UNIVERSITY OF MINNESOTA

DEPARTMENT OF AGRICULTURE

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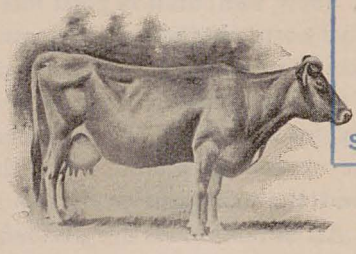

DIVISION DAIRY HUSBANDRY.

CLASS BULLETIN. No 2

FEEDING DAIRY COWS.

T. L. HAECKER.

THE question of feeding dairy stock in such a way that farmers can realize the greatest possible benefit from the food consumed, is one of vital importance in these times when the margin between the price of the product and the cost of production has become so small that it is only by reducing the cost of food to the minimum that reasonable profits can be made. In order to feed economically, the animal must be supplied with the nutrients needed for milk production in

the proper quantity and in the right proportion. To give an animal more of a certain nutrient than it can make use of is worse than wasted because it not only helps to fill the digestive tract with that for which it has no use, but energy is also wasted in expelling it from the system.

The real feeding value of our different kinds of food is, as yet, little understood. The market prices for the different grains and mill products are based upon supply and demand and not so much upon their feeding value. Farmers, as a general rule, know that bran is good food for dairy cows; they also know that corn, oats and barley are good, but they do not seem to understand why a mixture of such excellent feed as corn, oats and barley will not produce as good results as can be secured by feeding bran and oil meal in connection with them. The reason is plain, when the needs of the animal system and the composition of the different kinds of feed are known. All animal foods are divided into two classes with reference to bulk—roughage and concentrates. Roughage includes all the coarse portions of a ration, such as hay, stover, fodder corn, silage, roots, etc., while the term concentrates embraces all grains and mill products

In feed stuffs there are three groups of substances which must be considered in formulating a ration to secure best results. These are known as protein, carbohydrates and fat.

Protein is the name of a group of materials containing nitrogen and is sometimes called the nitrogenous group, in opposition to the carbohydrates, fat and ash, which are non-nitrogenous. The function of protein is to furnish materials for the formation of lean flesh, blood, tendons, nerves, hair, horns, wool and of the casein and albumin of milk. For the formation of these materials protein is absolutely indispensable. It is important to remember that no substance free from nitrogen can be converted into protein or be used as a substitute for protein. It is, therefore, necessary for an animal to receive a certain amount of protein in order to maintain existence, grow or produce milk.

Carbohydrates are made up of several substances, usually divided into two groups—nitrogen-free-extract, including starch, sugar, gums, etc., and crude fibre. Coarse fodders contain large amounts of crude fibre, while grain and mill stuffs contain little fibre, but are rich in starch and sugar. Carbohydrates are either stored up in the body as fat or are burned in the system to produce heat and energy.

Fat, or the material dissolved from a feeding stuff by ether, and for this reason often designated as ether extract, includes the fats, wax and the green coloring matter of plants. The fat of food is either stored up in the body or burned to furnish heat and energy. As a heat producer a pound of fat is worth as much as 2.25 pounds of carbohydrates. When fat has been multiplied by this factor the result is called fat equivalent.

A cow, or in fact nearly any mature animal, can use only from five to seven pounds of digestible carbohydrates and fat equivalent to one of protein. If we feed more carbohydrates without increasing the protein there will be an abnormal shrinkage in the flow of milk because the increase will cause the animal to lay on fat. If the ratio of protein to carbohydrates and fat equivalent is narrowed, the animal will need more heat than the carbohydrates and fat can supply and it will consume some of the protein to make up the deficiency. It follows, therefore, that for the best results the two groups of nutrients—protein and carbohydrates—must be fed within the limits stated.

But all our ordinary feeds, both in grain and roughage, contain carbohydrates largely in excess of an animal's needs, and mix the grain and roughage grown on the farm as we will, it always follows that we are short in protein or have too much of carbohydrates. In fact, all the nutrients needed by our farm animals are found in all our farm feed stuffs in great abundance except protein. In marsh and prairie hay, in timothy, millet, sorghum, fodder corn, stover and straw, there is more digestible carbohydrates than cattle can make use of.

The same is true with all our grains. In compounding rations from farm crops we always find it necessary to resort to some mill products, containing a high percentage of protein, to make good this shortage, except in cases where clover hay and alfalfa are available.

Since the supply of ash, carbohydrates and fat is always in excess of our needs, and being practically as free as water, air and light, it follows that they lose all commercial value, leaving digestible protein the measure of the money value of our feed stuffs for milk productions.

A ton of bran costs $10.00. It contains 238 pounds of water. It would be foolish to place any value on the water when there is plenty of it at home in the well. It contains 116 pounds of ash, 58 pounds of indigestible protein, 1,258 pounds of carbohydrates and 80 pounds of fat. It would be absurd to pay at the rate of $10.00 per ton for these materials when we have more at home than we have any use for. So the logical conclusion is that the $10.00 are paid for the 250 pounds of digestible protein. When bran is used in the ration hay can be fed as roughage, but corn stover cannot be made this part of the ration because it contains too little protein and too much carbohydrates, and in order to be able to feed stover, mill stuffs, containing a higher percentage of protein, must be purchased, which decreases the value of stover in proportion to the extra amount of protein that must be purchased. Or, in other words, stover is worth as much less as its protein content is less than that in the hay. When no hay is available and stover or corn fodder must be fed it will be necessary to resort to oil meal.

A ton of oil meal contains 184 pounds of water, 114 pounds of ash, 72 pounds of indigestible protein, 886 pounds of carbohydrates and 158 pounds of ether extract or fat. Surely no sane person would be guilty of buying these substances and paying at the rate of $20.00 to $25.00 per ton when he is already overstocked with them on the farm. So it must be that he is buying the digestible protein which is the only

nutrient lacking. The ton of linseed meal contains 586 pounds of digestible protein, and since the cost of this nutrient in bran was 4 cents a pound, the value of the ton of oil meal is $23.44 when it contains 29.3 per cent. digestible protein, and $22.08 per ton when it contains 27.6 per cent. The wider the nutritive ratio of food stuffs the more protein must be bought to balance the ration and the less money value these food stuffs have.

If we find any farm grown feed that contains enough digestible protein so that it will not be necessary to purchase any mill products, then that feed is worth to us as much more per ton as we would have to pay for the difference in protein if the farm feed contained a lower percentage; or, in other words, the money value of *all* the feed stuffs used in a ration for dairy cows depends upon the percentage of digestible protein they contain.

When bran can be purchased for $10.00 and oil meal for $22.00 we can afford to pay only 21 cents a bushel for corn, 12 cents for oats, 18 cents for barley, for we can get the only nutrient needed at these prices in bran and oil meal. If farmers will bear this in mind they will not feed 35-cent corn, 30-cent barley or 25-cent oats when shorts can be purchased for $8.00, bran for $10.00 and oil meal for $22.00 per ton.

Another mistake generally made is in buying shorts for dairy cows instead of bran ; presumably because shorts are heavy, so is sand. A ton of shorts contains 236 pounds of water,92 pounds of ash, 98 pounds of indigestible protein, 1,284 pounds of carbohydrates and 90 pounds of fat. As above stated all these substances are in great abundance on the farm. As the digestible protein is the nutrient needed, it follows that the 200 pounds of digestible protein in the ton of shorts fixes its value, and since we can get it in bran and oil meal at 4 cents a pound, shorts, when containing ten per cent. of digestible protein, is worth only $8.00 per ton for dairy cows when bran is worth $10.00. It should, however, be borne in mind that these values only hold good in feeding for milk. If an animal is being fed

for gain in weight, shorts would be preferable, especially in the case of feeding swine.

We find that the same inconsistency exists in regard to the market price of roughage. Take, for example, timothy hay and assume that it yields two tons per acre. In two tons there are 136 pounds of digestible protein, which at 4 cents a pound amounts to $5.44 worth of protein per acre, making its feeding value $2.71 per ton. This hay sells in our market for from $4.00 to $8.00 per ton. An acre of clover will produce about two tons of cured clover hay, containing 304 pounds of digestible protein, which at 4 cents a pound amounts to $12.16 worth of protein per acre, making its feeding value $6.08 per ton. An acre will produce six tons of fodder corn containing 312 pounds of digestible protein, which at 4 cents a pound makes $12.48 worth of protein in the six tons of fodder corn worth $2.08 per ton.

In view of these discrepancies between ruling market prices and the actual money value of feeding stuffs, we have for several years disregarded prices of feed and have based our calculations on the cost of digestible protein and have fed it in whatever palatable form we found it the cheapest. It is by this method and partially through the decrease in price of protein, that we have reduced the cost of producing a pound of butter from 10.6 cents in 1893 to 5.4 cents in 1897.

The profit in dairying, as in any other business, depends upon the margin between the product and the cost of production, and it is, therefore, of primary importance to provide feed stuffs at the least cost, and when grain is relatively high it may become necessary to discard our farm grains entirely, sell them and buy mill feed.

Cows should be fed all they will eat up clean, but such generous feeding should never be inaugurated after they have advanced far in the period of lactation, because in such case they will not materially increase in flow of milk, but will commence laying on fat, which is objectionable. The reason cows should be fed all they will take is because they must first be

provided with enough food for bodily maintenance and the more they will eat over and above this, the more they have available for converting into milk or gain. The amount required for bodily maintenance depends on the weight of the cow—the heavier she is the more food for maintenance she requires and the less will there be available for milk production. So if she gains in weight, each succeeding day she will need more food of support and since increase in weight does not increase her feeding powers, she will decrease in flow as she increases in weight.

That generous feeding pays is clearly illustrated in our record for the five years ending December 30, 1897. During the years 1893, 1895, 1896 and 1897 cows were fed all they would take, while during the year 1894 they were fed light.

	Milk.	Butter.	Cost of 1 lb. Butter.
1893,	6,407	364	10.6 cents.
1894,	4,909	271	10.9 cents.
1895,	7,418	352	8.0 cents.
1896,	7,454	349	6.3 cents.
1897,	6,962	351	5.4 cents.

These are averages of the entire herd and show that during the four years when receiving all they would eat up clean they averaged 354 lbs. of butter each, while the average yield for the year 1894, when on comparatively light feed, was only 271 lbs. The cost of production was also the greatest that year. The kind of feed has little, if anything, to do with the yield, so long as they get the required amount of nutrients in the right proportion and in palatable form. We get as much out of fodder corn as we do out of ensilage, and as much from a pound of protein in bran as from a pound of protein in any other concentrate.

They give just a trifle more milk when receiving some succulent feed, such as roots and ensilage, but practically the same amount of butter or other milk solids. We select the cheapest foods and so mix them that the cow gets one pound of digesti-

ble protein to six of carbohydrates and fat equivalent. If we should feed a wider ration, that is, one that contained more carbohydrates and fat equivalent than the amount stated, she would gradually lay on fat, shrink in milk and failure to breed would, probably follow. But when the above mentioned nutritive ratio is maintained, no such difficulties are encountered.

Our records show that changes in feed during the winter are objectionable, as changes always cause shrinkage in milk. A more uniform flow is maintained by feeding the same ration all winter, if possible. If it becomes necessary to make a change it should be very gradual, so the system can adjust itself to the variation in bulk, and the muscular action required by the stomach to digest that particular ration.

COMPOSITION OF FEEDING STUFFS.

The following tables give the digestible protein, carbohydrates and fat contained in one hundred pounds each of the feed stuffs commonly used in Minnesota, with their comparative value for dairy cows. The standard ration for a cow weighing 1,000 pounds in fair working condition and giving a good flow of milk, is 25 pounds of dry matter, 2.50 pounds of digestible protein, 12.50 pounds of digestible carbohydrates and .40 of a pound of digestible fat.

COMPARATIVE VALUE OF FEED STUFFS FOR DAIRY COWS.

Calculations based upon the percentage of digestible protein.

TABLE I.

	Percentage Composition.				Comparative Value per Ton when Timothy is Worth:						
	Dry Matter	Digestible.			$5.00	$6.00	$7.00	$8.00	$9.00	$11.00	$13.00
		Pro.	C-H.	Fat.							
Green Fodder.											
Corn Fodder . .	20.70	1.0	11.6	.4	1.47	1.76	2.06	2.35	2.65	3.23	3.82
Oat " . .	37.80	2.7	22.7	1.0	3.97	4.76	5.56	6.35	7.15	8.73	10.32
Red Clover . . .	29.20	3.1	14.8	.7	4.56	5.47	6.38	7.30	8.21	10.03	11.86
Sorghum Corn Silage.	26.00	1.2	15.0	.6	1.77	2.12	2.47	2.82	3.18	3.88	4.59
Hay and Dry Coarse Fodders.											
Corn Stover . . . (Field Cured.)	59.50	2.0	33.4	.6	2.94	3.52	4.12	4.70	5.30	6.46	7.64
Corn Fodder . . (Field Cured.)	57.80	2.5	34.6	1.2	3.68	4.41	5.15	5.88	6.62	8.09	9.56
Hay From—											
Timothy	87.68	3.4	43.4	1.3	5.00	6.00	7.00	8.00	9.00	11.00	13.00
Alfalfa	91.60	10.6	37.3	1.4	15.59	18.71	21.83	24.94	28.06	34.30	40.53
Alsike Clover . .	90.30	8.2	41.7	1.4	12.06	14.47	16.88	19.30	21.71	26.53	31.36
Red " . .	87.75	7.6	40.0	1.5	11.18	13.41	15.65	17.88	20.12	24.59	29.06
Millet	88.00	3.9	48.5	1.0	5.74	6.88	8.03	9.16	10.32	12.62	14.91

COMPARATIVE VALUE OF FEED STUFFS FOR DAIRY COWS.—*Continued.*

TABLE II.

	Percentage Composition.				Comparative Value per Ton when Timothy is Worth:						
	Dry Matter	Digestible.									
		Pro.	C-H.	Fat.	$5.00	$6.00	$7.00	$8.00	$9.00	$11.00	$13.00
Hay From—											
Orchard grass.	90.10	4.8	42.0	1.4	7.06	8.47	6.88	11.30	12.71	15.53	18.36
Prairie, upland	87.50	3.5	41.8	1.4	5.15	6.17	7.20	8.23	9.26	11.32	13.38
" mixed ..	84.10	3.4	41.5	1.2	5.00	6.00	7.00	8.00	9.00	11.00	13.00
Red Top	91.10	4.8	46.8	1.0	7.06	8.47	6.88	11.30	12.71	15.53	18.36
Sedge grass...	89.84	3.4	45.3	1.1	5.00	6.00	7.00	8.00	9.00	11.00	13.00
Soja bean.....	88.70	10.8	38.7	1.5	15.56	18.67	21.78	24.90	28.01	34.23	40.46
Wheat straw..	92.59	1.0	38.0	.4	1.47	1.76	2.06	2.35	2.65	3.23	3.82
Oat " ..	91.64	1.5	43.4	.5	2.21	2.65	3.09	3.53	3.97	4.85	5.73
Roots and Tubers.											
Potatoes.....	24.55	2.1	20.2	.....	3.09	3.71	4.33	4.94	5.56	6.80	8.03
Sugar Beets...	15.00	1.5	12.3	1.0	2.21	2.65	3.09	3.53	3.97	4.85	5.73
Mangels.....	14.00	1.5	9.0	1.0	2.21	2.65	3.09	3.53	3.97	4.85	5.73
Turnips.....	9.50	.8	6.5	.1	1.18	1.41	1.65	1.88	2.12	2.59	3.06
Ruta-Bagas...	11.40	.9	7.7	.1	1.33	1.59	1.86	2.12	2.39	2.92	3.45
Carrots.....	11.40	.8	7.8	.2	1.18	1.41	1.65	1.88	2.12	2.59	3.06

COMPARATIVE VALUE OF FEED STUFFS FOR DAIRY COWS.—*Continued.*

TABLE III.

	Percentage Composition.				Comparative Value per Ton when Bran is Worth:						
	Dry Matter	Digestible.									
		Pro.	C-H.	Fat.	$5.00	$6.00	$7.00	$8.00	$9.00	$11.00	$13.00
Mill Products.											
Barley Meal	88.10	7.4	62.9	2.0	2.96	3.55	4.14	4.74	5.33	6.51	7.70
Corn "	88.00	9.0	67.4	2.8	3.60	4.32	5.04	5.76	6.48	7.92	9.36
" & Cob "	84.90	6.5	56.3	2.9	2.60	3.12	3.64	4.16	4.68	5.72	6.76
Oat "	92.10	11.5	52.1	5.9	4.60	5.52	6.44	7.36	8.28	10.12	11.96
Pea "	89.50	16.8	51.8	.7	6.72	8.06	9.41	10.75	12.10	14.78	17.47
By Products.											
Bran.....	89.50	12.5	42.1	3.6	5.00	6.00	7.00	8.00	9.00	11.00	13.00
Buckw't shorts	88.90	21.1	33.5	5.5	8.44	10.13	11.82	13.49	15.19	18.57	21.94
Cotton seed m'l	91.86	32.0	20.2	10.0	12.80	15.36	17.92	20.48	23.04	28.16	33.28
Linseed meal..	90.00	27.6	33.5	7.3	11.04	13.25	15.46	17.66	19.87	24.29	28.70
Gluten " ..	90.00	24.5	47.0	6.7	9.80	11.76	13.72	15.68	17.64	21.56	25.48
Germ " ..	93.00	12.3	52.4	6.1	4.92	5.90	6.89	7.87	8.86	10.82	12.79
Brewers' Gr'ns (Dried)	91.10	14.7	36.6	4.8	5.88	7.06	8.23	9.41	10.58	12.94	15.29
Brewers' Gr'ns (Wet.(	24.30	3.9	9.3	1.4	1.56	1.87	2.18	2.50	2.81	3.43	4.06
Malt Sprouts..	89.80	18.7	43.5	1.2	7.48	8.98	10.47	11.97	13.46	16.46	19.45
Shorts.....	89.50	10.0	55.9	2.3	4.00	4.80	5.60	6.40	7.20	8.80	10.40

COMPARATIVE VALUE OF FEED STUFFS FOR DAIRY COWS.—*Continued.*

TABLE IV.

	Percentage Composition.				Comparative Value per Ton when Bran is Worth:						
	Dry Matter	Digestible.									
		Pro.	C-H.	Fat.	$5.00	$6.00	$7.00	$8.00	$9.00	$11.00	$13.00
Grains and Other Seeds.											
Barley	89.10	8.7	65.6	1.6	3.48	4.18	4.87	5.57	6.26	7.66	9.05
Corn	89.10	7.9	66.7	4.3	3.16	3.79	4.42	5.06	5.69	6.95	8.22
Flax	90.80	20.6	17.1	29.0	8.24	9.89	11.54	13.18	14.83	18.13	21.42
Millet seed	87.50	9.0	54.1	2.9	3.60	4.32	5.04	5.76	6.48	7.92	9.36
Oats	89.00	9.2	47.3	4.2	3.68	4.42	5.15	5.89	6.62	8.10	9.57
Peas	90.16	19.4	59.6	.5	7.76	9.31	10.86	12.52	13.97	17.07	20.18
Rye	88.40	9.9	67.6	1.1	3.96	4.75	5.54	6.34	7.13	8.71	10.30
Wheat	89.00	11.0	58.6	1.5	4.40	5.28	6.16	7.04	7.92	9.68	11.44
					Price per Bushel on Above Basis.						
					Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
Barley	.....	.....	.....	.....	8.4	10.0	11.7	13.4	15.0	18.4	21.7
Corn	.....	.....	.....	.....	8.8	10.6	12.4	14.2	15.9	19.5	23.0
Millet seed	.....	.....	.....	.....	8.6	10.4	12.1	13.8	15.6	19.0	22.5
Oats	.....	.....	.....	.....	5.9	7.1	8.2	9.4	10.6	13.0	15.3
Peas	.....	.....	.....	.....	23.3	27.9	32.6	37.6	41.9	51.2	60.5
Rye	.....	.....	.....	.....	11.1	13.3	15.5	17.7	19.9	24.4	28.8
Wheat	.....	.....	.....	.....	13.2	15.8	18.5	21.1	23.8	29.0	34.3

Since the prices of farm products are governed by the laws of supply and demand and not by their actual money value as feed stuffs, it often happens that certain products can be sold for more than their value as feed and others bought for less than their feeding value. To aid in selecting the most economical food the following tables have been arranged, giving the comparative value of the grains ordinarily grown on the farm, calculations being based on the percentage of digestible protein.

Value of Feed Stuffs based upon their Digestible Protein Content. Protein in Barley as a Basis.

	WHEN BARLEY IS WORTH PER BUSHEL							
	16 cts.	18 cts.	20 cts.	22 cts	24 cts.	26 cts.	28 cts.	30 cts.
Corn	16.9	19.1	21.2	23.3	25.4	27.5	29.7	31.8
Oats	11.3	12.7	14.1	15.5	16.9	18.3	19.7	21.2
Rye	21.2	23.9	26.6	29.2	31.2	34.5	37.2	39.8
Wheat	25.3	28.4	31.6	34.8	37.9	41.1	44.2	47.4
Bran, per ton..	$9.48	$10.78	$11.97	$13.17	$14.37	$15.58	$16.76	$17.96
Linseed Meal..	21.12	23.79	26 44	29.07	31.72	34.38	35.10	39.65

Value of Feed Stuffs based upon their Digestible Protein Content. Protein in Corn as a Basis.

	WHEN CORN IS WORTH PER BUSHEL							
	16 cts.	18 cts.	20 cts.	22 cts.	24 cts.	26 cts.	28 cts.	30 cts.
Barley.	15.	17.	18.9	20.8	22.7	24 5	26.4	28.3
Oats.	10.6	12.	13.3	14.6	16.	17.3	18.6	20.
Rye	20.	22.6	25.1	27.6	30.1	32.6	35.1	37.6
Wheat.	23.9	26.9	29.8	32 8	35.8	38.8	41.8	44.8
Bran, per ton..	$ 9.05	$10.16	$11.29	$12.43	$13.56	$14.68	$15.81	$16.94
Linseed Meal..	19.98	22.42	24.94	27.44	29.92	32.40	34.92	37.44

Value of Feed Stuffs based upon their Digestible Protein Content. Protein in Oats as a Basis.

	WHEN OATS IS WORTH PER BUSHEL							
	16 cts.	18 cts.	20 cts.	22 cts.	24 cts.	26 cts.	28 cts.	30 cts.
Barley	22.7	25.6	28.4	31.2	34.1	36.9	39.8	42.6
Corn	24.	27.1	30.1	33.1	36.1	39.1	42.1	45.1
Rye	30.1	33.9	37.7	41.4	45.2	49.	52.7	56.5
Wheat	35.9	40.4	44.8	49.3	53.8	58.3	62.8	67.3
Bran, per ton..	$13.58	$15.29	$16.99	$18.69	$19.53	$22.08	$23 78	$25.49
Linseed Meal..	30.00	33.75	37.50	41.25	43.11	48.75	52.50	56.28

Value of Feed Stuffs based upon their Digestible Protein Content. Protein in Rye as a Basis.

	WHEN RYE IS WORTH PER BUSHEL							
	16 cts.	18 cts.	20 cts.	22 cts.	24 cts.	26 cts.	28 cts.	30 cts.
Barley	12.	13.6	15.1	16.6	18.1	19.6	21.1	22.6
Corn	12.8	14.4	16.	17.6	19.2	20.7	22.3	23.9
Oats	8.5	9.6	10.6	11.7	12.7	13.8	14.9	15.9
Wheat	19.9	22.4	24 9	27.4	29.8	32.3	34.8	37.3
Bran, per ton..	$ 7.21	$ 8.12	$ 9.02	$ 9.93	$10.84	$11.72	$12.63	$13.54
Linseed Meal..	15.91	17.87	19.85	21.85	23.85	25.80	27.80	29.80

HOW TO COMPOUND A RATION.

In compounding rations several things should be taken into account. First—When hay is fed, the ration should contain, concentrates and roughage in about equal weight, while it should contain about once and a half as much roughage when sorgham stover or fodder corn is used, because these contain about 40 per cent. water, while the different kinds of hay contain in round numbers about 10 per cent. When ensilage is used the ration should contain from 20 to 30 pounds, and 6 to 8 pounds of hay. When grain is used for concentrates it is desirable to use two or more kinds because it makes the ration more palatable; cost of the ration should, however, not be ignored in making the selection and when a ration can be made with one kind of roughage and one or two kinds of grain or mill feed at a marked reduction in cost, variety should be waived and the economical ration used, as the maximum yield can be approximately secured by feeding good fodder corn for roughage and bran and oil meal for concentrates. Of these all cows are very fond and will eat a full ration all winter without showing the slightest inclination to tire of them.

Some succulent food is desirable in a ration, but not absolutely necessary under Minnesota conditions. Bran and oil meal, usually the cheapest concentrates and these are sufficiently laxative to counteract the constipating properties in the corn plant, timothy, millet and prairie hay. This combination also gives a fine flavor and waxy texture to butter. If cotton seed meal should be fed with this roughage the butter would be hard and crumbly and lack that excellent texture and exquisitly delicate flavor for which Minnesota butter has become famous.

The tables give the amount of dry matter contained in a hundred pounds of the different kinds of food in Minnesota, the digestible protein, carbohydrates and fat and their comparative money value as food for dairy cows, calculations being based upon the digestible protein, for reasons already stated. A standard ration should contain 24 pounds of dry matter and of digestible nutrients, 2.5 pounds of protein, 12.5 of carbohy-

drates and 0.5 of a pound of fat, for a cow weighing one thousand pounds in ordinary working condition. But in practical feeding, cows should be fed according to their feeding capacity and not according to their weight. Good results can be obtained by feeding about 2.25 pounds of protein to common cows and, until more definite information is obtained upon this subject, this will be the basis of our calculations. It also appears that no injurious effects are produced by feeding more fat than is fixed by the standard and that quite as satisfactory results are obtained when the ration contains three quarters of a pound of this nutrient.

In view of the fact that there is considerable variation in the composition of food stuffs, the exact amount of nutrients contained in any food is not known without resorting to chemical analysis, and since this is not possible with the farmer the ration may contain only approximately the amount of the different nutrients mentioned in the standard.

Let us assume that the available farm grown foods are timothy, barley, corn and oats, and undertake to form a ration composed of these only, using 14 pounds of timothy and four pounds each of the grains. By refering to Table I, it is found that in a hundred pounds of timothy there are 87.68 pounds of dry matter, dividing this by 100 gives .8768 the amount in one pound of hay and in 14 pounds 12.28; and by the same mathematical process we find the amount of the digestible nutrients in the 14 pounds of hay and in the grains used, which is as follows:

FOOD.	LBS.	D. M.	DIGESTIBLE.			COST, CENTS.
			PRO.	C-H	FAT.	
Timothy.....	14	12.28	.48	6.08	.18	2.80
Barley Meal...	4	3.52	.29	2.52	.08	2.50
Corn Meal....	4	3.52	.36	2.70	.11	1.78
Oat Meal.....	4	3.68	.46	2.08	.24	2.75
		23.00	1.59	13.38	.61	9.83

The ration contains 23 pounds of dry matter which is enough for an ordinary cow, but it contains only 1.59 pounds of digestible protein, which is only enough to produce a half mess of milk after deducting the amount needed for bodily maintenance. None of the food stuffs in the ration can be increased because the carbohydrates are already in excess of the amount needed, and a cow fed with this ration will rapidly shrink in the flow of milk and lay on fat. Local quotations for the feed used are timothy $4.00 per ton, barley 30 cents per bushel, corn 25 cents and oats 22 cents, making the ration cost 9.83 cents. In order to supply the nutrients needed for milk production it will be necessary to take out some of the farm grown grains and substitute some mill product that will supply the protein and decrease the carbohydrates and the cost of the ration. To this end the oats and corn are taken out, and 8 pounds of bran substituted which gives the following.

FOOD.	LBS.	D. M.	DIGESTIBLE.			COST, CENTS.
			PRO.	C-H	FAT.	
Timothy	14	12.28	.48	6.08	.18	2.80
Barley Meal...	4	3.52	.29	2.52	.08	2.50
Bran.....	8	7.16	1.00	3.39	.28	4.00
		22.96	1.77	11.99	.54	9.30

This ration is short in all the nutrients except fat, but if enough bran is added to supply the amount of protein needed, there will be too much carbolydrates. It will therefore be necessary to reduce the quantity of barley meal, and add either more bran or oil meal. The market value of the 4 pounds of oats and 4 pounds of corn taken out of the ration is 4.53 cents and with bran at $10.00 per ton, the 8 pounds of bran cost 4 cents, so in making this change the cost of the ration has been reduced .53 cents. If this ration is increased by 4 pounds of

bran, and the barley meal reduced 2 pounds we have the following:

FOOD.	LBS.	D. M.	DIGESTIBLE.			COST, CENTS.
			PRO.	C-H	FAT.	
Timothy	14	12.28	.48	6.08	.18	2.80
Barley Meal...	2	1.76	.15	1.26	.04	1.25
Bran.....	12	10.74	1.50	5.05	.43	6.00
		23.78	2.13	12.39	.65	10.05

This ration furnishes the nutrients needed for ordinary dairy work, but is still short in protein for a large milker. The ration costs a trifle more than the one preceding, but it also contains 2 pounds more of concentrates and the increase in the yield of milk will more than make good the additional cost. Were the rations restricted to 12 pounds of concentrates as were those preceding, its cost would be 8.8 cents. For a cow giving a large flow of milk one pound of oil meal should be added, which would increase it to 24.68 pounds of dry matter, 2.41 of protein, 12.73 of carbohydrates and .72 of a pound of fat.

Taking another illustration and assuming that clover hay is available and that its market price is $4.00 per ton:

FOOD.	LBS.	D. M.	DIGESTIBLE.			COST, CENTS.
			PRO.	C-H	FAT.	
Clover	14	12.28	1.06	5.60	.21	2.80
Barley Meal...	4	3.52	.29	2.52	.08	2.50
Corn Meal	4	3.52	.36	2.70	.11	1.78
Oat Meal	4	3.68	.46	2.08	.24	2.75
		23.00	2.17	12.90	.64	9.83

This ration furnishes the food nutrients nearly in the desired proportion and quantity, though it is a trifle short in protein and rather strong in carbohydrates. Cows fed with it can do satisfactory work but the ration is expensive. Taking out the 4 pounds of oats and substituting bran we have the following:

FOOD.	LBS.	D. M.	DIGESTIBLE.			COST, CENTS.
			PRO.	C-H	FAT.	
Clover	14	12.28	1.06	5.60	.21	2.80
Barley Meal ..	4	3.52	.29	2.52	.08	2.50
Corn Meal....	4	3.52	.36	2.70	.11	1.78
Bran.....	4	3.58	.50	1.69	.14	2.00
		22.90	2.21	12.51	.54	9.08

Exchanging the 4 pounds of oats for 4 pounds of bran has made an improvement in this ration and has reduced its cost 75 cents. With a cow having large feeding capacity two pounds of clover could be added which would increase the digestible protein to 2.35 pounds. The last two rations show what a valuable feed clover is. Were peas available, 4 pounds of pea meal could be substituted for the bran which would improve the ration but increase its cost.

When corn, silage, timothy and bran are to be used in a ration it can be made in the following proportions:

FOOD.	LBS.	D. M.	DIGESTIBLE.			COST.
			PRO.	C-H	FAT.	
Corn Silage...	30	7.80	.36	4.50	.18	2.40
Timothy	5	4.38	.17	2.17	.06	1.00
Barley Meal..	4	3.52	.29	2.52	.08	2.50
Bran	8	7.16	1.00	3.39	.28	4.00
Oil Meal	1	.90	.28	.34	.07	1.12
		23.76	2.10	12.92	.67	11.02

The ration contains less protein and more carbohydrates than is desirable, but it will give fairly good results. If a mixture of 8 pounds of bran and 2 of oil meal were used it would be better. If clover can be used the following combination could be made:

FOOD.	LBS.	D. M.	DIGESTIBLE.			COST.
			PRO.	C-H	FAT.	
Ensilage	30	7.80	.36	4.50	.18	2.40
Clover	6	5.27	.46	2.40	.09	1.20
Barley Meal..	4	3.52	.29	2.52	.08	2.50
Bran.....	8	7.16	1.00	3.39	.28	4.00
		23.75	2.11	12.81	.63	10.10

This ration contains a trifle more protein and is nearly one cent less in cost. By substituting 6 pounds of clover in place of the 5 pounds of timothy, we save the pound of oil meal, secure a better ration and reduce the cost. When early cut fodder corn is provided the following will make a most excellent ration:

FOOD.	LBS.	D. M.	DIGESTIBLE.			COST.
			PRO.	C-H	FAT.	
Fodder Corn...	20	11.56	.50	6.92	.24	2.00
Bran.....	10	8.95	1.25	4.27	.36	5.00
Oil Meal.....	2	1.80	.56	.67	.14	2.20
		22.31	2.31	11.88	.74	9.20

This ration is being fed the college herd this winter and the cows eat it with a relish, are apparently well satisfied with it and are doing excellent work in the dairy. Each cow is fed twice a day all she will take and none are laying on fat.