundredweight for the premix which is mixed at the elevator and $.10 per hundredweight for the complete feed which is mixed on the farm. The feeding losses are 10 percent for the dry hay and 4 percent for the total mixed ration. The final entries indicate that John wants to have the feed analysis included in the output of each analysis and he does not want the option to stop the output at a midpoint.

The following pages contain first the input form as completed for the example just described, the list back of the input from the computer and finally the output for this analysis.

NEWPLAN Program 31 Form 4
LEAST COST BALANCED DAIRY RATIONS*
GENERAL INPUT FORM

PROGRAM |3|1|4|1|5|
Prog. # Form # File #

YOUR NAME John Herdsman DATE 11/18/80

ADDRESS Rural, New York PHONE 277-6789

RATION TYPE 2-group TMR

	LINE NO.	ANALYSIS 1
Section I. Animal Characteristics		
1.a. Enter type of least cost ration desired:	01.	|3|3.0|0|7|0|3.5| (a b c d)
Milking Cows:		
2 = Conventional feeding; Roughages and concentrate are fed separately.		
3 = Mixed ration; Hay may be fed separate.		
Dry Cows:		
6 = Conventional feeding.		
7 = Mixed ration.		
b. Average body weight of cows (cwt.)		
c. Average milk production level (lbs. per cow per day). If dry cow, enter "000".		
d. Average butterfat test (%). If dry cow, enter "000".		
2. For Mixed ration (option 3 or 7 in 1a) only. For Conventional feeding, enter "0" and go to line 3.		
a. Lead factor for the production group. If dry cow, enter "000".	02.	|1.1|2|0|4|0|2| (a b c)
b. Number of cows in production group.		
c. Number of feedings per day.		
3.a. Option to Negative Energy Balance: Enter "0" if negative energy balancing is not desired for this group. Enter "1" if negative energy balancing is desired for this production group. If dry cow, enter "0".	03.	|1|0|0| (a b c)
b. If balancing for first lactation cows, enter "1", otherwise enter "0".		
c. If balancing for second lactation cows, enter "1", otherwise enter "0".		

*Developed by Robert Milligan, Charles Sniffen, Larry Chase and Wayne Knoblauch, Cornell University.

	LINE NO.	ANALYSIS 1

Section II. Feeds Available
(Enter "0" on line following last feed and proceed to Section III.)

4. Feed CORN SIL — 04. |151|020.0|1|2|
   a. Feed code. b. Price ($/T, cwt. or lb.). c. Unit.* d. How fed.**
   (a) (b) (c) (d)

5. Feed	MML HCS	05. |121|028.0|1|2|
6. Feed	MMG HAY	06. |130|050.0|1|0|
7. Feed	HMSC	07. |218|004.9|2|2|
8. Feed	SOY-48	08. |257|320.0|1|5|
9. Feed	DAIRY 40	09. |340|320.0|1|5|
10. Feed	DICAL	10. |402|025.0|2|4|
11. Feed	CALSULF	11. |401|015.0|2|4|
12. Feed	LIMESTON	12 |403|005.0|2|4|
13. Feed	MAG OX	13. |404|030.0|2|4|
14. Feed	TMS	14. |410|004.0|2|4|
15. Feed	HICA MIN	15. |419|030.0|2|4|
16. Feed		16. |0__|___._|_|_|
17. Feed		17. |___|___._|_|_|
18. Feed		18. |___|___._|_|_|
19. Feed		19. |___|___._|_|_|
20. Feed		20. |___|___._|_|_|
21. Feed		21. |___|___._|_|_|
22. Feed		22. |___|___._|_|_|
23. Feed		23. |___|___._|_|_|
24. Feed		24. |___|___._|_|_|
25. Feed		25. |___|___._|_|_|
26. Feed		26. |___|___._|_|_|
27. Feed		27. |___|___._|_|_|
28. Feed		28. |___|___._|_|_|
29. Feed		29. |___|___._|_|_|
30. Feed		30. |___|___._|_|_|

* Unit: Indicate if the given price is on a basis of ton, cwt. or lb.: 1 = $/ton, 2 = $/cwt., 3 = $/lb.

** How Fed: See Code Chart.

	LINE NO.	ANALYSIS 1

Section III. Modification of Feed Nutrient Composition
(Enter "0" on line after last modification. Whenever two or more modifications are entered for a feed, the feed code (c) needs only be entered for the first change.)

31.a.	Feed nutrient code* Corn Silage - DM	31.	01 | 35.00 | 51 | (a b c)
b.	Feed nutrient level		
c.	Feed code		
32.	MML HCS - DM	32.	01 | 41.00 | 121
33.	- Adj. Crude Protein	33.	02 | 14.00 |
34.	- Net Energy	34.	09 | 00.53 |
35.	MMG HAY - DM	35.	01 | 90.00 | 130
36.	- Adj. Crude Protein	36.	02 | 13.00 |
37.	HICA MIN - Calcium	37.	11 | 30.00 | 491
38.	- Magnesium	38.	13 | 03.00 |
39.		39.	0 | __.__ |
40.		40.	__ | __.__ |
41.		41.	__ | __.__ |
42.		42.	__ | __.__ |
43.		43.	__ | __.__ |
44.		44.	__ | __.__ |
45.		45.	__ | __.__ |
46.		46.	__ | __.__ |
47.		47.	__ | __.__ |
48.		48.	__ | __.__ |
49.		49.	__ | __.__ |
50.		50.	__ | __.__ |
51.		51.	__ | __.__ |
52.		52.	__ | __.__ |
53.		53.	__ | __.__ |
54.		54.	__ | __.__ |
55.		55.	__ | __.__ |
56.		56.	__ | __.__ |
57.		57.	__ | __.__ |
58.		58.	__ | __.__ |
59.		59.	__ | __.__ |
60.		60.	__ | __.__ |

	LINE NO.	ANALYSIS 1
Section III. Modification of Feed Nutrient Composition (continued)		
61. _____	61.	|_ _|_ _._ _|_ _ _|
62. _____	62.	|_ _|_ _._ _|_ _ _|
63. _____	63.	|_ _|_ _._ _|_ _ _|
64. _____	64.	|_ _|_ _._ _|_ _ _|
65. * _____	65.	|_ _|_ _._ _|_ _ _|

More modifications of feed nutrient compositions can be entered in lines 66-77. However, these lines are formatted differently to allow nutrient levels with many digits to be entered:

66. HICA MIN - Iron	66.	|18|419| (a, b)
a. Feed nutrient code. b. Feed code.		
67.a. Number of significant digits to right of decimal point. b. Feed nutrient level.	67.	|0|00001000| (a, b)
68. _____	68.	|0_|_ _ _|
69.	69.	|_|_ _ _ _ _ _ _ _|
70. _____	70.	|_ _|_ _ _|
71.	71.	|_|_ _ _ _ _ _ _ _|
72. _____	72.	|_ _|_ _ _|
73.	73.	|_|_ _ _ _ _ _ _ _|
74. _____	74.	|_ _|_ _ _|
75.	75.	|_|_ _ _ _ _ _ _ _|
76. _____	76.	|_ _|_ _ _|
77.	77.	|_|_ _ _ _ _ _ _ _|

*If more modifications of feed nutrient composition need to be made, one can do this via Program 64, "Data Expansion Program". Be sure to run Program 64 before you run the Least Cost Ration.

To proceed to Program 64, enter the following in line 65.

65. |-|_ _ _ _ _|_ _|0|
file security code | data file used with Program 64 | Form 0

	LINE NO.	ANALYSIS 1

Section IV. Modification of Animal Nutrient Requirements

(Enter "0" on line following last modification of nutrient requirement and proceed to Section V.)

78. a. Cow requirement code* Iron — 78. |24|1|0001.00| (a b c)
    b. Option: scaler or absolute nutrient requirement. 1 = scaler; 2 = absolute nutrient requirement.
    c. The scaler or absolute nutrient requirement.

79.	Copper Min.	79. |26|1|0001.00|
80.	Copper Max.	80. |27|1|0001.00|
81.	Min. Calcium: Phos.	81. |13|2|0001.80|
82.		82. |0 ||| . |
83.		83. | ||| . |
84.		84. | ||| . |
85.		85. | ||| . |
86.		86. | ||| . |
87.		87. | ||| . |

Section V. Restrictions on Levels of Feeds to be Included in Balanced Ration

(Enter "0" on line following last restriction and proceed to Section VI.)

88. a. Feed code MMG HAY - Min. — 88. |130|3|1|05.00| (a b c d)
    b. Max., exact, or min.**
    c. Level type***
    d. Level amount****

89.		89. |0 ||| . |
90.		90. | ||| . |
91.		91. | ||| . |
92.		92. | ||| . |
93.		93. | ||| . |
94.		94. | ||| . |
95.		95. | ||| . |
96.		96. | ||| . |
97.		97. | ||| . |

* Cow Requirement Code: See Code Chart.
** Max., exact, or min.: 1 = maximum amount; 2 = exact amount; 3 = minimum amount
*** Level Type: See Code Chart.
**** Level Amount: See Code Chart.

	LINE NO.	ANALYSIS 1
Section VI. Additional Feed Information		
98. a. Pre-mix batch size (cwt.). Enter "99" if pre-mix batch size is to be tailored to concentrate batch size. b. Pre-mix costs ($/cwt.) (mixing, transportation, etc.). c. Concentrate or Total Mix Ration batch size (cwt.). Enter "999" if Total Mix Ration batch size is to be tailored to amount fed per group per feeding. d. Concentrate costs ($/cwt.) (mixing, transportation, etc.)	98.	|99|.30|999|.10| (a b c d)
99. a. % feeding losses of concentrate or complete feed. b. % feeding losses of roughages. c. Enter "1" if want feed analysis in adjusted analyses; "0" otherwise. d. Enter "1" if want option to stop output halfway; "0" otherwise. e. State code (for N.Y. enter "31").	99.	|04|10|1|0|31| (a b c d e)

```
BE READY FOR LIST BACK
VALUE  1 IS  313007035
VALUE  2 IS    1120402
VALUE  3 IS        100
VALUE  4 IS  151020012
VALUE  5 IS  121028012
VALUE  6 IS  130050010
VALUE  7 IS  218004922
VALUE  8 IS  257320015
VALUE  9 IS  340320015
VALUE 10 IS  402025024
VALUE 11 IS  401015024
VALUE 12 IS  403005024
VALUE 13 IS  404030024
VALUE 14 IS  410004024
VALUE 15 IS  419030024
VALUE 16 IS           0
VALUE 31 IS   13500151
VALUE 32 IS   14100121
VALUE 33 IS   21400000
VALUE 34 IS   90053000
VALUE 35 IS   19000130
VALUE 36 IS   21300000
VALUE 37 IS  113000419
VALUE 38 IS  130300000
VALUE 39 IS           0
VALUE 66 IS       18419
VALUE 67 IS        1000
VALUE 68 IS           0
VALUE 78 IS  241000100
VALUE 79 IS  261000100
VALUE 80 IS  271000100
VALUE 81 IS  132000180
VALUE 82 IS           0
VALUE 88 IS  130310500
VALUE 89 IS           0
VALUE 98 IS  393039910
VALUE 99 IS    4101031
IS THE INPUT RIGHT
```

BE READY FOR ANALYSIS 1

CORNELL COOPERATIVE EXTENSION

DEPARTMENTS OF AGRICULTURAL ECONOMICS
AND ANIMAL SCIENCE

RATION FORMULATED FOR: JOHN HERDSMAN
DATE: 11/20/80

PRODUCTION INFORMATION

AVE. MILK: 70.LBS LEAD FACTOR: 1.12 BALANCED FOR: 78.4LBS

FAT TEST: 3.5 % BODY WT.: 1300. LBS 3.56 % MAINTENANCE

NO. OF COWS: 40 NO. OF FEEDINGS: 2 BALANCED FOR: MATR COW

FEED ANALYSIS

FEED INGREDIENT	DRY MATTER %	ADJ CR PROTEIN % D.M.	ADJ A D F % D.M.	NET ENERGY MCAL/LB.	CAL-CIUM % D.M.	PHOS-PHORUS % D.M.
151 CORN SIL	35.0	8.5	28.0	0.75	0.23	0.20
121 MML HCS	41.0	14.0	38.0	0.53	1.10	0.26
130 MMG HAY	90.0	13.0	40.0	0.52	0.71	0.20
218 HMSC	70.0	10.0	1.4	0.91	0.02	0.30
257 SOY-48	90.0	53.9	2.0	0.92	0.36	0.75
340 DAIRY40	89.0	45.0	3.0	0.92	2.40	1.40
402 DICAL	99.0	0.0	0.0	0.0	31.00	18.00
401 CALSULF	99.0	0.0	0.0	0.0	32.00	0.0
403 LIMESTON	99.0	0.0	0.0	0.0	37.00	0.0
404 MAG OX	99.0	0.0	0.0	0.0	0.0	0.0
410 TMS	99.0	0.0	0.0	0.0	0.0	0.0
419 HICA MIN	99.0	0.0	0.0	0.0	30.00	12.00

RATION COSTS/COW/DAY

TOTAL FEED COST: $ 4.26 PURCHASED FEED COST: $ 3.04

TOTAL RATION COST: $ 4.34 VALUE OF HOME GROWN FEED: $ 1.21

QUANTITY OF EACH FEED INGREDIENT IN RATION

PRE-MIX

FEED INGREDIENT	POUNDS IN PRE-MIX	PERCENT OF PRE-MIX
401 CALSULF	1.37	21.12
403 LIMESTON	3.63	55.91
404 MAG OX	0.46	7.12
410 TMS	1.03	15.85
TOTAL	6.49	

COMPLETE FEED

FEED INGREDIENT	POUNDS IN BATCH	AS FED LBS/COW	AS FED PERCENT OF CMPL FD	AS FED PERCENT OF RATION	DRY MATTER LBS/COW	DRY MATTER % OF RATION
PREMIX	6.5	0.34	0.43	0.40	0.34	0.72
151 CORN SIL	916.6	48.31	60.52	56.95	16.91	35.95
218 HMSC	234.0	12.33	15.45	14.54	3.63	18.31
257 SOY-48	28.8	1.52	1.90	1.79	1.37	2.90
340 DAIRY40	338.7	17.32	21.70	20.42	15.42	32.69
TOTAL	1514.5	79.82		94.11	42.66	90.46

DRY HAY FED SEPARATE FROM COMPLETE FEED

130 MMG HAY	5.00	5.89	4.50	9.54

PRE-MIX AND COMPLETE FEED INFORMATION

FEED INGREDIENT	DRY MATTER %	ADJ CR PROTEIN % D.M.	ADJ A D F % D.M.	NET ENERGY MCAL/LB.	CAL-CIUM % D.M.	PHOS-PHORUS % D.M.
400 PREMIX	99.0	0.0	0.0	0.0	25.33	0.0
PRE-MIX PRICE= 3.73 PER CWT						
200 COMPLETE	50.3	23.4	13.5	0.84	1.17	0.67
COMPLETE FEED PRICE= 4.37 PER CWT						

NUTRIENT COMPOSITION OF TOTAL RATION

	NUTRIENT CONTENT		NUTRITIONAL CONSTRAINTS MINIMUM	MAXIMUM
DRY MATTER INTAKE	3.46 % BW	45.0 LBS	40.5 LBS	45.0 LBS
ADJ CRUDE PROTEIN	22.45 % DM	10.10 LBS	7.41 LBS	
NON-PROT NITROGEN	0.0 %PRO	0.0 LBS		0.50 LBS
ADJUSTED A D F	6.75 LBS	15.00 % DM	15.00 % DM	
NET ENERGY(NEL)		33.07 MCAL	34.30 MCAL	
NEGATIVE ENERGY BALANCE		1.23 MCAL		
CALCIUM	1.13 % DM	230.8 GRMS	144.5 GRMS	
PHOSPHORUS	0.63 % DM	128.2 GRMS	85.5 GRMS	128.2 GRMS
CAL TO PHOS RATIO		1.80 TO 1	1.80 TO 1	3.00 TO 1
MAGNESIUM		0.220 % DM	0.220 % DM	0.500 % DM
POTASSIUM		0.910 % DM	0.800 % DM	
SODIUM		0.180 % DM	0.180 % DM	0.400 % DM
CHLORIDE		0.324 % DM	0.250 % DM	
SULFUR		0.20 % DM	0.20 % DM	0.30 % DM
FAT		3.82 % DM		6.00 % DM
SUPPLEM. VITAMIN A		88.8 THIU	42.9 THIU	
SUPPLEM. VITAMIN D		88.8 THIU	6.5 THIU	

QUANTITY OF OTHER NUTRIENTS IN RATION:

SOLUBLE PROTEIN	6.36 % DM	28.32 %PROT		
ACID DETER FIBER	7.52 LBS	16.70 % DM		
IRON		189 PPM	100 PPM	
ZINC	60 PPM			
COPPER		10 PPM	10 PPM	30 PPM
MANGANESE	41 PPM			
SUPPLEM. IODINE	0.24 PPM			
SUPPL. SELENIUM	0.03 PPM			
SUPPL. VIT. E	322.0 I U			

NOTE THE FOLLOWING NUTRIENT REQUIREMENTS HAVE BEEN CHANGED:

MINIMUM CALCIUM:PHOSPHORUS RATIO

PRICES AT WHICH COMPOSITION OF RATION WILL CHANGE

PRICES AT WHICH INGREDIENTS IN RATION WILL:

INGREDIENT	UNIT	INCREASE	CURRENT VALUE	DECREASE
151 CORN SIL	TON	$ 0.0	$ 20.00	$ 53.73
130 MMG HAY	TON	$ 0.0	$ 50.00	$999.99
218 HMSC	CWT	$ 3.12	$ 4.90	$ 11.26
257 SOY-48	TON	$234.30	$320.00	$560.07
340 DAIRY40	TON	$ 0.0	$320.00	$346.85
401 CALSULF	CWT	$ 0.0	$ 15.00	$386.46
403 LIMESTON	CWT	$ 0.0	$ 5.00	$123.57
404 MAG OX	CWT	$ 0.0	$ 30.00	$999.99
410 TMS	CWT	$ 0.0	$ 4.00	$999.99

PRICE AT WHICH INGREDIENTS NOT IN RATION WILL ENTER:

INGREDIENT	UNIT	ENTER	CURRENT VALUE	CHANGE REQUIRED
121 MML HCS	TON	$ 0.0	$ 33.00	$ 33.00
402 DICAL	CWT	$ 0.0	$ 35.00	$ 35.00
419 HICA MIN	CWT	$ 0.0	$ 30.00	$ 30.00

RESTRICTIONS WHICH ARE CONSTRAINING

NUTRITIONAL CONSTRAINTS:

CONSTRAINT	LIMIT	AMOUNT	MARGINAL VALUE	EFFECT OF ONE % LIMIT INCREASE
DRY MATTER INTAKE	MAX	46.2 LBS	-133.0 CTS	-60.9 CTS
ADJUSTED A D F	MIN	15.00 % DM	134.0 CTS	9.0 CTS
NET ENERGY(NEL)	MIN	34.30 MCAL	199.0 CTS	68.2 CTS
PHOSPHORUS	MAX	128.3 GRMS	-0.4 CTS	-0.5 CTS
CAL TO PHOS RATIO	MIN	1.30 TO 1	0.3 CTS	2.2 CTS
MAGNESIUM	MIN	0.22 % DM	3.5 CTS	0.3 CTS
SODIUM	MIN	0.13 % DM	2.9 CTS	0.2 CTS
SULFUR	MIN	0.20 % DM	4.1 CTS	0.4 CTS
COPPER	MIN	10 PPM	1824.3 CTS	0.8 CTS

FEED INGREDIENT CONSTRAINTS:

130 MMG HAY	MIN	5.00 LBS	5.6 CTS	0.3 CTS

This is a fairly typical first analysis for a reasonably experienced user of the program. There are, however, several reasons why this would not want to be accepted as the final output for John to use in feeding his herd. There also are several items, particularly relative to negative energy balance, that are illustrated by this example. The first problem concerns the copper restriction. Two items should be noted. First there was no feed ingredient specifically provided high in copper and secondly the copper restriction is binding. These two situations lead to a questioning of the role of the copper restriction in this ration. An investigation discovers that the effect of a one percent limit increase in copper has the greatest impact of any of the minor minerals. This indicates that there was an undesirable effect of the copper restriction on the ration. The 0.8 cents cost of a one percent limit increase is below the one cent guideline previously proposed but the 0.8 cents is significantly higher than any of the other minor minerals; a situation that dictates further analysis. The phosphorus maximum also indicates that there may have been undesirable inclusion or exclusion of the minerals and perhaps other feed ingredients in order to meet the copper restriction. An adjusted analysis should be considered in which a copper source is made available or in which the copper restriction is eliminated or reduced.

A second ration characteristic of concern is that no hay crop is fed except for the 5 pound minimum of mixed mainly legume hay. The user would want to consider entering a maximum proportion of the roughage that could be corn silage. One would need to be careful in imposing this restriction since negative energy balancing is already used and imposing an additional constraint could result in an infeasible solution.

Perhaps the most interesting part of this output from the standpoint of usefulness in educating users in how to use the new program, is the fact that negative energy balanced was used. As indicated in the earlier discussion of input, negative energy balance is a last resort source of energy and its entry into the program is limited by placing a very high cost on the body tissue used for negative energy balance. Consequently, when negative energy balance is used, the program meets all requirements; however, the cost of the ration is determined almost entirely by minimization of the energy cost. The cost necessary to meet other restrictions becomes almost totally unimportant. This is illustrated in our example by the 10.1 pounds of protein included in the ration when only 7.41 pounds is required. The reason can be seen by looking at the feed ingredients summary and noting that both the soy and the dairy 40 have a higher energy value than the high moisture shelled corn, thus with energy being the driving force of a negative energy balance solution, some of the high protein feed is used as an energy source in addition to being a protein source because energy content was higher and dry matter content was higher thus avoiding any reduction of dry matter intake because of the fermentation of the high moisture shelled corn. It should be noted, however, that some high moisture shelled corn was utilized. This problem could be corrected if it continued when other adjustments are made by incorporating a

minimum proportion of the complete ration that is high moisture shelled corn.[1]

Using Formulations from Previous Analyses

One of the features of this program not adequately described in previous sections of this manual is the option to use a premix, a concentrate mix formulated in a conventional feeding formulation or a complete feed formulated in a total mixed ration as a feed ingredient in the next analysis. An illustration of the usefulness of this option is in the John Herdsman example just discussed. In this case, John obtained a premix containing the mineral and vitamin ingredients at the elevator and used that premix in his mixer; consequently, he is limited to one premix formulation. If, in an adjusted analysis, you were balancing for the low group of John's herd, you could enter the premix (feed code 400) as a feed ingredient and the amount of that premix needed to meet the requirements of the low-producing group would be included. When using this option, you must eliminate from the list of feed ingredients all of the ingredients of the premix. You could accomplish the entry of the premix and the elimination of the ingredients included in that premix by entering feed code 400 and its price, which could be taken from the output of the previous analysis, on input line 10; then in line 11 enter a "0" to indicate that the remaining feed ingredients should be eliminated. The elimination of the ingredients contained in the premix is important to avoid small quantities of individual feed ingredients entering solution due to the rounding involved in the process of establishing the nutrient content of the premix and due to differing relative requirements as production level changes.[2]

A similar procedure can be used in a conventional feed formulation when a concentrate mix is to be fed to cows at different production levels. This is again accomplished by entering the concentrate mix (feed code 300) in the next analysis and eliminating all of the ingredients contained in that concentrate. Again a price of the concentrate mix, which would probably be the price that is included in the output, must be entered. The analysis including the concentrate mix then solves for the quantity of this concentrate mix and the quantities of forage required to meet the nutrient requirements of a cow at the production level specified. The use of this procedure should be carried out with care since it is very easy to enter production levels where the ration cannot be balanced and consequently an infeasible solution results. This situation is particularly true when production is increased and at high production levels. It would be best in most instances to start with a production level at or near the top of the range which you are going to be balancing and use the concentrate formulated as a basis for moving over the range.

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[1] The authors are in the process of taking a detailed look at the procedures used in negative energy balance, since the concept of last resort may in fact have been taken too far. If any changes are made, users will be notified. If you have questions, contact the authors.

[2] If an ingredient can be fed in addition to the amount included in the premix, you do not have to delete it.

The same option exists for the complete feed in a total mixed ration formulation. This option using feed code 200 should be used with extreme care as an infeasible solution normally results if the production level is increased and either an infeasible solution or considerable overfeeding of nutrients results when the production level is lowered.

Using the Expansion Data Program

Although a large number of input lines are available for making changes in the nutrient content of the feed ingredients specified, in some situations, particularly where large numbers of forages are used, these spaces may prove to be inadequate. For this reason a provision has been added to the program to use the Expansion Data Program or Program 64 Form 0. This program is designed to hold additional lines of input in exactly the same format as input line 31 through 65. When you know that you are going to use this program, you simply make an entry in input line 65 as described in the footnote of the input form (line 65). You then record the information required to run Program 64 in lines 01 and 02 and then starting in line 03 the additional coefficient changes required. Input line 65 in Program 31 should be filled out with a minus sign in the first digit, file security code (which is unique to your authorization code and which you should have recorded along with that authorization code), the data file in which the expansion data is entered and a zero in the ninth digit. A second data files is required to hold the expansion data.

You should always input and run Program 64 before Program 31 because data from 64 are needed to run Program 31. Also be careful not to put changes for feed ingredients that you may choose later to change or exclude in Program 64 because you actually have to sign out of Program 31 and into Program 64 in order to make changes in Program 64 input. If you do find in running the program that you need to exclude a feed that changes are contained in Program 64, it is probably simpler to put a maximum of 0 on that feed rather than to reenter program 64 and eliminate the changes.

An example input form for Program 64 is contained on the next two pages. Input line 01 requires information about where the data is to be used. You must enter the program number to be expanded, which in this case is 31, or 031, the form number which is 4 and the number of digits in the expansion line which is 9. After entering a "0" in input line 02, enter the data starting in line 03 exactly as you would have entered it in 31 through 65. You then complete the program by entering a 0 in the line following the last change. When the input is correct, so indicate and the program is executed which means the data is recorded and the only output is a statement indicating the number of changes you entered in Program 64. If any errors in this input are detected when running Program 31, they are indicated in the output under error messages as ERROR AT INPUT LINE 65.

DATA EXPANSION PROGRAM

Program: 64

Form: 0

System: teletype

File: _____

NAME: _____ ADDRESS: _____

PHONE: _____ DATE: _____

PROBLEM: To expand on the input section of NEWPLAN programs that are designed for and need a larger input section than the basic program allows.

INPUT	LINE NO.	FIRST ANALYSIS	ADJUSTED ANALYSIS
01. a. Program number to be expanded b. Form number c. Number of digits in expansion lines	01.	|– a –|b|c|	|– a –|b|c|
02.	02.	0	
03. Expansion line number 1	03.	_____	_____
04. Expansion line number 2	04.	_____	_____
05. Expansion line number 3	05.	_____	_____
06. Expansion line number 4	06.	_____	_____
07. Expansion line number 5	07.	_____	_____
08. Expansion line number 6	08.	_____	_____
09. Expansion line number 7	09.	_____	_____
10. Expansion line number 8	10.	_____	_____
11. Expansion line number 9	11.	_____	_____
12. Expansion line number 10	12.	_____	_____
13. Expansion line number 11	13.	_____	_____
14. Expansion line number 12	14.	_____	_____
15. Expansion line number 13	15.	_____	_____
16. Expansion line number 14	16.	_____	_____
17. Expansion line number 15	17.	_____	_____

INPUT	LINE NO.	FIRST ANALYSIS	ADJUSTED ANALYSIS
18. Expansion line number 16	18.		
19. Expansion line number 17	19.		
20. Expansion line number 18	20.		
21. Expansion line number 19	21.		
22. Expansion line number 20	22.		
23. Expansion line number 21	23.		
24. Expansion line number 22	24.		
25. Expansion line number 23	25.		
26. Expansion line number 24	26.		
27. Expansion line number 25	27.		
28. Expansion line number 26	28.		
29. Expansion line number 27	29.		
30. Expansion line number 28	30.		
31. Expansion line number 29	31.		
32. Expansion line number 30	32.		
33. Expansion line number 31	33.		
34. Expansion line number 32	34.		
35. Expansion line number 33	35.		
36. Expansion line number 34	36.		
37. Expansion line number 35	37.		
38. Expansion line number 36	38.		
39. Expansion line number 37	39.		
40. Expansion line number 38	40.		
41. Expansion line number 39	41.		
42. Expansion line number 40	42.		
43. Expansion line number 41	43.		
44. Expansion line number 42	44.		
45. Expansion line number 43	45.		

A P P E N D I X

Feed Ingredient Tables

Table 1. Feed Ingredients.

Nutrient Code			01	02	03	04	05	07	08	09	10	11
Feed Description	Feed Name	Feed Code	Dry Matter	Adjusted Crude Protein	Soluble Protein	Unavailable Protein	NPN	ADF	Adjusted ADF	Net Energy$_L$ *	Discount Factor**	Calcium
			%	% of D.M.	% of Protein	-----% of Dry Matter------				Mcal/lb. D.M.	%	% of D.M.
ROUGHAGES												
Legume Hay	LEG HAY	110	87	18.0	25	1.0	0	32	32.0	0.60	4	1.20
Legume Hay Crop Silage	LEG HCS	111	49	17.0	52	2.0	0	32	32.0	0.60	4	1.20
Mixed Mainly Legume Hay	MML HAY	120	87	15.5	25	1.0	0	38	38.0	0.55	4	1.10
Mixed Mainly Legume Hay Crop Silage	MML HCS	121	47	14.5	52	2.0	0	38	38.0	0.55	4	1.10
Mixed Mainly Grass Hay	MMG HAY	130	88	12.5	22	0.8	0	40	40.0	0.52	4	0.71
Mixed Mainly Grass Hay Crop Silage	MMG HCS	131	46	12.0	45	1.5	0	40	40.0	0.52	4	0.81
Grass Hay	GRAS HAY	140	88	10.5	21	0.7	0	40	40.0	0.48	4	0.64
Grass Hay Crop Silage	GRAS HCS	141	41	10.0	54	1.5	0	40	40.0	0.48	4	0.63
Corn Silage	CORN SIL	151	33	8.5	45	0.7	0	28	28.0	0.75	4	0.22
Corn Silage with 10 lbs. Urea/Ton	C S NPN	152	33	12.5	65	0.7	1.5	28	28.0	0.75	4	0.22
Small Grain Silage	SM G SIL	160	32	10.0	46	1.0	0	40	40.0	0.65	4	0.30
Your Roughage #1	ROUGH 1	191										
Your Roughage #2	ROUGH 2	192										
Your Roughage #3	ROUGH 3	193										
Your Roughage #4	ROUGH 4	194										
Complete Feed	COMPLETE	200										
CONCENTRATES												
Barley	BARLEY	204	89	13.0	17	0.8	0	7	3.0	0.94	4	0.05
Barley, high moisture	HMBARLEY	205	75	13.0	35	0.8	0	9	3.0	0.94	4	0.05
Beet Pulp, dried	BEETPULP	208	91	9.3	4	1.0	0	34	17.0	0.89	4	0.77
Brewers Grains, dry	D BREWRS	210	92	26.5	6	2.8	0	25	11.0	0.74	4	0.30
Brewers Grains, wet	W BREWRS	211	22	25.0	12	5.0	0	25	11.0	0.79	4	0.30
Citrus Pulp	CITRUS	214	90	6.9	30	0.7	0	23	22.0	0.87	4	2.10
Corn, yellow, cracked	CSHCORN	216	89	10.0	12	0.6	0	3	1.4	0.91	4	0.02
Corn, yellow, ground	GSHCORN	217	89	10.0	12	0.6	0	3	1.4	1.01	4	0.02

* 1 x maintenance.

** Percent discount per increment of maintenance.

Table 1. Feed Ingredients. (continued)

Feed Description	Feed Name	Feed Code	12 Phosphorus	13 Magnesium	14 Potassium	15 Sodium	16 Chloride	17 Sulfur	18 Iron	19 Zinc	20 Copper	21 Manganese	22 Fat
			% of Dry Matter						Parts Per Million (PPM) of Dry Matter				% of D.M.
ROUGHAGES													
Legume Hay	LEG HAY	110	0.27	0.22	2.20	0.020	0.20	0.25	164	21	7	43	3.2
Legume Hay Crop Silage	LEG HCS	111	0.27	0.22	2.30	0.020	0.20	0.25	325	28	7	46	3.3
Mixed Mainly Legume Hay	MML HAY	120	0.26	0.20	2.10	0.010	0.20	0.25	184	27	7	48	2.7
Mixed Mainly Legume Hay Crop Silage	MML HCS	121	0.26	0.20	2.10	0.020	0.20	0.23	303	32	7	49	2.7
Mixed Mainly Grass Hay	MMG HAY	130	0.20	0.16	1.70	0.010	0.20	0.05	148	26	5	62	2.7
Mixed Mainly Grass Hay Crop Silage	MMG HCS	131	0.23	0.18	1.90	0.020	0.20	0.24	297	28	6	61	2.7
Grass Hay	GRAS HAY	140	0.20	0.16	1.70	0.010	0.20	0.26	166	27	5	86	2.7
Grass Hay Crop Silage	GRAS HCS	141	0.23	0.17	1.90	0.020	0.20	0.13	261	31	5	71	2.7
Corn Silage	CORN SIL	151	0.20	0.13	0.85	0.010	0.10	0.13	184	25	4	31	3.0
Corn Silage with 10 lbs. Urea/Ton	C S NPN	152	0.20	0.13	0.85	0.010	0.10	0.13	184	25	4	31	3.0
Small Grain Silage	SM G SIL	160	0.25	0.02	3.41	0.290	0.10	0.20	100	30	8	80	3.6
Your Roughage #1	ROUGH 1	191											
Your Roughage #2	ROUGH 2	192											
Your Roughage #3	ROUGH 3	193											
Your Roughage #4	ROUGH 4	194											
Complete Feed	COMPLETE	200											
CONCENTRATES													
Barley	BARLEY	204	0.37	0.15	0.45	0.030	0.02	0.18	150	30	3	30	2.1
Barley, high moisture	HMBARLEY	205	0.37	0.15	0.45	0.030	0.02	0.18	150	30	3	30	2.1
Beet Pulp, dried	BEETPULP	208	0.11	0.30	0.23	0.090	0.10	0.22	330	10	14	39	0.7
Brewers Grains, dry	D BREWRS	210	0.54	0.20	0.05	0.010	0.06	0.20	170	80	5	41	6.5
Brewers Grains, wet	W BREWRS	211	0.54	0.20	0.05	0.010	0.06	0.20	170	80	5	41	6.5
Citrus Pulp	CITRUS	214	0.13	0.16	0.77	0.100	0.10	0.07	170	16	6	7	3.7
Corn, yellow, cracked	CSHCORN	216	0.30	0.13	0.36	0.002	0.03	0.14	30	21	4	6	4.4
Corn, yellow, ground	GSHCORN	217	0.30	0.13	0.36	0.002	0.03	0.14	30	21	4	6	4.4

Table 1. Feed Ingredients. (continued)

Nutrient Code			01	02	03	04	05	07	08	09	10	11
Feed Description	Feed Name	Feed Code	Dry Matter	Adjusted Crude Protein	Soluble Protein	Unavailable Protein	NPN	ADF	Adjusted ADF	Net Energy$_L$*	Discount Factor**	Calcium
			%	% of D.M.	% of Protein	-----% of Dry Matter------				Mcal/lb. D.M.	%	% of D.M.
CONCENTRATES (continued)												
High Moisture Shelled Corn	HMSC	218	70	10.0	40	0.6	0	3	1.4	0.91	4	0.02
Ground Ear Corn (corn & cob meal)	EARCORN	220	86	9.3	16	0.6	0	12	3.0	0.91	4	0.04
High Moisture Ear Corn	HMEC	221	70	9.3	45	0.6	0	12	3.0	0.91	4	0.04
Corn Cobs	COBS	224	90	2.8	11	0.1	0	39	2.9	0.51	4	0.11
Corn Distillers Grains, dry	DDISTIL	226	91	25.1	22	5.6	0	18	5.0	1.01	4	0.16
Corn Distillers Grains, wet	WDISTIL	227	25	25.1	22	5.6	0	18	5.0	1.01	4	0.16
Corn Gluten Feed	GLUTFEED	230	90	24.4	49	0.7	0	10	2.0	0.93	4	0.33
Corn Gluten Meal	GLUTMEAL	231	92	66.3	6	2.4	0	5	1.0	0.96	4	0.18
Fat, animal	FAT	232	99	0.0	0	0.0	0	0	0.0	2.32	4	0.00
Hominy Feed, yellow	HOMINY	234	91	12.1	19	0.4	0	12	2.0	1.05	4	0.05
Linseed Meal	LINSEED	236	91	38.6	20	0.9	0	19	4.0	0.86	4	0.43
Molasses	MOLASSES	240	75	4.3	100	0.0	0	0	0.0	0.81	0	1.19
Oats, grain	OATS	244	89	12.9	30	0.8	0	17	7.0	0.86	4	0.07
Oat Hulls	OATHULL	246	92	3.3	29	0.4	0	42	40.0	0.36	4	0.11
Peanut Meal	PEANUT	248	89	52.0	20	1.3	0	6	2.0	0.94	4	0.20
Rapeseed Meal	RAPESEED	250	89	42.0	28	1.1	0	21	0.0	0.84	4	0.65
Rye	RYE	252	88	13.8	17	0.9	0	7	3.0	0.91	4	0.07
Soybeans, Whole	SOYBEANS	254	89	37.7	33	5.0	0	7	7.0	1.05	4	0.28
Soybean Oil Meal-44	SOY-44	256	90	48.9	18	1.2	0	10	2.0	0.92	4	0.36
Soybean Oil Meal-48	SOY-48	257	90	53.9	18	1.4	0	5	2.0	0.92	4	0.36
Soybean Mill Feed	SOYMILL	258	89	12.0	26	0.8	0	50	1.3	0.89	4	0.45
Urea	UREA	262	89	281.0	100	0.0	100	0	0.0	0.00	4	0.00
Wheat	WHEAT	264	89	14.6	25	0.4	0	4	2.0	0.94	4	0.06
Wheat Bran	WHEATBRN	266	89	16.3	43	0.5	0	15	3.0	0.79	4	0.11
Wheat Middlings	WHEATMID	268	89	18.0	40	0.4	0	10	2.0	0.91	4	0.11
Whey	WHEY	271	7	13.0	100	0.0	100	0	0.0	0.89	4	0.96
Your Concentrate #1	CONC 1	291										
Your Concentrate #2	CONC 2	292										
Your Concentrate #3	CONC 3	293										
Your Concentrate #4	CONC 4	294										
Concentrate	CONCENTR	300										

* 1 x maintenance.

** Percent discount per increment of maintenance.

Table 1. Feed Ingredients. (continued)

Nutrient Code			12	13	14	15	16	17	18	19	20	21	22
Feed Description	Feed Name	Feed Code	Phos-phorus	Mag-nesium	Potas-sium	Sodium	Chloride	Sulfur	Iron	Zinc	Copper	Mang-anese	Fat
			% of Dry Matter						-Parts Per Million (PPM)- of Dry Matter				% of D.M.
CONCENTRATES (continued)													
High Moisture Shelled Corn	HMSC	218	0.30	0.13	0.36	0.002	0.03	0.14	30	21	4	6	4.4
Ground Ear Corn (corn & cob meal)	EARCORN	220	0.24	0.10	0.44	0.010	0.03	0.14	80	20	3	8	3.7
High Moisture Ear Corn	HMEC	221	0.24	0.10	0.44	0.010	0.03	0.14	80	20	3	8	3.7
Corn Cobs	COBS	224	0.04	0.07	0.84	0.000	0.00	0.46	230	3	7	6	0.6
Corn Distillers Grains, dry	DDISTIL	226	0.79	0.07	0.10	0.020	0.20	0.32	200	80	49	30	8.0
Corn Distillers Grains, wet	WDISTIL	227	0.79	0.07	0.10	0.020	0.20	0.32	200	80	49	30	8.0
Corn Gluten Feed	GLUTFEED	230	0.86	0.32	0.63	0.050	0.25	0.24	300	53	53	26	2.7
Corn Gluten Meal	GLUTMEAL	231	0.51	0.05	0.03	0.100	0.08	0.44	20	29	31	8	2.7
Fat, animal	FAT	232	0.00	0.00	0.00	0.000	0.00	0.00	0	0	0	0	99.0
Hominy Feed, yellow	HOMINY	234	0.58	0.26	0.59	0.010	0.06	0.03	70	16	16	16	6.6
Linseed Meal	LINSEED	236	0.91	0.66	1.52	0.150	0.04	0.44	360	36	28	41	1.5
Molasses	MOLASSES	240	0.11	0.47	3.17	0.170	2.80	0.35	250	30	8	50	0.0
Oats, grain	OATS	244	0.39	0.18	0.42	0.002	0.06	0.38	80	33	7	43	4.5
Oat Hulls	OATHULL	246	0.16	0.09	0.52	0.040	0.10	0.12	110	150	5	20	1.8
Peanut Meal	PEANUT	248	0.65	0.04	1.29	0.070	0.03	0.30	290	36	16	32	6.3
Rapeseed Meal	RAPESEED	250	1.00	0.50	1.40	0.010	0.04	0.60	260	87	6	62	1.0
Rye	RYE	252	0.36	0.14	0.52	0.030	0.03	0.17	70	36	7	60	2.1
Soybeans, whole	SOYBEANS	254	0.66	0.31	1.80	0.130	0.03	0.24	90	18	17	33	20.0
Soybean Oil Meal-44	SOY-44	256	0.75	0.30	2.20	0.002	0.01	0.45	130	48	40	31	5.2
Soybean Oil Meal-48	SOY-48	257	0.75	0.30	1.90	0.002	0.01	0.45	130	48	40	31	1.0
Soybean Mill Feed	SOYMILL	258	0.17	0.13	1.00	0.050	0.02	0.07	100	24	16	14	1.7
Urea	UREA	262	0.00	0.00	0.00	0.000	0.00	0.00	0	0	0	0	0.0
Wheat	WHEAT	264	0.45	0.17	0.45	0.040	0.08	0.17	40	43	5	44	1.8
Wheat Bran	WHEATBRN	266	1.30	0.62	1.40	0.006	0.05	0.25	190	117	14	130	4.5
Wheat Middlings	WHEATMID	268	0.96	0.39	1.10	0.240	0.03	0.18	100	140	20	130	4.5
Whey	WHEY	271	0.80	0.14	1.30	3.000	4.00	1.10	140	3	49	6	1.0
Your Concentrate #1	CONC 1	291											
Your Concentrate #2	CONC 2	292											
Your Concentrate #3	CONC 3	293											
Your Concentrate #4	CONC 4	294											
Concentrate	CONCENTR	300											

Table 1. Feed Ingredients. (continued)

Nutrient Code			01	02	03	04	05	07	08	09	10	11
Feed Description	Feed Name	Feed Code	Dry Matter	Adjusted Crude Protein	Soluble Protein	Unavailable Protein	NPN	ADF	Adjusted ADF	Net Energy$_L$*	Discount Factor**	Calcium
			%	% of D.M.	% of Protein	-------% of Dry Matter-------				Mcal/lb. D.M.	%	% of D.M.
COMMERCIAL CONCENTRATES												
12% Dairy Concentrate	DAIRY12	312	89	13.5	24	.4	0	7	3.0	1.00	4	1.50
14% Dairy Concentrate	DAIRY14	314	89	15.7	25	.5	0	7	3.0	0.99	4	1.50
16% Dairy Concentrate	DAIRY16	316	89	18.0	25	.5	0	7	3.0	0.99	4	1.50
18% Dairy Concentrate	DAIRY18	318	89	20.2	25	.6	0	7	3.0	0.98	4	1.50
20% Dairy Concentrate	DAIRY20	320	89	22.5	25	.7	0	7	3.0	0.98	4	1.50
24% Dairy Concentrate	DAIRY24	324	89	27.0	25	.8	0	7	3.0	0.97	4	1.50
26% Dairy Concentrate	DAIRY26	326	89	29.2	25	.9	0	7	3.0	0.96	4	1.50
30% Dairy Concentrate	DAIRY30	330	89	33.7	25	1.0	0	7	3.0	0.95	4	1.80
32% Dairy Concentrate	DAIRY32	332	89	36.0	25	1.0	0	7	3.0	0.94	4	1.80
36% Dairy Concentrate	DAIRY36	336	89	40.4	25	1.0	0	7	3.0	0.93	4	2.20
38% Dairy Concentrate	DAIRY38	338	89	42.7	25	1.0	0	7	3.0	0.93	4	2.20
40% Dairy Concentrate	DAIRY40	340	89	45.0	25	1.0	0	7	3.0	0.92	4	2.40
44% Dairy Concentrate	DAIRY44	344	89	49.4	25	1.0	0	7	3.0	0.90	4	3.00
Your Commercial Concentrate #1	COM CON1	391										
Your Commercial Concentrate #2	COM CON2	392										
Your Commercial Concentrate #3	COM CON3	393										
Your Commercial Concentrate #4	COM CON4	394										
Premix	PREMIX	400										

* 1 x maintenance.

** Percent discount per increment of maintenance.

Table 1. Feed Ingredients. (continued)

Nutrient Code			12	13	14	15	16	17	18	19	20	21	22
Feed Description	Feed Name	Feed Code	Phos-phorus	Mag-nesium	Potas-sium	Sodium	Chloride	Sulfur	Iron	Zinc	Copper	Mang-anese	Fat
			% of Dry Matter						Parts Per Million (PPM) of Dry Matter				% of D.M.
COMMERCIAL CONCENTRATES													
12% Dairy Concentrate	DAIRY12	312	0.70	0.30	1.00	0.400	0.60	0.25	300	125	18	60	3.5
14% Dairy Concentrate	DAIRY14	314	0.70	0.30	1.00	0.400	0.60	0.25	300	125	18	60	3.5
16% Dairy Concentrate	DAIRY16	316	0.70	0.30	1.00	0.400	0.60	0.25	300	125	18	60	3.5
18% Dairy Concentrate	DAIRY18	318	0.70	0.30	1.00	0.400	0.60	0.25	300	125	18	60	3.5
20% Dairy Concentrate	DAIRY20	320	0.70	0.30	1.00	0.400	0.60	0.25	300	125	18	60	3.5
24% Dairy Concentrate	DAIRY24	324	0.70	0.30	1.00	0.400	0.60	0.25	300	125	18	60	3.5
26% Dairy Concentrate	DAIRY26	326	0.70	0.30	1.00	0.400	0.60	0.25	300	125	18	60	3.5
30% Dairy Concentrate	DAIRY30	330	1.10	0.30	1.00	0.400	0.60	0.25	300	125	18	60	3.0
32% Dairy Concentrate	DAIRY32	332	1.10	0.30	1.00	0.400	0.60	0.25	300	125	18	60	3.0
36% Dairy Concentrate	DAIRY36	336	1.10	0.30	1.00	0.400	0.60	0.25	300	125	18	60	3.0
38% Dairy Concentrate	DAIRY38	338	1.10	0.30	1.00	0.400	0.60	0.25	300	125	18	60	3.0
40% Dairy Concentrate	DAIRY40	340	1.40	0.30	1.00	0.400	0.60	0.25	300	125	18	60	2.0
44% Dairy Concentrate	DAIRY44	344	1.50	0.30	1.00	0.400	0.60	0.25	300	125	18	60	2.0
Your Commercial Concentrate #1	COM CON1	391											
Your Commercial Concentrate #2	COM CON2	392											
Your Commercial Concentrate #3	COM CON3	393											
Your Commercial Concentrate #4	COM CON4	394											
Premix	PREMIX	400											

Table 1. Feed Ingredients. (continued)

Nutrient Code			01	02	03	04	05	07	08	09	10	11
Feed Description	Feed Name	Feed Code	Dry Matter	Adjusted Crude Protein	Soluble Protein	Unavailable Protein	NPN	ADF	Adjusted ADF	Net Energy$_L$*	Discount Factor**	Calcium
			%	% of D.M.	% of Protein	-----% of Dry Matter------				Mcal/lb. D.M.	%	% of D.M.
MINERALS												
Calcium Sulfate	CALSULF	401	99	0	0	0	0	0	0	0	0	22
Dicalcium Phosphate	DICAL	402	99	0	0	0	0	0	0	0	0	21
Limestone	LIMESTON	403	99	0	0	0	0	0	0	0	0	37
Magnesium Oxide	MAG OX	404	99	0	0	0	0	0	0	0	0	0
Magnesium Potassium Sulfate	MAGKSULF	405	99	0	0	0	0	0	0	0	0	0
Magnesium Sulfate	MAGSULF	406	99	0	0	0	0	0	0	0	0	0
Monosodium Phosphate	MONOPHOS	407	99	0	0	0	0	0	0	0	0	0
Sodium Bicarbonate	BICARB	408	99	0	0	0	0	0	0	0	0	0
Sodium Sulfate	SODISULF	409	99	0	0	0	0	0	0	0	0	0
Trace Mineral Salt	TMS	410	99	0	0	0	0	0	0	0	0	0
Iron Sulfate	IRONSULF	411	99	0	0	0	0	0	0	0	0	0
Iron Carbonate	IRONCARB	412	99	0	0	0	0	0	0	0	0	0
Zinc Sulfate	ZINCSULF	413	99	0	0	0	0	0	0	0	0	0
Zinc Oxide	ZINCOXID	414	99	0	0	0	0	0	0	0	0	0
Copper Sulfate	COPPSULF	415	99	0	0	0	0	0	0	0	0	0
Copper Oxide	COPPOXID	416	99	0	0	0	0	0	0	0	0	0
Manganese Sulfate	MANGSULF	417	99	0	0	0	0	0	0	0	0	0
Manganese Oxide	MANGOXID	418	99	0	0	0	0	0	0	0	0	0
High Calcium Mineral Supplement	HICA MIN	419	99	0	0	0	0	0	0	0	0	21
Low Calcium Mineral Supplement	LOCA MIN	420	99	0	0	0	0	0	0	0	0	8
Your Mineral #1	MINERAL1	421										
Your Mineral #2	MINERAL2	422										
Your Mineral #3	MINERAL3	423										
Your Mineral #4	MINERAL4	424										
Your Vitamin #1	VITAMIN1	437										
Your Vitamin #2	VITAMIN2	438										
Your Vitamin #3	VITAMIN3	439										
Your Vitamin #4	VITAMIN4	440										

* 1 x maintenance.

** Percent discount per increment of maintenance.

Table 1. Feed Ingredients. (continued)

Nutrient Code			12	13	14	15	16	17	18	19	20	21	22
Feed Description	Feed Name	Feed Code	Phos-phorus	Mag-nesium	Potas-sium	Sodium	Chloride	Sulfur	Iron	Zinc	Copper	Mang-anese	Fat
			% of Dry Matter						Parts Per Million (PPM)				% of D.M.
MINERALS													
Calcium Sulfate	CALSULF	401	0	0.00	0	0	0	18.00	0	0	0	0	0
Dicalcium Phosphate	DICAL	402	18	0.00	0	0	0	0.00	0	0	0	0	0
Limestone	LIMESTON	403	0	0.00	0	0	0	0.00	0	0	0	0	0
Magnesium Oxide	MAG OX	404	0	53.00	0	0	0	0.00	0	0	0	0	0
Magnesium Potassium Sulfate	MAGKSULF	405	0	11.00	18	0	0	22.00	0	0	0	0	0
Magnesium Sulfate	MAGSULF	406	0	9.50	0	0	0	12.50	0	0	0	0	0
Monosodium Phosphate	MONOPHOS	407	25	0.00	0	19	0	0.00	0	0	0	0	0
Sodium Bicarbonate	BICARB	408	0	0.00	0	25	0	0.00	0	0	0	0	0
Sodium Sulfate	SODISULF	409	0	0.00	0	14	0	10.00	0	0	0	0	0
Trace Mineral Salt	TMS	410	0	0.10	0	38	58	0.04	1,000	2,000	250	2,000	0
Iron Sulfate	IRONSULF	411	0	0.00	0	0	0	11.00	330,000	0	0	0	0
Iron Carbonate	IRONCARB	412	0	0.00	0	0	0	0.00	350,000	0	0	0	0
Zinc Sulfate	ZINCSULF	413	0	0.00	0	0	0	11.00	0	345,000	0	0	0
Zinc Oxide	ZINCOXID	414	0	0.00	0	0	0	0.00	0	730,000	0	0	0
Copper Sulfate	COPPSULF	415	0	0.00	0	0	0	13.00	0	0	250,000	0	0
Copper Oxide	COPPOXID	416	0	0.00	0	0	0	0.00	0	0	800,000	0	0
Manganese Sulfate	MANGSULF	417	0	0.00	0	0	0	19.00	0	0	0	270,000	0
Manganese Oxide	MANGOXID	418	0	0.00	0	0	0	0.00	0	0	0	600,000	0
High Calcium Mineral Supplement	HICA MIN	419	12	4.00	2	0	0	2.00	2,500	3,200	200	500	0
Low Calcium Mineral Supplement	LOCA MIN	420	20	5.00	2	0	0	2.00	2,600	3,200	200	500	0
Your Mineral #1	MINERAL1	421											
Your Mineral #2	MINERAL2	422											
Your Mineral #3	MINERAL3	423											
Your Mineral #4	MINERAL4	424											
Your Vitamin #1	VITAMIN1	437											
Your Vitamin #2	VITAMIN2	438											
Your Vitamin #3	VITAMIN3	439											
Your Vitamin #4	VITAMIN4	440											

Table 2. Iodine, Selenium and Vitamin Contents of Commercial Concentrates and Mineral Supplements.

Feed Nutrient Code			23	24	25	26	27
Feed Description	Feed Name	Feed Code	Supplemental Iodine	Supplemental Selenium	Supplemental Vitamin A	Supplemental Vitamin D	Supplemental Vitamin E
			-----PPM of DM-----		---'000 Inter. Units--		Inter. Units
12% Dairy Concentrate	DAIRY12	312	0.5	0.1	3	3	12
14% Dairy Concentrate	DAIRY14	314	0.5	0.1	3	3	12
16% Dairy Concentrate	DAIRY16	316	0.5	0.1	3	3	12
18% Dairy Concentrate	DAIRY18	318	0.5	0.1	3	3	12
20% Dairy Concentrate	DAIRY20	320	0.5	0.1	3	3	12
24% Dairy Concentrate	DAIRY24	324	0.5	0.1	3	3	12
26% Dairy Concentrate	DAIRY26	326	0.5	0.1	3	3	12
30% Dairy Concentrate	DAIRY30	330	0.5	0.1	6	6	15
32% Dairy Concentrate	DAIRY32	332	0.5	0.1	6	6	15
36% Dairy Concentrate	DAIRY36	336	0.5	0.1	6	6	15
38% Dairy Concentrate	DAIRY38	338	0.5	0.1	6	6	15
40% Dairy Concentrate	DAIRY40	340	0.5	0.1	6	6	15
44% Dairy Concentrate	DAIRY44	344	0.5	0.1	6	6	15
Trace Mineral Salt	TMS	410	70.0	0.0	0	0	0
High Calcium Mineral Supplement	HICA MIN	419	12.0	10.0	150	150	150
Low Calcium Mineral Supplement	LOCA MIN	420	12.0	10.0	150	150	150

Table 3. Maximum Proportions of Feed Ingredients Allowed in the Ration.

Feed Nutrient Code			29	30
Feed Description	Feed Name	Feed Code	Maximum Percent of Concentrate Mix (conventional feeding only)	Maximum Percent of Total Ration*
			----------Percent----------	
Barley	BARLEY	204	60	
Brewers Grains, dry	D BREWRS	210	25	25
Brewers Grains, wet	W BREWRS	211	25	25
Citrus Pulp	CITRUS	214	25	40
Corn Distillers Grains, dry	DDISTIL	226	50	25
Corn Distillers Grains, wet	WDISTIL	227	50	25
Corn Gluten Feed	GLUTFEED	230	50	25
Corn Gluten Meal	GLUTMEAL	231	50	25
Fat	FAT	232	10	
Hominy Feed, yellow	HOMINY	234	50	
Linseed Meal	LINSEED	236	50	
Molasses	MOLASSES	240	10	10
Oats, grain	OATS	244	50	
Oat Hulls	OATHULL	246	50	
Rapeseed Meal	RAPESEED	250	50	
Rye	RYE	252	25	
Soybeans, whole	SOYBEANS	254	25	15
Soybean Oil Meal-44	SOY-44	256	50	
Soybean Oil Meal-48	SOY-48	257	50	
Soybean Mill Feed	SOYMILL	258	50	
Wheat	WHEAT	264	25	25
Wheat Bran	WHEATBRN	266	25	
Wheat Middlings	WHEATMID	268	15	
Whey	WHEY	271	10	30

* If no value is entered, there is no restriction on that feed ingredient.