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EC627 Revised 1953 Feeding Milk Cows

C. W. Nibler

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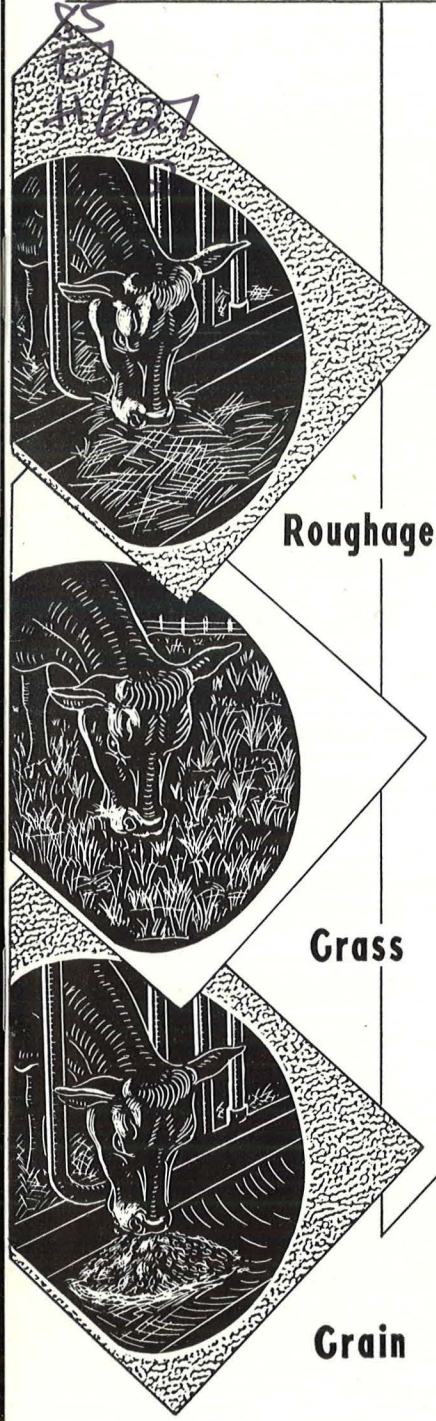


FEEDING MILK COWS

EXTENSION SERVICE
UNIVERSITY OF NEBRASKA COLLEGE OF AGRICULTURE
AND U. S. DEPARTMENT OF AGRICULTURE
COOPERATING
W. V. LAMBERT, DIRECTOR

CONTENTS

Feeding Milk Cows

C. W. NIBLER [1]

MILK cows are maintained on Nebraska farms to convert the grass, hay, and silage into a product which is more readily marketed. They are the most efficient of the farm animals in converting roughages into edible foods for humans. Many of the by-products from factories and mills are used by cows for body growth and milk production. Examples of these by-products are wheat bran, sugar beet pulp, and brewers' grain.

The dairy enterprise is a part of the farm enterprise, and nearly all the cows' feeds can be produced on the farm. The bulk of the milk cow's ration should be high-quality roughages. In addition, it may be necessary to purchase a small amount of high-protein concentrates.

A cow inherits from her ancestors the ability to produce milk and butterfat. After that, it is the owner's responsibility to feed and manage her to secure profitable production year after year. It has been said that "dairymen should breed production into their cows and then feed the production out of them."

In general, profits from cows depend upon their production. Although feed costs increase with increased production, profits increase more rapidly than feed costs. Nebraska cows that produced 400 pounds of butterfat in 1951 in dairy herd improvement associations returned $256 above feed cost, compared with $98 for cows that produced only 200 pounds of butterfat.

Below is shown feed costs for cows producing at different levels and the return above feed costs.

Level of milk production	Value of product	Feed cost	Income over feed cost	Feed cost per 100 pounds of milk
Pounds	*Dollars*	*Dollars*	*Dollars*	*Dollars*
5,000	269	135	134	2.70
7,000	356	152	204	2.17
9,000	421	165	256	1.83
11,000	473	176	297	1.60
13,000	533	189	344	1.45
15,000	600	200	400	1.33
17,000	660	212	448	1.25

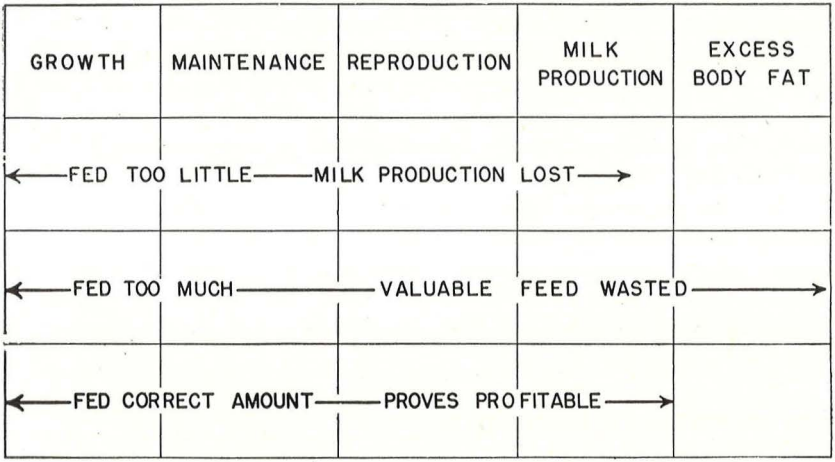
It is more profitable to feed ample and balanced rations to a few cows which have the ability to produce than to feed poorly many cows which do not have the ability to produce. About 50 per cent of the

[1] This circular was originally written by H. P. Davis and M. N. Lawritson. It has been revised by C. W. Nibler.

cost of producing milk is for feed. The other 50 per cent is equally divided—25 per cent for labor and 25 per cent for housing, miscellaneous supplies, and depreciation on equipment. Because feed costs are important in milk production, anything that can be done to decrease feed costs and maintain production should be applied to the herd.

Cows use feed to maintain their bodies, to develop the foetus or unborn calf, and to furnish energy for milk production. They convert excess feed into body fat. In addition, immature females need feed for body growth. The chart below shows why it is necessary to feed the correct amounts of the proper feeds.

A COW USES HER FEED FOR



This diagram shows body functions that are taken care of before a cow uses her feed for milk production. A cow fed less than she needs first takes care of body functions and what remains is used for milk production. Therefore, she does not produce what she is capable of producing. The same cow, if fed too much, will become fat. When the cow is fed all the high-quality roughages she will eat plus a balanced grain mixture according to her milk production, then production and feed are in balance.

Cows differ as individuals; probably no two are alike. They vary in their ability to produce, their ability to reproduce, their desire to eat, and in many other ways. A good caretaker knows his herd so thoroughly that he is acquainted with the individual characteristics of the cows and adjusts his methods of feeding and management accordingly. The owner must be familiar with many facts in order to properly feed his milk cows; however, he must train himself to be a

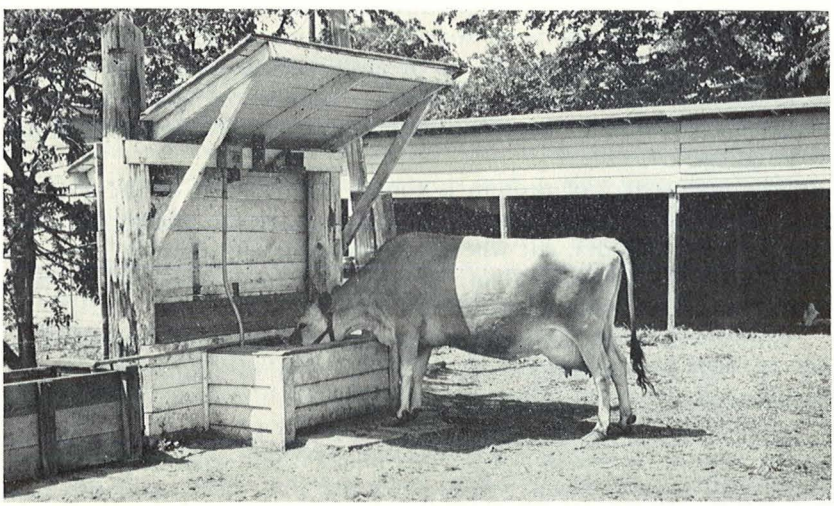
close observer so that an abnormal condition can be quickly detected and corrected. Regardless of the method of feeding used, it is of first importance that the correct nutrients be fed in sufficient amounts.

NUTRIENTS

The nutrients in feeds which perform specific functions in the cow's body and in milk production are water, carbohydrates, fats, proteins, minerals and vitamins. Each nutrient is important and the absence of one might interfere with normal body functions and milk production. The partial absence of one nutrient will reduce the total production more than it will influence the composition of milk.

Water. Water makes up 70 to 80 per cent of the cow's body, carries the digested food materials into the body, carries waste products away, helps control body temperature and makes up about 87 per cent of milk. It is one of the most important nutrients, usually the cheapest, but sometimes is a limiting factor in production.

For each gallon of milk a cow produces, she needs 3 to 5 gallons of water. Cows drink more water when they have free access to it. Water should be fresh and clean. In the winter, water should be free from ice. It is not necessary to warm water, but the temperature should be maintained above freezing. The consumption of water will vary with seasonal temperatures and the kind of feeds eaten.



The water level in the small rectangular, insulated trough where the cow is drinking is regulated by a float. In the winter, water temperature is maintained at 38 to 44 degrees F. by a heating element made from soil-heating cable and regulated by a thermostat. In the summer, water is placed in the larger tank on the left.

Carbohydrates. The grains produced on Nebraska farms are excellent sources of carbohydrates. The sugar, starches and woody or fibrous materials of the plants are the carbohydrates. Carbohydrates are separated into two classes of substances. The first group, called "crude fiber," includes the carbohydrates which are relatively insoluble. These have little or no feed value. A good example is wheat straw. The second group are the more soluble carbohydrates and are called nitrogen-free extracts. In this group are included the starches, the sugars, and the organic acids like acetic and lactic acids in silage. In addition, small quantities of fiber may be included in the second group. Commercial feed labels generally show the carbohydrates as crude fiber and nitrogen-free extract. Carbohydrates are used for energy and milk production. If a cow receives ample nutrients she probably receives plenty of corbohydrates. Extra carbohydrates will be changed by the body into fat.

Fat. Generally carbohydrates and fats are spoken of as one, because they both serve the same purpose. Although the two are interchangeable, there is two and one-fourth times more energy in fats than in carbohydrates. Fats are often listed on the label by manufacturers as "fat," "crude fat," or "ether extracts." Practically all the home-grown grains contain sufficient fats for practical feeding.

Proteins. Proteins are necessary in the cow's ration, and there are no substitutes. Probably the lack of protein limits production more than the lack of any other single nutrient. However, one should never lose sight of the necessity of supplying sufficient amounts of all the nutrients. Proteins are made up of amino acids, sometimes referred to as the "building blocks." Because a number of amino acids are necessary, it is best to furnish different grains and at least two kinds of roughages.

The best source of protein is young, tender grass or the good legume roughages. As the grasses and legumes mature, the protein content declines. Alfalfa, cut when it is not over one-tenth in bloom, is higher in protein content than when more mature. About 75 per cent of the protein is in the leaves of the legumes.

Cottonseed meal, linseed meal, soybean meal and gluten meal are all rich sources of protein and are used to supplement home-grown grains.

The animal protein factor (APF) is made by the cow in her digestive system. In fact, one of the first places where scientists discovered the animal protein factor was in cow's manure. Because of this fact, no additional feeds containing the animal protein factor are needed for heifers and cows.

Minerals. The body of a dairy cow contains many minerals. Two or three are needed in rather large quantities. Common salt is a

necessity. Milk cows need one or two ounces daily. This can be supplied by adding one pound of salt to every 100 pounds grain mix. Coarse granulated salt placed in a tight box, conveniently located, and protected from the wind and rain, will supply a sufficient amount. Cows may not receive enough salt by just licking a block. Calcium and phosphorus are needed by dairy animals for bone, teeth, milk production, and for reproduction. Cows lacking in either or both of these minerals may show a depraved appetite by chewing on sticks, bones, or posts. They may also show a condition of rheumatism and may not reproduce normally.

Alfalfa and other legumes are rich in calcium. Wheat bran and cottonseed meal are both rich in phosphorus. Steamed bone meal is nature's best mineral because it contains both calcium and phosphorus in the same proportion as they are in the body. Steamed bone meal is easily supplied by placing one pound in 100 pounds of the grain mix. For additional mineral, place equal parts of steamed bone meal and salt in a box. Salt also should be provided in another box. If just one mixture is provided, use one part of steamed bone meal to four parts salt. The latter will provide both salt, calcium and phosphorus in about the right proportions.

The other minerals are needed in such small quantities that practically all of them will be supplied with a good ration of high-quality roughages and a balanced grain ration. To produce feed crops high in the essential nutrients, the fertility of the soil should be maintained at a high level.

Calcium and phosphorus are stored in the cow's body and used when the need is greatest. Probably at no time are the intake and use equal. When given an opportunity, cows can build up reserves of some minerals in their bodies. The reserves are usually accumulated from good nutritious pastures and during the period when the cows are dry.

Within the last few years phosphorus has been supplied from phosphate rock. When this phosphorus supplement is used, it is essential that the fluorine be reduced to less than 0.1 per cent in the defluorinated phosphates.

Under conditions in Nebraska it is questionable whether iodine is needed. A lack of iodine will cause goiter in calves. If a deficiency is suspected, iodine salt can be fed. The iodine oxidizes rather rapidly from block salt; therefore, some of it is wasted.

In purchasing minerals it is important to secure the maximum amount of phosphorus for the dollar spent. Many times minerals, composed of nonessentials, are purchased at a high price.

Vitamins. Vitamins are highly complex organic compounds which are not classed with proteins, carbohydrates and fats. Most of the 15

known vitamins have been discovered since 1911. Probably more vitamins and their functions will be discovered in future years. According to present knowledge, ruminating animals have the ability to make all the vitamins they need except vitamins A and D.

Vitamin A is necessary for growth and maintenance of health. This vitamin is found abundantly in green grasses, in the green leaves of roughages and in yellow corn. The forerunner of vitamin A is carotene which is found in green and yellow plants. The carotene content of alfalfa decreases with storage and exposure to rainy, damp weather. Cows store vitamin A within their bodies when the supply is abundant and use it when the supply decreases. After the long, winter feeding season and before grass starts in the spring, the vitamin A supply in a cow's system is at a low level. The vitamin A in milk increases and decreases with the cow's supply. Milk is highest in vitamin A when the pastures are green and lush, and lowest just before the pasture season starts. Because butterfat contains vitamin A, there is practically none in skim milk. Colostrum, or the first milk produced after freshening, may be ten times as rich in vitamin A as later milk from the same cow.

Dairy animals on a vitamin A-deficient ration show certain characteristics. Night blindness is one of the first symptoms. Several stages of night blindness can be recognized and the condition may progress to total blindness unless the deficiency is corrected. Swelling of the legs and forequarters is often found in cattle deficient in vitamin A. In addition, there may be a nervous disorder displayed by a lack of coordination, staggering gait and spasms. A ration deficient in vitamin A may interrupt normal sexual activity. Cows may not conceive and if they do become pregnant, they either abort or bear weak or blind calves which often fail to survive. With the exception of new yellow corn, all farm grains are poor sources of vitamin A.

Vitamin D, absorbed by the animal's body from the sunshine, is necessary in the assimilation of calcium and phosphorus. Therefore, it becomes essential in the development of teeth and bone. Cows secure vitamin D from sunshine in the summer and from eating sun-cured roughages in the winter. Cows have the ability to store this vitamin in their bodies. The lack of vitamin D in the diet of young stock will cause rickets. Symptoms of rickets are enlarged joints (particularly the front knees), bent knees, loss of appetite, arched back, and stiffness.

The fish oils are a good source of vitamin D for calves. Mature animals will receive plenty from being outside in the summer and from good winter rations.

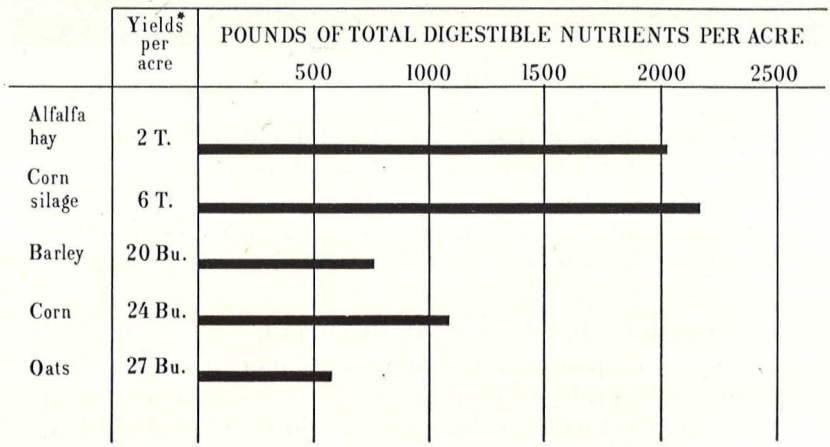
The effect of vitamin E upon reproduction has been discussed a great deal, but there are no facts available showing that it influences

reproduction in cattle. If it is needed in small quantities, the common feeds should supply an ample amount. Vitamins of the B complex are formed by the bacteria in the cow's paunch.

ROUGHAGES

Dairy cattle can eat and store in their paunch large quantities of roughages. Because of the special functions of the bacteria in the rumen or paunch of cattle, grasses, the hays, and silages can be utilized better by dairy animals and other ruminants than by any other kind of livestock. In Nebraska, more nutrients per acre can be produced with alfalfa hay and silage than with grains. Because the roughages are expensive to move, they should be fed where they are produced.

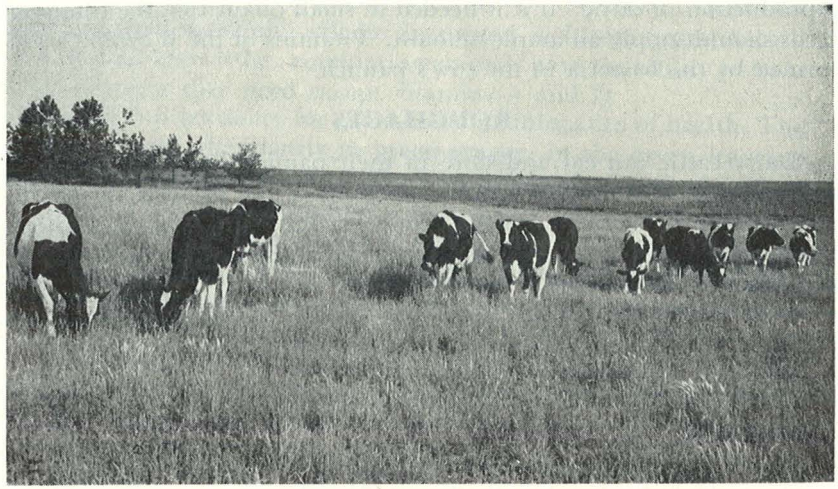
NUTRIENTS PER ACRE FROM DIFFERENT YIELDS OF FEED CROPS



*AVERAGE YIELDS FROM NEBR. DEPT. OF AGR. AND INSPECTION

Pastures. There are no better or cheaper nutrients than those produced in a luscious pasture. The use of pastures reduces the labor required to care for cows, provides a variety of feeds, furnishes protein and vitamin A, stimulates milk production and returns the manure directly to the soil. On Nebraska farms everything possible should be done to improve the quality of the pastures. Different parts of the state are adapted to different pasture plans, but the following basic principles apply to all farms.

1. Develop and manage pastures to produce the maximum amount of feed for the longest possible grazing season.
2. Use recommended grasses and legumes in the pasture mixture.



Cows harvesting bromegrass and alfalfa.

3. Use supplementary crops like rye and sudan grass during times when permanent pastures aren't producing enough feed.
4. Maintain soils that produce pastures in a high state of fertility by the application of manure and the necessary plant food elements.
5. Keep pastures free from weeds by clipping.
6. Do not graze pastures when grass is too short. Let grasses be 4 to 6 inches tall before grazing. Always maintain at least a 3-inch grass stubble. Sudan grass should be 12 to 15 inches tall before grazing.

Small grain, legumes and grasses can all be worked into a successful pasture plan. Rye seeded early in the fall with ample moisture will provide late fall and early spring pasture. Bromegrass and alfalfa seeded in the fall should be ready to pasture the following May if the moisture conditions are good. The seedbed needs to be properly prepared. Second-year sweetclover is good to use in parts of Nebraska, particularly in the irrigated sections. Sudan grass is drouth-resistant, and makes a good pasture in July and August. Do not pasture sudan after a frost or drouth if new growth appears at the base of the plants. A pasture mostly of alfalfa is always hazardous because of the danger of bloat.

These precautions can be followed as insurance against bloat when legumes are grazed.

1. Always provide some dry roughage. This is a good practice on any kind of pasture. A rack in the pasture that is kept full of dry roughage at all times is a practice many dairymen successfully follow.
2. Feed animals dry roughages before they are permitted to graze legumes.
3. Do not turn animals on legumes after a rain or heavy dew.
4. Provide plenty of salt and water in the pasture.
5. Have material available that can be used for the treatment of bloat.

To guard against off flavors in milk, remove cows from pastures at least two hours before milking.

When cows are on pasture, give them plenty of salt, water and shade.

Succulent roughages. Succulent roughages are corn, cane and grass silages, wet sugar beet pulp, and sugar beet top silage, or any roughage high in moisture. Corn and cane will yield more nutrients per acre when fed as silage than in any other way. Silages add variety to the ration, and they also increase the consumption of roughages.

About three pounds of silage is equal to one pound of a high-quality legume roughage. Large cows will eat 70 to 80 pounds of silage daily if it is the only roughage. It is better, however, to feed a conservative amount (35 to 40 pounds daily) for a longer period than to feed the greater amounts during the winter months or for a short period. Silage can be kept for long periods, when properly preserved, and may be used when drouth decreases feed supplies. The best corn silage is made when about half the kernels are dented. Atlas or Leoti Red sorghums make excellent silage and should be placed in the silo when seeds are changing from the milk to the soft-dough stage. Producing some forage sorghums for silage is an insurance against drouth.

Mixing corn and forage sorghums in equal amounts makes better silage than sorghums alone. Corn and cane for silage should be harvested before frost. If the crop is killed by frost, it should be harvested immediately before the leaves become dry. Corn or sorghums that do not pack well should have water added.

Sugar beet tops make excellent silage and can be cured by stacking on well-drained ground. Slight spoilage occurs on the outside, but the inside of the stack makes high-quality silage. Silage from beet tops is more laxative than that from corn, and therefore more precaution should be taken in feeding it.

Sweet corn, after the ears are snapped for the cannery, makes good silage. Sweet corn silage is about 75 per cent as valuable as silage from well-eared corn.

Atlas sorghum, harvested with a field cutter, transported to the trench silo with dump trucks and packed with a tractor makes an economical silage and gives a high yield of feed per acre. A board is placed on the cultivator shovels to level the chopped sorghum as it is placed in the silo. The windbreak prevents snow from being deposited in the silo.

Legumes, small grains and grasses make good silages. In May and June, rains make it difficult to harvest high-quality hay. To overcome this climatic factor, the first cutting of alfalfa, sweetclover, or bromegrass may be placed in the silo. Small grains, a combination of the legumes, and grasses can be successfully placed in the silo. In making grass silage, the silo needs smooth, airtight walls and tight doors. The silo should be well reinforced so that it will stand high silage pressures. When being filled, the crop material should be kept well distributed in the silo and well tramped near the wall.

There are many kinds of temporary and permanent silos which can be used on Nebraska farms. Each has its advantages and disadvantages, and conditions on the farm will influence one's decision on the kind of silo selected. Bulletins about silos and silage are available from local county agricultural agents.

If the crop, after being cut, is wilted to a moisture content of 65 to 68 per cent, good silage can be made without a preservative.

On a good drying day hay cut and left in the swath 2 to 4 hours should be wilted sufficiently to place in the silo. The time should be

increased if the sky is overcast or conditions are less favorable for drying.

Grasses, and particularly legumes, contain less easily fermented carbohydrates than corn or sorghums. Because of this, sometimes preservatives are added to the crop when placed in the silo. The quality of the silage seems to depend more upon the quality of the crop and the moisture content than upon whether the wilting or preservative method is used.

In the following table the quantities of preservatives to use in making silages are suggested. The amounts given here are the amounts that should be used per ton of crop in the silo.

SUGGESTED QUANTITIES OF PRESERVATIVES TO USE IN MAKING SILAGES
(Per ton of crop ensiled)

	* Molasses	Phosphoric acid (75%)	Corn and cob meal	Ground corn, barley or wheat	Whey, dried
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Legumes, fresh green:					
Alfalfa, red clover	80	20	200	150	40
Soybeans, Ladino clover	100	30	250	200	60
Legumes, wilted: All crops	60	15	150	100	30
Legumes and grasses mixed, before grass is headed out:					
Fresh green	80	20	200	150	40
Wilted	60	15	100	100	30
Legumes and grasses mixed, after grass is headed out:					
Fresh green	60	15	100	100	30
Wilted	None	None	None	None	None
Grasses and cereals before heading out:					
Fresh green	60	20	200	150	40
Wilted	40	10	100	100	30
Grasses and cereals after heading out:					
Fresh green	40	10	100	75	20
Wilted	None	None	None	None	None

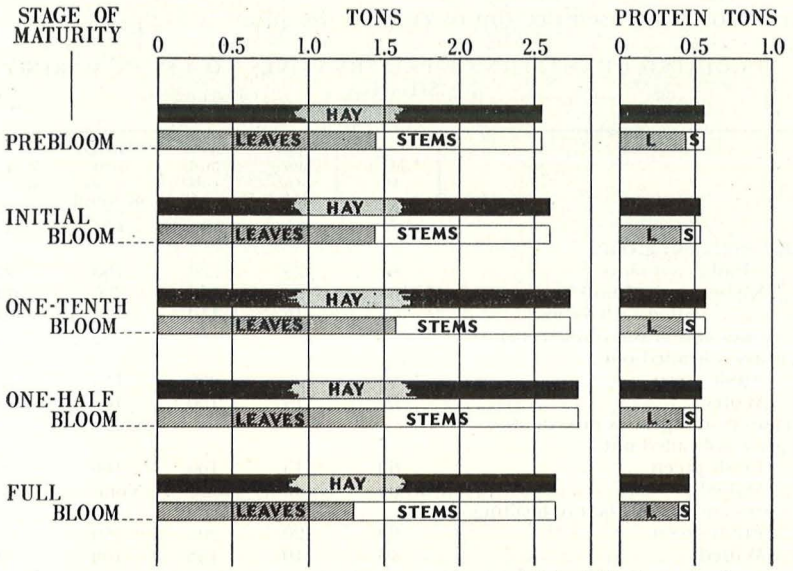
* This is liquid molasses. If dried molasses is used, decrease by 50 per cent.

Silage should be fed after milking and preferably outside so that the silage will not cause off flavors in milk.

Dry roughages. Hay is the basis for winter feeding. Climatic conditions, stage of maturity, methods of handling, and fertility of the soil influence the quality of hay. Green, fine-stemmed, leafy alfalfa is the best roughage available in Nebraska. Regardless of the variety of legume or grass, the quality is best and the protein highest when it is harvested in an early stage. Alfalfa harvested when from one-tenth to one-half in bloom will make up 50 per cent of its weight and 75 per cent of its protein content from the leaves. As the plant matures, the available protein decreases and the hay is more stemmy.

In other words, the proportion of stems to leaves increases. The carotene, forerunner of vitamin A, is closely related to the green color; therefore, it is important to conserve the green hay. Brome and alfalfa mixture makes a good hay, but it is slightly lower in protein than alfalfa alone. Red clover is similar to alfalfa but slightly lower in protein and less palatable. The protein yield per acre is highest if red clover is cut when 50 per cent in bloom.

THE YIELDS OF HAY AND PROTEIN PER ACRE ARE INFLUENCED BY THE STAGE OF MATURITY AT WHICH ALFALFA IS CUT.



The largest yields of high-grade hay are obtained if alfalfa is cut when one-tenth to one-half in bloom. The yield of protein per acre shows little variation during the prebloom, initial-bloom, tenth-bloom and half-bloom stages. At the half-bloom stage of growth of alfalfa about half the total hay consists of leaves, but they contribute approximately three-fourths of the total protein.

Sweetclover makes a fair roughage if cut before the plant is too large and stemmy. This legume is more difficult to cure properly. Sweetclover contains a factor that interferes with the normal clotting of blood; therefore, animals eating sweetclover should not be dehorned or castrated because of excess bleeding or even death. Sweetclover is better when used for pasture or silage than when used for hay.

Soybean hay is high in protein, being equal to alfalfa. Soybeans make a good emergency hay crop but are more profitable when harvested for their beans. Soybeans are harder to cure properly than alfalfa.

Prairie hay or hay made from many of the native grasses is low in protein and not as palatable as the hay from legumes. The protein of the prairie or native grass hays is highest when cut at a very early stage. These hays can add a little variety to the cow's ration, but are best fed to calves. If fed to cows as all or part of the roughage, it is necessary to increase the protein content of the grain ration.

Sudan grass, millet, or oat hays are low in protein and minerals and are poor roughages for dairy cattle. They can be used in times of emergency, but results will be disappointing unless the protein content of the grain ration is increased. Fodders from the sorghums are similar to sudan grass hay; however, there is more waste. These fodders are very fibrous. A great deal of waste occurs in the field before and after corn and sorghum fodders are harvested. The growth of sorghums is sometimes checked or stopped by drouth, frost, trampling, mowing or wilting. After that, there is danger of prussic acid poisoning, particularly if the new growth is grazed. When sorghums are properly cured as hay or dry fodder, the poisonous property is greatly reduced. Silage made from sorghums is generally safe. Corn stover, which is the corn plant with the ears removed, is lower in feed value than corn fodder. When corn stover is fed, the amount of corn eaten can be more easily regulated by means of the grain ration.

Forage sorghums and corn yield more and make a better feed when harvested for silage. The feed from an acre of corn fodder has less feed value than when the corn is harvested for silage.

Cured sugar beet tops make a good roughage high in carbohydrates and low in protein. About 20 per cent of the sugar beets produced per acre can be calculated as cured sugar beet tops. For example, 10 tons of sugar beets per acre should yield about 2 tons of cured tops.

One of the miscellaneous roughages available in Nebraska is bean straw, from the Great Northern bean, a ton of which, when of good quality, is equal to about 800 pounds of alfalfa. Another roughage is the straw secured when alfalfa is threshed for seed.

Grinding hays or fodders does not change their composition nor increase their digestibility. Cows do not have an opportunity to sort out the better parts, and thus eat more fiber and a smaller percentage of leaves. Numerous experiments have shown that grinding does not pay. Cows do not like hays or fodders ground too fine, and then there is danger of impaction in the digestive tract when eaten. If roughages are very scarce and of poor quality and grinding can be done at a reasonable cost, there might be some justification for it.

The chopping of hays or fodders makes it possible to store more feed in a limited space.

The importance of feeding roughages of high quality cannot be too strongly emphasized. The total nutrients produced per acre are

highest with the roughages. Hay improperly cured, which causes the leaves and color to be lost, is of inferior quality. Weeds reduce the quality of hay and pasture, and should be eliminated. The losses that occur in hay-making are: (1) Losses of leaves and other finer parts by shattering; (2) Losses by fermentation and bleaching; and (3) Losses of nutrients by leaching, owing to heavy rains.

Hay mowed very early in the morning is drier by evening than hay mowed later or about noon. The practice of mowing hay early on a clear morning can contribute to better-quality hay.

Baling hay from the windrow is becoming a common practice. Hay of good quality can be made with the windrow baler, if these precautions are followed:

1. Hay when baled should not contain more than 25 per cent moisture.
2. Hay should not be packed too tightly in the bale. With a moisture content of 25 per cent, the bales should not weigh more than 8 pounds per cubic foot. Drier hay can be packed a little tighter.
3. Bales stored in the hay mow should be placed on edge. Place the fold edge of one bale next to the chaff edge of the next one and with the alternate layers at right angles. Bales should not be crowded close together. Loose hay should be removed from a top of a layer of bales before the next layer is placed on it.

Although weather conditions cannot be controlled, everything else that can be done to produce quality roughage is to the dairyman's advantage.

GRAINS

A combination of the grains are fed dairy cattle to supplement the nutrients of the roughages. The costly part of the milk cow's ration is the grain. Cows receive about 75 per cent of their total nutrients from roughages and 25 per cent from the grain mixture. About 65 per cent of the nutrients are required for body maintenance and 35 per cent for milk production. Dairy herd improvement association records during the past few years show that the cost of roughages has been practically 46 per cent, and the cost of grain 54 per cent of the total feed cost. Although the most expensive part of the ration is the grain, cows producing in the profitable brackets must receive part of their nutrients from the concentrates. A skilled feeder will vary the amount and protein content of the grain ration with the quality of roughage fed. Home-grown grain should be the basis of the grain ration.

Corn is very palatable, high in carbohydrates and low in protein. Is is the best energy- and heat-producing grain grown on Nebraska farms. Corn should not be fed alone, although it should make up a large proportion of the concentrates fed.

Corn and cob meal or ground ear corn contains about 90 per cent of the nutrients of ground shelled corn. There is little feed value in corn cobs or the husks which appear on ground, snapped corn.

Oats are an excellent cow feed. They are bulky, cooling, palatable, and of the home-grown grains, one of the highest in protein. They should be one of the important grains in the grain ration. Oats are slightly higher in digestible protein, and a little lower in total digestible nutrients than corn.

Wheat is a little pasty or heavy, but is well liked by dairy cows. It has practically the same feed value as corn, but needs to be mixed with lighter feeds. Not over one-third of the grain ration should be wheat.

Rye is equal to corn or wheat in feed value, but not as palatable. Probably not over one-third of the ration should be rye.

Grain sorghum is equal to corn. If the grain is not ground, about one-half of it passes through the cow unchewed and undigested.

Soybeans are an excellent source of protein equal in value to linseed oil meal, when fed cracked or ground. Results show no harmful effects when soybeans are used liberally in the grain ration.

Culled beans, sorted out from first-quality beans in western Nebraska, are a good protein substitute. They have 50 per cent of the value of cottonseed meal, but should not make up more than one-fifth of the concentrate mixture. They are rather unpalatable unless mixed with other grains.

All home-grown grains should be ground before feeding. Grain should be ground to a medium degree, not fine. This means that grain should be gritty, not mealy or floury. Crushed or rolled grains have the same value as medium-ground grains. During the process of grinding or when the grain is mixed after grinding, additional supplements can be added.

BY-PRODUCT FEEDS

Many by-products are available on the market and are excellent feeds. They should be mixed or blended with home-grown grains.

Wheat bran is bulky, well liked by cows, high in phosphorus, and a good source of protein. It makes an excellent feed for dairy cattle when mixed with home-grown grains. It has about the same feed value as oats and is a good substitute for them.

Linseed oil meal is the product left after oil is extracted from flax. It is an excellent source of protein, palatable and slightly lax-

ative. **Cottonseed oil meal** is slightly higher in protein than linseed oil meal but not as laxative or palatable. **Soybean oil meal** is the meal left after oil has been removed from the beans. It has about the same protein content as cottonseed oil meal, but is lower in phosphorus.

Safflower oil meal is manufactured in western Nebraska and is the product left after oil is removed from the safflower seed. Meal from the hulled seed is slightly higher than linseed meal in protein, while meal from the unhulled seed is about one-half as high.

Corn gluten meal is a by-product from the manufacture of starch. It is about the same as soybean oil meal in digestible protein but the protein is of lower quality. Gluten meal is heavy and needs to be combined with bulky feeds.

Corn gluten feed is a by-product from the manufacture of corn starch, but should not be mistaken for corn gluten meal as it contains only 60 per cent as much digestible protein. It is slightly less palatable than corn, oats, and wheat bran and needs to be blended with other feeds.

Brewers' dried grain and **distillers' dried grain** are by-products from the manufacture of alcohol and liquors from corn, barley and other grains. Brewers' dried grain equals corn gluten feed in digestible protein, but is lower in total digestible nutrients. Brewers' dried grain is not very palatable and should not make up over one-third of the concentrates. Distillers' dried grain is relatively high in protein and high in fat. It is slightly superior to corn gluten feed. Other by-products secured from grains are malt sprouts and wet brewers' grain.

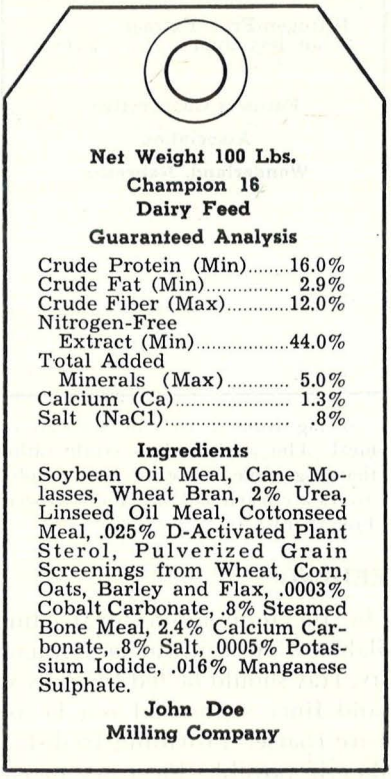
Dried sugar beet pulp is obtained by drying part of the residue left after sugar is extracted from beets. It may be dried with or without molasses. This feed is palatable, bulky, slightly laxative and keeps well in storage. It is high in carbohydrates, but relatively low in protein. Dried sugar beet pulp may be fed dry or soaked. It makes an ideal feed for filling show cattle.

Molasses is used as an appetizer. Sometimes it can increase the palatability of feeds. In general, the nutrients purchased in molasses are more costly than in home-grown grains.

Urea is a manufactured nitrogen product which dairy cows can use as a source of protein. One pound of urea contains as much nitrogen as 6.4 pounds of cottonseed or soybean meal, but contains no food energy. One pound of urea plus 6 pounds of grain replaces 7 pounds of oil meal. Urea must be thoroughly blended and completely mixed with the grain. Urea should be fed at a rate not greater than 3 per cent of the concentrate mixture. It should not be used in calf starter rations.

PREPARED DAIRY FEEDS

Many different commercial dairy feeds are sold on the market. The quality of the feeds varies. Some are of excellent quality and others of low quality. For individuals milking a few cows and buying all their feed, perhaps it is justifiable to purchase a prepared feed. Individuals who raise grains can most economically balance the grain ration with one of the high protein concentrates, such as soybean oil meal, cottonseed oil meal, linseed oil meal or corn gluten meal. Concentrates should be compared on the basis of digestible protein. The most important factor in purchasing supplements is the cost of a pound of digestible protein.



Net Weight 100 Lbs.

Champion 16
Dairy Feed

Guaranteed Analysis

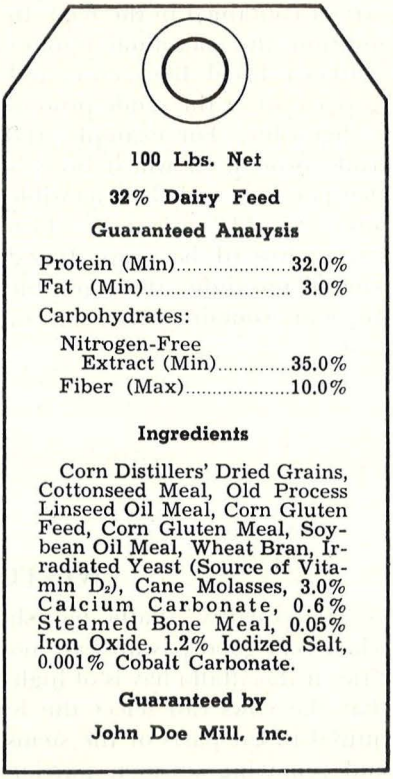
Crude Protein (Min).....16.0%
Crude Fat (Min)..... 2.9%
Crude Fiber (Max).....12.0%
Nitrogen-Free
Extract (Min).....44.0%
Total Added
Minerals (Max)..... 5.0%
Calcium (Ca)..... 1.3%
Salt (NaCl)..... .8%

Ingredients

Soybean Oil Meal, Cane Molasses, Wheat Bran, 2% Urea, Linseed Oil Meal, Cottonseed Meal, .025% D-Activated Plant Sterol, Pulverized Grain Screenings from Wheat, Corn, Oats, Barley and Flax, .0003% Cobalt Carbonate, .8% Steamed Bone Meal, 2.4% Calcium Carbonate, .8% Salt, .0005% Potassium Iodide, .016% Manganese Sulphate.

John Doe
Milling Company

A tag from a sack that contains a medium amount of protein. Generally the fiber is higher than in the higher protein feeds. The feed also contains more grain screenings. The urea is a nonprotein nitrogen.



100 Lbs. Net

32% Dairy Feed

Guaranteed Analysis

Protein (Min).....32.0%
Fat (Min)..... 3.0%
Carbohydrates:
Nitrogen-Free
Extract (Min).....35.0%
Fiber (Max).....10.0%

Ingredients

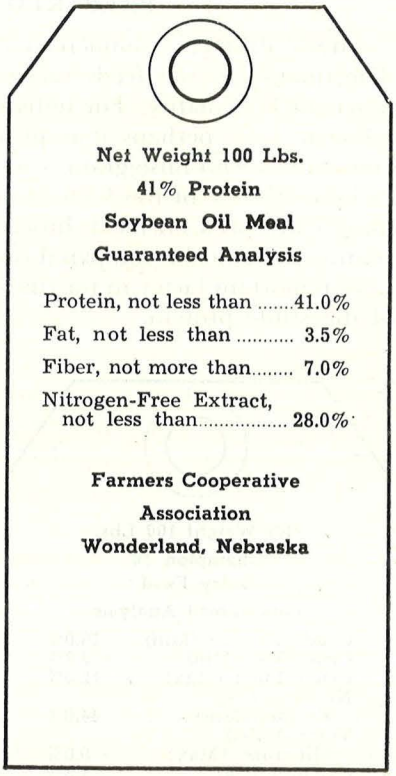
Corn Distillers' Dried Grains, Cottonseed Meal, Old Process Linseed Oil Meal, Corn Gluten Feed, Corn Gluten Meal, Soybean Oil Meal, Wheat Bran, Irradiated Yeast (Source of Vitamin D_2), Cane Molasses, 3.0% Calcium Carbonate, 0.6% Steamed Bone Meal, 0.05% Iron Oxide, 1.2% Iodized Salt, 0.001% Cobalt Carbonate.

Guaranteed by

John Doe Mill, Inc.

A tag from a sack of feed relatively high in protein. The analysis shows crude, not digestible nutrients. Generally the quantities of the ingredients are varied, depending upon their price.

Nebraska laws require that the manufacturers of commercial feeds and mineral mixtures label their products. The analysis placed on the feed tag shows the minimum amounts of crude protein, fat, and nitrogen-free extract contained in the feed. In addition, the maximum amount of fiber is listed. Between 75 and 85 per cent of the crude protein is digestible. For example, the crude protein in wheat bran is 16.9 per cent and the digestible protein is 13.7 per cent. This factor should be considered when determining the digestible nutrients contained in a sack of feed.



A tag from a sack of soybean oil meal. The analysis lists crude rather than digestible nutrients. The carbohydrates are listed as Fiber and Nitrogen-Free Extract.

WINTER FEEDING

High-quality alfalfa hay should be the foundation for feeding when very good pastures are not available. Cows will eat large quantities if the alfalfa hay is of high quality. Hay should be fed liberally so that the cows can select the leaves and finer stems and not be required to eat parts of the stems that are coarse. Providing fresh hay and removing uneaten portions makes it possible for cows to eat larger amounts. Hay should be fed in large feed racks or roomy places where the cows can eat freely without disturbance. If only good-quality hay is fed, three to four pounds per 100 pounds of live weight is needed per day. This is the amount actually consumed, and does not include the hay which might be wasted.

Feed silage liberally. This succulent, palatable feed will help keep the cows in good physical condition. About three pounds of silage will replace one pound of alfalfa hay. Large cows can eat 75 to 80 pounds silage daily, but rarely is it advisable to feed this much. If hay is limited, then silage can help spread the supply over a longer period.

The grain ration should contain home-produced ground grains and be palatable. In addition, it should be economical. It is important to handle and store ground grains and feeds so that they are highly palatable. Feed mixtures which become moldy, musty, rancid, burnt or weevily will not be relished by the cows. Rats, mice, or chickens many times lower the palatability of feeds by running over them while in storage. If roughage is limited, the grain ration needs to be bulkier than when good-quality roughage is fed liberally.

After cows eat all the high-quality roughage possible, then feed grain according to some good plan. Different rules can be used in determining the amount of grain to feed. For Ayrshires, Brown Swiss, Holsteins and Milking Shorthorns that are producing more than 18 pounds of milk daily, feed one pound of grain for each 3½ to 4 pounds of milk produced. For Guernseys and Jerseys that are producing more than 12 pounds of milk daily, feed one pound of grain for each 3 to 3½ pounds of milk produced.

The amount of grain fed milk cows should be determined by the size of the animal, quantity of milk produced and the butterfat content of the milk. The table below is a good guide as to the amounts of grain to feed.

GUIDE FOR FEEDING GRAIN

Daily milk production	Milk testing		
	3% to 4% fat	4% to 5% fat	5% to 6% fat
	Grain to be fed daily	Grain to be fed daily	Grain to be fed daily
Lbs.	*Lbs.*	*Lbs.*	*Lbs.*
15*	2.5	4.5	6.0
20	4.0	6.0	8.0
25	6.5	8.0	10.0
30	8.0	11.0	13.0
35	10.0	13.5	16.0
40	12.0	15.0	18.0
45	14.0	17.0	20.0
50	16.0	20.0	22.0
55	18.0	22.0	
60	20.0	22.0	
65	22.0	24.0	
70 or above	24.0	24.0	

* With good quality legume roughage, cows of the lower-testing breeds do not need grain until they produce 18 pounds milk daily, and cows of the higher-testing breeds, 12 pounds milk daily.

When the large quantities of grain are fed, it is important that the condition of the cows be closely observed. Regardless of the amount of grain required by a cow, she should not be fed more than she can safely handle.

The amount of protein in the grain ration should vary with the protein content of the roughage. With high-quality alfalfa hay fed liberally, it is necessary to add only small quantities of a protein concentrate to home-grown grains. As the protein content of the roughage decreases, larger quantities of a protein concentrate should be mixed with the home-grown grains. A number of suggested rations have been prepared, using different combinations of grains, by-products and protein concentrates to be fed with roughages of different protein levels. For suggested grain rations, see the following tables.

SUGGESTED GRAIN RATIONS (10 TO 12 PER CENT DIGESTIBLE PROTEIN) TO USE WITH A HIGH-PROTEIN ROUGHAGE

(Nebraska's best high protein roughage is green, leafy, fine-stemmed alfalfa or red clover hay fed without silage.)

Feed	Mix 1	Mix 2	Mix 3	Mix 4	Mix 5	Mix 6
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Ground corn	500	.....	.....	400	.....	.....
Ground corn & cobs	.....	500	.....	.....	.....	.....
Ground grain sorghums	.....	.....	.....	.....	400	.....
Ground oats	300	300	400	.....	300	200
Ground barley	.....	.....	400	300	.....	400
Wheat bran	150	100	200	250	250	.....
Dried beet pulp	.....	.....	.....	.....	.....	300
*High-protein feed	50	100	.....	50	50	100
Total	1000	1000	1000	1000	1000	1000

SUGGESTED GRAIN RATIONS (12 TO 14 PER CENT DIGESTIBLE PROTEIN) TO USE WITH A MEDIUM-PROTEIN ROUGHAGE

(An example of a medium-protein roughage is alfalfa hay and corn or cane silage, or a mixture of alfalfa and prairie hay.)

Feed	Mix 1	Mix 2	Mix 3	Mix 4	Mix 5	Mix 6
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Ground corn	400	.....	.....	350	.....	.....
Ground corn & cobs	.....	400	.....	.....	.....	.....
Ground grain sorghums	.....	.....	.....	.....	400	.....
Ground oats	300	200	300	.....	300	100
Ground barley	.....	.....	400	300	.....	400
Wheat bran	150	200	200	200	100	.....
Dried beet pulp	.....	.....	.....	.....	.....	300
*High-protein feed	150	200	100	150	200	200
Total	1000	1000	1000	1000	1000	1000

* High-protein feeds include cottonseed oil meal, linseed oil meal, corn gluten meal, soybean oil meal, and ground soybeans.

SUGGESTED GRAIN RATIONS (16 TO 18 PER CENT DIGESTIBLE PROTEIN) TO USE WITH A LOW-PROTEIN ROUGHAGE

(A low-protein roughage is cane or corn fodder, or prairie hay fed with or without corn or cane silage.)

Feed	Mix 1	Mix 2	Mix 3	Mix 4	Mix 5	Mix 6
				Lbs.	*Lbs.*	*Lbs.*
Ground corn	300	.....	.....	200	.....	.....
Ground corn & cobs	.....	250	.....	.....	.....	.....
Ground grain sorghums	.....	.....	.....	.....	250	.....
Ground oats	200	250	250	.....	250	100
Ground barley	.....	.....	300	300	.....	350
Wheat bran	200	200	200	200	200	.....
Dried beet pulp	.....	.....	.....	.....	.....	200
*High-protein feed	300	300	250	300	300	350
Total	1000	1000	1000	1000	1000	1000

* High-protein feeds include cottonseed oil meal, linseed oil meal, corn gluten meal, soybean oil meal, and ground soybeans.

The grain ration should be kept economical. It is necessary to change grain rations at different times, depending upon prices. The digestible protein of the grain ration is the most expensive part and is the determining factor as to what should be in the ration. On page 31 is shown what a pound of digestible protein costs when feeds sell at different prices.

By using different tables in this bulletin it is possible to determine the digestible protein percentage and its costs in the grain ration.

1. Multiply the per cent of digestible protein in each feed (see table 3, pages 28 and 29) by the number of pounds of that feed in the mixture.
2. Add the results.
3. Divide the sum by the total pounds of the mixture.
4. Multiply the result by 100, which will give the per cent of digestible protein.

EXAMPLE

Feed	Pounds	Per cent digestible protein	Pounds digestible protein
Ground corn	500	7.4	37.0
Ground oats	300	9.4	28.2
Wheat bran	150	13.7	20.5
Cottonseed oil meal	50	37.9	18.9
	1000		104.6

104.6 ÷ 1000 = .1046.

.1046 x 100 = 10.46 or 10.5 per cent.

This grain ration contains 10.5 per cent digestible protein and can be fed with a high-protein roughage like good, green, leafy al-

falfa hay. To increase the protein content of this grain ration, replace some of the low-protein grain (corn) with a high-protein feed (cottonseed oil meal).

To determine what feeds to buy, compare the cost of one pound of digestible protein in different feeds. The protein concentrates are purchased to supplement the home-grown grains and to increase the protein content of the grain mixture.

1. Determine the cost of the feeds on a hundredweight basis.
2. Determine the pounds of digestible protein in the feed.
3. Divide the cost by the pounds of digestible protein in the feed.

EXAMPLE

Feed	Pounds	Cost	Per cent digestible protein	Pounds digestible protein
Cottonseed oil meal	100	4.00	37.9	37.9

$4.00 ÷ 37.9 = .1055 or 11c cost per pound digestible protein.

SUMMER FEEDING

The basis of summer feeding is good, luscious pasture. Early in the spring the grasses are high in protein and carotene. As they mature in July and August, the protein and carotene content decreases. Cows on good pastures early in the season will need less grain than later in the season when the amounts of feed from the grasses decrease.

Turn cows on pastures in the spring when the grass is 4 to 6 inches tall and thick enough so that cows can fill in a short time. Grasses at first are watery and dry feed is needed when they are changed from winter to summer feeding. A rack kept full of hay in the pasture is a good feeding practice. When pastures are abundant the amount of grain fed can be reduced and then increased the latter part of the season. Cows of the lower-testing breeds, producing more than 18 pounds milk daily, need to be fed about one pound of grain to each five pounds of milk produced. Cows of the high-testing breeds need about one pound of grain to four pounds milk. The protein content of the grain ration should be the same as the one fed cows eating a good-quality, high-protein roughage. (See Grain Rations, page 22.)

As pastures mature and feed decreases, increase grain to practically a winter feeding level, using the grain ration fed to cows on a medium-protein roughage. (See Grain Rations, page 22.)

In addition, the feeding of silage when pastures are short is an excellent practice.

FEEDING DRY COWS

During the period when cows are dry, they should gain in weight. This is the time to get cows in good condition. Cows dry two months or less probably cannot be over-conditioned during that period. Cows in good condition at calving time will produce more after freshening and their milk will test higher than when they are thin. The amount of grain fed daily will depend upon the size of the cow, her condition and the length of the period she is dry. Most cows can use three to six pounds of grain daily. One needs to use his best judgment in getting cows in the proper condition before freshening. Large cows, thin in flesh, with a short rest period (three to six weeks) may need 10 to 12 pounds grain daily to properly prepare them for their next lactation. In addition, dry cows need all the good-quality roughage they will eat.

The grain ration fed cows two weeks before freshening and after freshening should contain very little corn and more of the bulkier feeds like oats and wheat bran.

FEEDING COWS AT CALVING TIME

Before they calve, cows should receive a grain ration that has a laxative and cooling effect. This type of ration causes a cow to clean more easily and reduces the inflammation in the udder. The grain ration before and after calving should be made up of oats, wheat bran and one of the oil meals.

A good ration to feed at this time is:

Ground oats	5 parts
Wheat bran	4 parts
Soybean oil meal	1 part

Immediately after calving, feed cows bran made into a mash with warm water. If bran is not available, use ground oats.

Feed the light cooling ration for four or five days after calving, changing over gradually to the regular grain ration. It will take a few weeks before cows are producing their maximum, and during this period the grain should be gradually increased.

FEEDING HERD BULLS

The herd bull needs the proper feeds for development and normal functions. Mature bulls on good pastures need only small quantities of grain, while young growing bulls will need larger amounts. Bulls that are confined need good roughage and a small amount of silage. There is always danger of bulls developing too much of a paunch. A mixture of alfalfa and prairie hay is better than alfalfa alone.

The amount of grain will depend upon the size and condition. About 0.5 pound grain is needed for every 100 pounds live weight. A 1600-pound bull should have about 8 pounds grain plus 16 to 18 pounds of hay daily.

The digestible protein in the grain ration should not exceed 12 to 14 per cent. In general, the protein content can be lower than that used for producing cows. Simple grain mixtures are just as good for bulls as complicated ones.

THE USE OF FEEDING STANDARDS

For practical purposes it is not necessary to prepare rations for individual cows. A ration prepared for the entire herd using the maximum amounts of roughages and home-grown grains balanced with protein concentrates to fit the kind of roughage available will fulfill practically all the needs for feeding dairy cows in Nebraska.

There is some value in knowing how to balance rations for individual cows on the basis of digestible protein and total digestible nutrients. This method can be followed for the entire herd if a ration is balanced for an average cow in the herd.

First, cows use feed for the maintenance of their bodies. Table 1 shows the amounts of digestible protein and total digestible nutrients required for the maintenance of cows of different sizes.

TABLE 1.—DAILY REQUIREMENTS FOR MILK COWS*

Maintenance (recommended)	Digestible protein	Total digestible nutrients
Weight of cow (lbs.)	*Lbs.*	*Lbs.*
800	0.54	6.5
900	0.59	7.2
1000	0.65	7.9
1100	0.71	8.6
1200	0.76	9.3
1300	0.82	10.0
1400	0.87	10.6
1500	0.92	11.3
1600	0.98	11.9
1700	1.03	12.6
1800	1.08	13.2

* From Morrison's "Feeds and Feeding," 21st Edition.

In the requirements of digestible protein and total digestible nutrients, there is some variation; however, those shown in table 1 are the amounts advised under usual conditions.

In addition to maintenance requirements, nutrients are required for milk production. In table 2 are the recommended nutrients for each pound of milk containing different percentages of butterfat.

TABLE 2.—REQUIREMENTS FOR MILK PRODUCTION *

Milk production (recommended)	Digestible protein	Total digestible nutrients
	Lbs.	*Lbs.*
For each 1 lb. of 3.0% milk	0.043	0.28
For each 1 lb. of 3.5% milk	0.046	0.30
For each 1 lb. of 4.0% milk	0.049	0.32
For each 1 lb. of 4.5% milk	0.052	0.35
For each 1 lb. of 5.0% milk	0.056	0.37
For each 1 lb. of 5.5% milk	0.059	0.40
For each 1 lb. of 6.0% milk	0.062	0.42

* From Morrison's "Feeds and Feeding," 21st Edition.

The daily requirements for a cow that weighs 1200 pounds and produces 48 pounds of 4 per cent milk are as follows:

	Digestible protein	Total digestible nutrients
1200-lb. cow maintenance (from table 1)	.76	9.3
48 lbs. of 4 per cent milk (from table 2) (48 x .049 and 48 x .32)	2.35	15.4
Total requirements	3.11	24.7

Now that the total requirements are known, the problem is to furnish them from the feeds available or purchased. Available are alfalfa hay, corn silage and grain mix No. 1 recommended for use with a medium-protein roughage (page 22).

Nutrients furnished by different amounts of feeds are as follows:

		Digestible protein	Total digestible nutrients
		Lbs.	*Lbs.*
Alfalfa hay—15 lbs. (15 x .105 and .503)		1.57	7.5
Corn silage—40 lbs. (40 x .012 and .18)		.48	7.2
Nutrients furnished by roughage		2.05	14.7
Ground corn (400 x .074 and .837)	400 lbs.	29.60	334.8
Ground oats (300 x .094 and .701)	300 lbs.	28.20	210.3
Wheat bran (150 x .137 and .672)	150 lbs.	20.55	100.8
Soybean oil meal (150 x .372 and .784)	150 lbs.	55.80	117.60
Total	1000 lbs.	134.15	763.50
Nutrients in 1 pound		.134	.763
Nutrients required		3.11	24.7
Nutrients furnished by roughage		—2.05	—14.7
Nutrients required from grain		1.06	10.0
Nutrients furnished by 12 lbs. grain		1.61	9.16
Difference		+ .55	— .84

This combination of feeds, fed as recommended, furnishes slightly more protein than required and slightly less total digestible nutrients, but is close enough for all practical purposes.

TABLE 3.—THE AMOUNTS OF TOTAL PROTEIN, DIGESTIBLE PROTEIN AND TOTAL DIGESTIBLE NUTRIENTS IN COMMON FEEDS

Feeds	Constituents per 100 lbs. feed		
	Total protein	Digestible protein	Total digestible nutrients
	Lbs.	*Lbs.*	*Lbs.*
Concentrates			
Barley	12.7	10.0	77.7
Beans, field or navy	22.9	20.2	78.7
Beet pulp, dried	9.2	4.3	67.8
Beet pulp, molasses, dried	10.7	7.1	72.1
Brewers' grain, dried	25.6	20.7	65.3
Corn-and-cob meal	7.3	5.3	73.2
Corn, dent	9.7	7.4	83.7
Corn gluten feed	25.5	21.9	76.0
Corn gluten meal	43.1	36.6	80.2
Cottonseed meal (45% protein and over)	46.2	37.9	78.4
Distillers' grain, with solubles dried from corn	28.8	21.0	80.9
Distillers' grain, dried from rye	18.5	11.1	60.8
Flaxseed	24.0	21.8	108.3
Grain sorghums	9.5	5.8	77.5
Linseed meal	35.4	30.8	77.2
Linseed meal (37% protein or over)	38.0	33.1	77.4
Malt sprouts	26.8	20.6	70.9
Molasses, cane	2.9	0.0	54.0
Oats	12.0	9.4	70.1
Oats, light weight	12.3	8.5	60.1
Rye	12.6	10.0	76.1
Safflower seed oil meal (hulled seed)	38.0	32.7	55.5
Soybean seed	37.9	33.7	87.6
Soybean oil meal	44.3	37.2	78.4
Tankage (60%)	60.6	51.5	68.4
Wheat bran	16.9	13.7	67.2
Wheat shorts (brown)	16.9	14.4	74.3
Wheat, average all type	13.2	11.1	80.0
Dry roughages			
Alfalfa	14.8	10.5	50.3
Alfalfa, dehydrated	18.9	13.8	54.7
Alfalfa and bromegrass hay	12.4	7.2	46.8
Clover, red	11.8	7.1	52.2
Corn fodder	6.8	3.3	53.9
Corn stover	5.8	2.0	45.5
Oat hay	8.2	4.9	47.3
Oat straw	4.1	0.7	44.7
Prairie hay	5.7	2.1	49.6
Sorghum fodder	6.2	3.3	52.4
Soybean hay	14.4	9.6	49.0
Soybean straw	4.0	1.2	38.5
Sudan grass hay	8.8	4.3	48.5
Sweetclover hay	13.5	9.4	47.3
Timothy hay	6.5	2.9	48.9
Succulent feeds			
Alfalfa, green	4.5	3.4	14.7
Beet pulp, wet	1.5	0.8	8.9
Blue grass, green (Kentucky pasture)	5.5	3.9	19.2
Brewers' grains, wet	5.7	4.6	16.6

TABLE 3.—*Continued*

Feeds	Constituents per 100 lbs. feed		
	Total protein	Digestible protein	Total digestible nutrients
	Lbs.	*Lbs.*	*Lbs.*
Corn cannery refuse	2.0	1.1	11.5
Mangels, roots	1.3	0.9	7.0
Potatoes	2.2	1.3	17.9
Silage, alfalfa (wilted)	6.0	4.1	21.3
Silage, alfalfa (high in water)	3.7	1.9	12.7
Silage, corn	2.2	1.2	18.1
Silage, corn and sorghum	1.9	1.0	16.4
Silage, grass, considerable legumes grain added	5.1	3.2	20.6
Silage, sorghum (grain)	2.1	1.1	17.8
Silage, sorghum (sweet)	1.6	0.8	15.2
Silage, soybean	4.2	2.6	15.0
Sugar beet tops	3.8	2.6	14.9

RELATIONSHIP BETWEEN PRICE PER BUSHEL AND 100 POUNDS OF COMMON FEEDS

Price per bushel	Cost per 100 pounds when a bushel weighs				
	32 lbs.	48 lbs.	56 lbs.	60 lbs.	70 lbs.
	(Oats)	(Barley)	(Shelled corn or rye)	(Soybeans or wheat)	(Ear corn)
$0.10	$0.32	$0.21	$0.18	$0.17	$0.14
.15	.47	.31	.27	.25	.21
.20	.63	.42	.36	.33	.29
.25	.78	.52	.45	.42	.36
.30	.94	.62	.54	.50	.43
.35	1.09	.73	.63	.58	.50
.40	1.25	.83	.71	.67	.57
.45	1.41	.94	.80	.75	.64
.50	1.56	1.04	.89	.83	.71
.55	1.72	1.15	.98	.92	.79
.60	1.88	1.25	1.07	1.00	.86
.65	2.03	1.35	1.16	1.08	.93
.70	2.19	1.46	1.25	1.17	1.00
.75	2.34	1.56	1.34	1.25	1.07
.80	2.50	1.67	1.43	1.33	1.14
.85	2.66	1.77	1.52	1.42	1.21
.90	2.81	1.87	1.61	1.50	1.29
.95	2.97	1.98	1.70	1.58	1.36
1.00	3.13	2.08	1.79	1.67	1.43
1.05	3.28	2.19	1.88	1.75	1.50
1.10	3.44	2.29	1.96	1.83	1.57
1.15	3.59	2.40	2.05	1.92	1.64
1.20	3.75	2.50	2.14	2.00	1.71
1.25	3.91	2.60	2.23	2.08	1.74
1.30	4.06	2.71	2.32	2.17	1.86
1.35	4.22	2.81	2.41	2.25	1.93
1.40	4.37	2.92	2.50	2.33	2.00
1.45	4.53	3.02	2.59	2.42	2.07
1.50	4.69	3.12	2.68	2.50	2.14

COMPARATIVE COST PER POUND OF TOTAL DIGESTIBLE NUTRIENTS IN FEEDS

	Total digestible nutrients in 100 lbs. of feed	Cost of feed per ton, dollars																						
		6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
	(Lbs.)	Cost of 1 pound of digestible nutrients, cents																						
Roughages																								
Alfalfa hay	50.3	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0										
Red clover hay	52.2	0.6	0.8	1.0	1.1	1.3	1.5	1.7	1.9	2.1	2.3	2.5	2.7	2.9										
Prairie hay	49.6	0.6	0.8	1.1	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0										
Soybean hay	49.0	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.1										
Grains																								
Barley	77.7			0.6	0.8	0.9	1.0	1.1	1.3	1.4	1.5	1.7	1.8	1.9	2.0	2.2	2.3	2.4	2.6	2.8	3.1	3.3	3.6	3.9
Corn	83.7			0.6	0.7	0.8	1.0	1.1	1.2	1.3	1.4	1.6	1.7	1.8	1.9	2.0	2.2	2.3	2.4	2.6	2.9	3.1	3.3	3.6
Oats	70.1			0.7	0.8	1.0	1.1	1.3	1.4	1.5	1.7	1.8	2.0	2.1	2.3	2.4	2.6	2.7	2.8	3.1	3.4	3.7	4.0	4.3
Wheat	80.0			0.6	0.7	0.9	1.0	1.1	1.3	1.4	1.5	1.6	1.8	1.9	2.0	2.1	2.3	2.4	2.5	2.7	3.0	3.2	3.5	3.7
Rye	76.1			0.6	0.8	0.9	1.0	1.2	1.3	1.4	1.6	1.7	1.8	2.0	2.1	2.2	2.4	2.5	2.6	2.9	3.1	3.4	3.7	3.9
Supplements																								
Beet pulp	67.8			0.7	0.9	1.0	1.2	1.3	1.5	1.6	1.8	1.9	2.1	2.2	2.3	2.5	2.6	2.8	2.9	3.2	3.5	3.8	4.1	4.4
Molasses, cane	54.0			0.9	1.1	1.3	1.5	1.7	1.9	2.0	2.2	2.4	2.6	2.8	3.0	3.1	3.3	3.5	3.7	4.1	4.4	4.8	5.2	5.6
Wheat bran	67.2			0.7	0.9	1.0	1.2	1.3	1.5	1.6	1.8	1.9	2.1	2.2	2.4	2.5	2.7	2.8	3.0	3.3	3.6	3.9	4.2	4.5

COMPARATIVE COST PER POUND OF DIGESTIBLE PROTEIN IN FEEDS

	Digestible protein in 100 lbs. of feed	Cost of feed per ton, dollars																						
		6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	44	48	52	56	60
	(Lbs.)	Cost of 1 pound of digestible protein, cents																						
Roughages																								
Alfalfa hay	10.5	2.9	3.8	4.8	5.7	6.7	7.6	8.6	9.5	10.5	11.4	12.4	13.3	14.3										
Red clover hay	7.1	4.2	5.6	7.0	8.5	9.9	11.3	12.7	14.1	15.5	17.1	18.3	19.7	21.1										
Prairie hay	2.1	14.3	19.0	23.8	28.6	33.3	38.1	42.9	47.6	52.4	57.1	61.9	66.7	71.4										
Soybean hay	9.6	3.1	4.2	5.2	6.2	7.3	8.3	9.4	10.4	11.4	12.5	13.5	14.6	15.6										
Grains																								
Barley	10.0			5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	22.0	24.0	26.0	28.0	30.0
Corn	7.4			6.8	8.1	9.5	10.8	12.2	13.5	14.9	16.2	17.6	18.9	20.3	21.6	23.0	24.3	25.7	27.0	29.7	32.4	35.1	37.8	40.5
Oats	9.4			5.3	6.4	7.4	8.5	9.6	10.6	11.7	12.8	13.8	14.9	16.0	17.0	18.1	19.1	20.2	21.3	23.4	25.5	27.7	29.8	31.9
Wheat	11.1			4.5	5.4	6.3	7.2	8.1	9.0	9.9	10.8	11.7	12.6	13.5	14.4	15.3	16.2	17.1	18.0	19.8	21.6	23.4	25.2	27.0
Wheat bran	13.7			3.6	4.4	5.1	5.8	6.6	7.3	8.0	8.8	9.5	10.2	10.9	11.7	12.4	13.1	13.9	14.6	16.1	17.5	20.0	20.4	21.9
Protein Supplements																								
Corn gluten feed	21.9								4.6	5.0	5.5	5.9	6.4	6.8	7.3	7.8	8.2	8.7	9.1	10.0	11.0	11.9	12.8	13.7
Corn gluten meal	36.6								2.7	3.0	3.3	3.6	3.8	4.1	4.4	4.6	4.9	5.2	5.5	6.0	6.6	7.1	7.7	8.2
Cottonseed meal	37.9								2.6	2.9	3.2	3.4	3.7	4.0	4.2	4.5	4.8	5.0	5.3	5.8	6.3	6.9	7.4	7.9
Linseed meal (37% and over)	33.1								3.0	3.3	3.6	3.9	4.2	4.5	4.8	5.1	5.4	5.7	6.0	6.6	7.2	7.8	8.4	9.1
Soybean meal	37.2								2.7	2.9	3.2	3.5	3.8	4.0	4.3	4.6	4.8	5.1	5.4	5.9	6.4	7.0	7.5	8.1
Soybeans	33.7								3.0	3.3	3.6	3.9	4.2	4.5	4.7	5.0	5.3	5.6	5.9	6.5	7.1	7.7	8.3	8.9

RATIONS CAN BE BALANCED FOR PRACTICAL PURPOSES BY USING THE INFORMATION BELOW

The procedure to follow is to decide which quality of roughage you are feeding—high, medium or low. Select a feed mixture under the roughage class. Your choice will be determined by the feeds you have on hand and by those you can get. See Groups of Feeds A, B, C, and D below. When feed of any group is called for, one or more may be used. If possible, *use three or more feeds in your mixture.*

High-Quality Roughage or Good Pasture

Good Green Leafy Alfalfa or Choice Clover Hay

Mix No. 1	**Mix No. 2*
900 lbs. — A Feed	800 lbs. — A Feed
100 lbs. — D Feed	150 lbs. — B Feed
	50 lbs. — D Feed

Mix No. 3

800 lbs. — A Feed
200 lbs. — C Feed

Medium-Quality Roughage or Fair Pasture

Good Mixed Hay or Fair Legume Hay, Fed with or without Corn Silage

Mix No. 4	**Mix No. 5*
750 lbs. — A Feed	600 lbs. — A Feed
250 lbs. — D Feed	200 lbs. — B Feed
	200 lbs. — D Feed

Mix No. 6

600 lbs. — A Feed
400 lbs. — C Feed

Low-Quality Roughage or Poor Pasture

Prairie or Other Grass Hay, Corn, or Cane Fodder, Fed with or without Corn Silage

Mix No. 7	**Mix No. 8*
650 lbs. — A Feed	500 lbs. — A Feed
350 lbs. — D Feed	200 lbs. — B Feed
	300 lbs. — D Feed

Mix No. 9

500 lbs. — A Feed
100 lbs. — B Feed
200 lbs. — C Feed
200 lbs. — D Feed

A FEEDS—Low in Protein Farm-Grown Grains

Ground Corn	Ground Barley
Corn & Cob Meal	Ground Oats

B FEEDS—Medium in Protein

16% Dairy Feed

Wheat Bran	Wheat Middlings

C FEEDS—Medium-Rich in Protein

Corn Gluten Feed	24% Dairy Feed
Dried Brewers' Grains	Distillers' Dried Grains

D FEEDS—Rich in Protein

Linseed Meal	Corn Gluten Meal
Soybean Oil Meal	Cottonseed Meal
Ground Soybeans	32% to 34% Dairy Feed

* BEST RATIONS

ADD—1 lb. salt and 1 lb. steamed bone meal to 100 lbs. grain mix.