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Balancing Rations for
Dairy Cows

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BALANCING RATIONS FOR DAIRY COWS

Feed is the largest item of expense in connection with the production of milk. Successful dairying is consequently dependent to a large extent upon the judgment of the feeder in selecting and combining feeds for his cows.

The problem of the feeder is to provide most economically the materials necessary to enable the cow best to accomplish her work. These materials are the digestible protein and carbohydrates and fats in the feeds and are grouped under the general term of nutrients. The nutrients are used by the animal body as follows: The protein is used mainly in the upkeep of the body and is the source of the casein and albumen in the milk. The carbohydrates and fats supply the body with heat and energy and are the source of the fats and sugars in the milk.

A ration is a day's feed, and when the proteins and other nutrients are present in the ration in the proportion to meet all the needs of the animal without waste the ration is known as a balanced ration. The relation of the proteins to the other nutrients in the feed is called the nutritive ratio. The nutritive ratio is obtained by dividing the carbohydrates and fats by the proteins.

In order to balance a ration properly one must spend a little time in studying the subject and in becoming familiar with the composition and character of the various feed stuffs.

A list of the more important and common feeds together with the amounts of dry matter, ash or mineral matter, and nutrients contained therein is given in Table I. A column is also included giving the nutritive ratio of each feed.

TABLE I. COMPOSITION AND DIGESTIBLE NUTRIENTS IN FEEDING STUFFS

FEEDING STUFF	AMOUNT IN 100 POUNDS					Nutritive ratio or balance
	Dry matter	Ash or mineral matter	Digestive nutrients			
			Crude protein	Carbo-hydrates and fats	Total	
CONCENTRATES	lbs.	lbs.	lbs.	lbs.	lbs.	1 to
Barley	90.7	2.7	9.0	70.4	79.4	7.8
Barley shorts	89.8	4.2	11.0	60.2	71.2	5.5
Oats	90.8	3.5	9.7	60.7	70.4	6.3
Wheat	89.8	1.9	9.2	70.9	80.1	7.7
Wheat bran	89.9	6.3	12.5	48.4	60.9	3.9
Wheat middlings	89.3	3.7	15.7	62.5	78.2	4.0
Wheat shorts	89.6	4.4	13.4	55.9	69.3	4.2
Wheat, mill-run	89.9	5.2	12.9	54.1	67.0	4.2
Corn, dent	89.5	1.5	7.5	78.2	85.7	10.4
Corn, flint	87.8	1.5	7.7	76.5	84.2	9.9
Corn and cob meal	89.6	1.5	6.1	72.0	78.1	11.8
Buckwheat	87.9	2.1	8.1	55.3	63.4	6.8
Rye	90.6	2.0	9.9	71.1	81.0	7.2
Rye bran	88.6	3.5	12.2	62.9	75.1	5.2
Beet pulp, dried	91.8	3.5	4.6	67.0	71.6	14.6
Beet pulp, molasses	92.4	5.6	5.9	69.4	75.3	11.8
Emmer (speltz)	91.3	3.7	9.5	67.0	76.5	7.1
Kafir-corn	88.2	1.7	9.0	71.0	80.0	7.9
Sorghum grain	87.3	1.9	7.5	72.0	79.5	9.6
Alfalfa meal	91.2	9.0	10.2	40.5	50.7	4.0
Molasses	74.2	6.4	1.0	58.2	59.2	58.2
Cocoanut-meal	90.4	4.9	18.8	60.2	79.0	3.2
Soybean-meal	88.2	5.4	38.1	45.1	83.2	1.2
Linseed-meal O. P.	90.9	5.4	30.2	47.7	77.9	1.6
Cottonseed-meal	92.5	6.2	37.0	41.2	78.2	1.1
ROUGHAGE						
Red clover hay	87.1	7.1	7.6	43.3	50.9	5.7
Alsike clover hay	87.7	8.3	7.9	39.4	47.3	5.0
Sweet clover hay	91.4	7.2	10.9	39.8	50.7	3.7
Alfalfa hay	91.4	8.6	10.6	41.0	51.6	3.9
Vetch hay	92.9	8.2	11.6	46.4	58.0	4.0
Oats and vetch hay	84.3	6.7	6.9	40.2	47.1	5.8
Oats and peas hay	83.4	7.3	8.3	40.5	48.8	4.9
Oats hay	88.0	6.8	4.5	41.9	46.4	9.3
Wheat hay	91.9	6.4	4.0	50.3	54.3	12.6
Rye hay	91.9	5.1	2.9	43.6	46.5	15.0
Sudan hay	90.0	6.4	2.7	47.0	49.7	17.4
Timothy hay	88.4	4.9	3.0	45.5	48.5	15.2
Mixed hay	87.2	5.6	4.3	47.0	51.3	10.9
Millet hay	85.7	6.3	5.0	50.0	55.0	10.0
Corn fodder	81.7	5.0	3.0	50.7	53.7	16.9
Corn stover	81.0	5.5	2.1	44.0	46.1	21.0
Oats straw	88.5	5.4	1.0	44.6	45.6	44.6
Wheat straw	91.6	5.2	0.7	36.2	36.9	51.7
SUCCULENTS						
Corn silage	26.3	1.7	1.1	16.6	17.7	15.1
Clover silage	27.8	2.5	1.3	10.6	11.9	8.2
Oats and vetch silage	23.1	1.6	1.7	13.2	14.8	7.9
Sunflower silage	19.2	1.9	1.3	10.6	11.9	8.2
Oats and pea silage	27.5	2.8	2.8	14.8	17.6	5.3
Oats silage	28.3	1.9	1.5	15.8	17.3	10.5
Carrots	11.7	1.2	0.9	9.0	9.9	10.0
Mangels	9.4	1.0	0.8	6.6	7.4	8.2
Turnips	9.05	0.9	1.0	6.4	7.4	6.4
Potatoes	21.2	1.1	1.1	16.0	17.1	14.5
Artichokes	20.5	1.7	1.0	14.8	15.8	14.8
Pumpkins	8.3	0.9	1.1	5.6	6.7	5.1
Kale	11.3	1.9	1.9	5.4	7.3	2.8
Cabbage	8.9	0.8	1.9	6.0	7.9	3.2
Rape	16.7	2.2	2.6	10.7	13.3	4.1
Apple pomace	20.6	1.0	0.9	16.4	17.3	18.2

The first step in balancing a ration is to ascertain the requirements of the cow in feed or nutrients. These requirements are: (1) for maintenance or upkeep of the body, and (2) materials for the making of milk. The amount of feed required is dependent upon the weight of the animal and the amount and richness of the milk. Tables II and III supply this information.

TABLE II. NUTRIENTS REQUIRED DAILY FOR BODY MAINTENANCE BY COWS OF DIFFERENT WEIGHTS.

Weight of cow	Crude protein	Carbo-hydrates and fats	Total
lbs.	lbs.	lbs.	lbs.
800	.56	5.78	6.34
900	.63	6.50	7.13
1000	.70	7.23	7.93
1100	.77	7.95	8.72
1200	.84	8.67	9.51

TABLE III. NUTRIENTS REQUIRED FOR THE PRODUCTION OF ONE POUND OF MILK CONTAINING A GIVEN PERCENT OF BUTTER-FAT.

Fat in milk	Crude protein	Carbo-hydrates and fats	Total
%	lbs.	lbs.	lbs.
3.0	.047	.240	.287
3.5	.049	.263	.312
4.0	.054	.287	.341
4.5	.057	.312	.369
5.0	.060	.334	.394
5.5	.064	.359	.423
6.0	.067	.383	.450

As an illustration of how to proceed we shall assume that we have a cow weighing approximately 1000 pounds and giving 25 pounds of 4-percent milk daily. In Table II we find the maintenance requirements of the cow and in Table III we find the nutrients required to produce one pound of 4-percent milk, which amount multiplied by 25 gives the necessary nutrients to produce 25 pounds of milk. From these figures the total daily requirements of the cow are computed as presented in Table IV.

TABLE IV. DAILY FOOD REQUIREMENTS OF A COW WEIGHING 1000 POUNDS AND GIVING 25 POUNDS OF 4-PERCENT MILK

	Crude protein	Carbo-hydrates and fat	Total
	lbs.	lbs.	lbs.
For maintenance .....	.70	7.23	7.93
To produce 25 lbs. 4-percent milk	1.35	7.19	8.54
	2.05	14.42	16.47

The next step is to make a selection of feed stuffs that will meet these requirements. The ration should contain a considerable amount of roughage, (1) because the cow requires a bulky ration, and (2) because nutrients can usually be supplied more cheaply in this form than any other. It is therefore the common practice to give the cow all the hay or other coarse fodder she will clean up. Since the cow's ability to consume roughage is limited, however, some grain or concentrate is necessary if she is a large producer. It is also desirable, and necessary for best results, that some succulent feed be included in the ration, such as silage, roots, or kale.

By referring to Table I we may make such selections of roughage, succulent feeds, and concentrates as shown in Table V.

TABLE V. BALANCED RATIONS FOR A 1000-POUND COW GIVING 25 POUNDS OF 4-PERCENT MILK

	Crude protein	Carbo-hydrates and fat	Total
	lbs.	lbs.	lbs.
15 lbs. oats hay .....	.68	6.28	6.96
25 lbs. corn silage .....	.28	4.15	4.49
20 lbs. kale .....	.38	1.08	1.46
2 lbs. barley .....	.18	1.41	1.59
2 lbs. wheat bran .....	.25	.97	1.22
1 lb. soybean .....	.38	.45	.83
Total.....	2.15	14.34	16.55
12 lbs. alfalfa hay	1.27	4.92	6.19
40 lbs. corn silage .....	.44	6.64	7.08
2 lbs. barley .....	.18	1.41	1.59
2 lbs. oats .....	.19	1.21	1.40
1 lb. oil-meal .....	.30	.48	.78
Total.....	2.38	14.66	17.04
20 lbs. oats and vetch hay	1.38	8.04	9.42
40 lbs. mangels .....	.32	2.64	2.96
3 lbs. barley .....	.27	2.11	2.38
3 lbs. mill-run .....	.39	1.62	2.01
Total.....	2.36	14.41	16.77

These rations are given to illustrate the method used in building up a ration rather than to present those that are ideal. Many others equally good can be formulated and perhaps cheaper feeds substituted for some of those used.

It will be noticed that the nutrients provided in these rations do not correspond exactly with the animal's requirements. Foods vary considerably in composition, and rations built up by this method can only be fairly close approximations. An immature animal will need nutrients for growth in addition to her requirements for maintenance and milk production. An animal poor in flesh will need additional feed to regain the lost flesh. Rations should therefore be varied to meet the individual needs of the animal.

The amount of milk that a cow can give is limited to the protein content of the ration, and as a surplus of protein can be used for other purposes in the animal body it is the practice of most careful feeders to supply this nutrient somewhat in excess of actual requirements.

Under Oregon conditions, with the mild winters and the cheap proteins in the form of legume hays, the nutritive ratio may be narrowed to 1 to 5½ to advantage and profit. In tables IV and V, crude protein may therefore be increased to 2.50 pounds and carbohydrates and fats decreased to 14.00 pounds, the total nutrients remaining the same.

In making a grain mixture for a herd it is well to compute the requirements of a cow giving an average amount of milk. This same mixture can then be fed to cows giving greater or lesser amounts in the proportion of one pound of grain to each four pounds of milk given by the cow.

Classification of Feeds. Feeds vary widely in the proportions of digestible nutrients or actual feed materials they contain. Some feeds have the digestible feed materials in the right balance to meet all the requirements of the animal body for maintenance and for milk production, some have a surplus of carbohydrates and fats, and others have a surplus of proteins.

Feeds or rations suitable for milk production have a balance or nutritive ratio, which means relationship of proteins to carbohydrates and fats, of from 1 to 5 to 1 to 7. Feeds with a wider balance than 1 to 7 are known as carbohydrate feeds while those with a balance of less than 1 to 5 are called protein feeds. Keeping this classification in mind will aid the feeder in selecting the feeds necessary to make a balanced ration.

Table I above, in the last column, gives the balance of each of the feeds named therein. Table VI below gives a classification of some of the more important feeds. Others may easily be added by the reader.

TABLE VI. CLASSIFICATION OF MORE IMPORTANT FEEDS

Feeds in Balance	Carbohydrate Feeds	Protein Feeds
Clover hay	Timothy hay	Alfalfa hay
Oats and vetch hay	Grain hay	Vetch hay
Oats and pea silage	Mixed hay	Kale
Turnips	Corn silage	Cabbage
Pumpkins	Carrots	Wheat bran
Oats	Mangels	Wheat middlings
Rye bran	Barley	Wheat mill-run
	Corn	Oil-meal
	Beet pulp	Cottonseed-meal
	Molasses	Soybean-meal

Feeds in balance are complete within themselves and can be fed in any amount or in any combination without disturbing the balance or relationship of protein to carbohydrates and fats. If, however, any carbohydrate feed or feeds are used, one or more protein feeds must then be included. Conversely, any protein feeds selected can only be balanced by adding one or more carbohydrate feeds. The correct amount of each to be used can only be accurately determined by following the method outlined in this bulletin. A feeder, however, by carefully studying feeds and the individual needs of his animals, can soon learn to make the proper feed combinations. Rations out of balance, if long continued, reduce profits or cause actual loss.

Mineral Requirements. Recent investigations indicate that under certain conditions dairy rations may be deficient in salt, iodine, phosphorus, and calcium. Much is as yet unknown, but from the information available the following suggestions are made.

Cows in milk require at least one ounce of salt daily and if high producers more is required. It may be given in the feed or placed where accessible.

Iodine is required only in sections where goitre is prevalent among calves. As a preventive, iodine in the form of potassium iodide is given. A solution is made of the potassium iodide at the rate of 15 grains of the crystals to 1 ounce of water. One ounce of this solution is placed on the feed once per week during gestation.

Phosphorus and calcium may be needed in addition to that contained in different feeds especially with high producing cows. With low producing or ordinary cows additional phosphorus may not be needed, since legume hays, grains, wheat bran, and shorts, and high protein concentrates contain relatively high amounts of this element. This is especially true if legume roughage together with wheat bran or shorts are a part of the ration prior to freshening.

Calcium (lime) is often more deficient than phosphorus, but may not be required in additional amounts if the roughages used consist of alfalfa, clover, or vetch. With the use of grain hays and grasses of the non-legumes, and especially where these are grown on acid soils, additional calcium may prove advantageous. It may be added by mixing 2 to 4 pounds of wood ashes, ground limestone, ground steam-bone-flour, or ground phosphate rock, with 100 pounds of grain. Apparently these are the only minerals that may be deficient. It is therefore unnecessary to purchase expensive proprietary mixtures.

Steamed or sterilized bone flour or meal is more generally used by dairymen, since it supplies both calcium and phosphorus in high amounts and is reasonably priced.

The importance of pasture, green roughage, and well cured legume hay, in the keeping up of mineral supply, cannot be over emphasized, and the value of a rest period of 6 to 8 weeks, when the cows are liberally fed and put in good condition before freshening, should not be overlooked.