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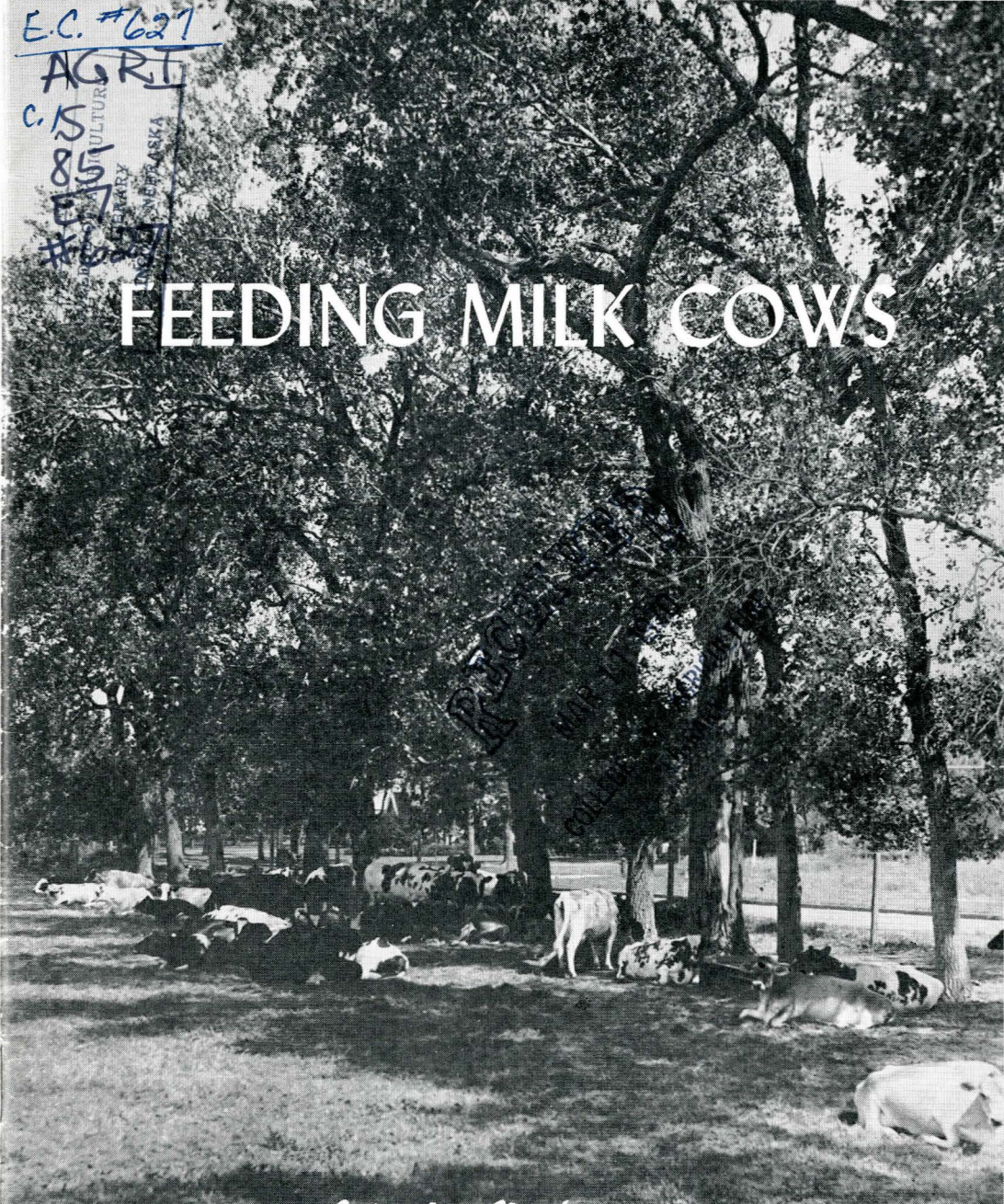

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Contents

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Feeding Milk Cows

H. P. Davis and M. N. Lawritson

THE primary purpose of keeping milk cows is to convert feed, labor and management into milk and money. To achieve this purpose, feed of the proper kind, quality and amounts must be supplied. Up to the limits of the inherited ability of the cow to produce milk, the amount of production obtained is directly dependent upon the feed and care which the cow receives. Successful feeding and management consist of getting the largest quantity of milk from the cow at the lowest cost, and doing this year after year.

A good, producing dairy cow is one of the most efficient animals on the farm, furnishing more human food from a given quantity of feed than does any other animal. For each 100 pounds of digestible organic matter consumed, she produces 18 pounds of edible solids in milk. Such milk production cannot be maintained unless energy to produce it is supplied.

Uses of Feed

A MATURE dairy cow uses feed chiefly for maintaining her body, for material to make milk, and for development of her unborn calf. A certain amount of feed is necessary to keep the cow's body in good working order for performing such duties as chewing and digesting food, pumping blood, making repairs in the body tissue, and providing energy for moving about. The feed needed for these various functions is called the "maintenance" requirement. In addition a cow should be supplied sufficient feed to assure profitable milk production and development of her unborn calf. A ration that exactly meets these needs in addition to the maintenance requirements is called a "balanced ration."

The first principle of feeding is plenty of feed, not only during the milking period but also during the dry period between lactations. A cow, if healthy, can be so fed that she can produce profitably for several successive lactation periods with no "off years." While dry, she needs to build up her body and replace materials that have been depleted as a result of a heavy milking period, and store nutrients in preparation for the succeeding lactation.

Nutrients Needed for Feeding Cows

FEEDS vary greatly in the proportions and availability of the various nutrients for use by animals. From experimentation, the requirements of animals for maintaining their bodies, for growth and milk production have been determined. A balanced ration will supply enough nutrients to keep a mature milking cow at a uniform weight, to develop her unborn calf, and to produce milk. In the case of immature animals additional nutrients are needed for growth. Part of the nutrients pass through the animal body undigested, part are used to furnish the energy for chewing and digesting the food, and part are wasted as gases. This is illustrated in Table 1.

It will be noted that equal quantities of these three common feeds have substantially equal quantities of total nutrients and of gross energy. Energy is power to do work and is usually measured by units of heat called calories. Digestion trials have determined that 80.6 pounds of

Table 1. Comparison of Nutrient Values.[1]

Kind of Feed	Quantity of Feed	Total Nutrients Protein Carbohydrates and Fat	Total Digestible Nutrients	Gross Energy	Net Energy
	lbs.	*lbs.*	*lbs.*	*Therms* [2]	*Therms* [2]
Corn Meal	100	88.77	80.6	201.49	92.58
Timothy Hay	100	86.77	46.9	204.94	48.63
Wheat Straw	100	83.77	35.7	201.58	11.07

[1] Adapted from "The Nutrition of Farm Animals," by H. P. Armsby, MacMillan Co.
[2] A therm is 1000 large calories and is the quantity of heat needed to raise 2200 lbs. of water one degree C.

the 88.77 pounds of total nutrients in corn meal are digestible nutrients, while in the case of wheat straw only 35.7 pounds of the 83.77 pounds of total nutrients are digestible. These differences indicate the losses due to the feed that passes through undigested, to the labor of chewing and digestion, and to the loss in gases. Gross energy does not allow for any losses, while net energy represents the actual nutritive value of the feed for use of the animal. On that basis corn meal with 92.58 therms is nearly twice as useful as timothy hay which has only 48.63 therms, and more than eight times as useful as wheat straw. While net energy is the most accurate method of measuring the respective feeding value of different foodstuffs, not enough research has been carried on to include the large number of feeds available, so the common practice when balancing rations is to use total digestible nutrients even though there are some obvious inaccuracies as evidenced in Table 1.

Protein. Protein is the general name given to a very large number of organic substances which contain nitrogen. Some protein is present in all common feeds. However, all proteins are not equal and their usefulness depends upon the quantity and proportion of certain vital amino acids which they contain. Since protein is essential for carrying on such vital functions as repair of tissue and making of blood, muscle and milk, it is important that there be an adequate quantity available. The standards that have been worked out for the protein requirements of maintenance, growth and milk production refer to total digestible protein. To insure the proper proportion of the several amino acids it is desirable to supply the protein in a ration from three or more different plant sources. Such a procedure will likely result in obtaining a fair balance of the essential amino acids which are the building blocks of protein. *There is no substitute for protein.*

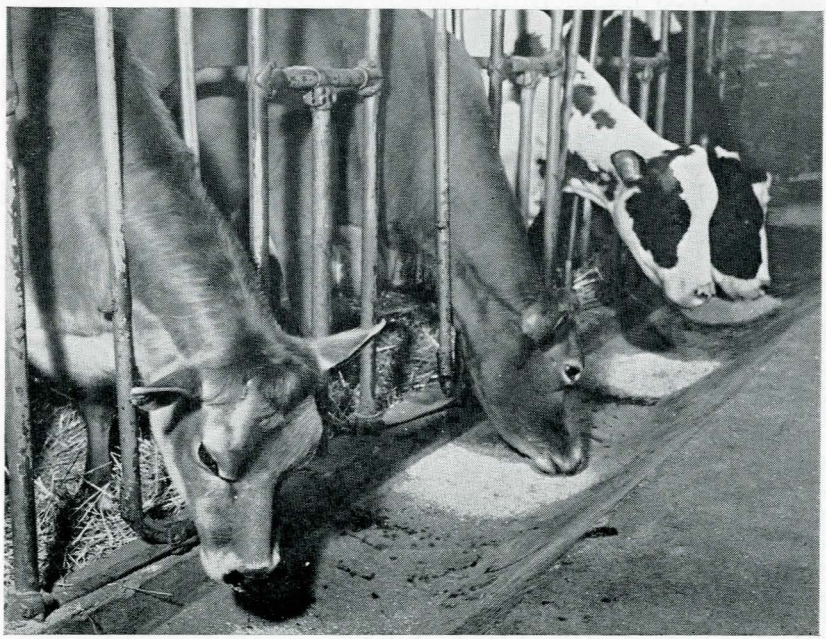
Grasses in the early stages of their growth contain enough of the right kind of protein to furnish a balanced ration for a cow giving a moderate quantity of milk. As grasses mature the percentage of protein becomes smaller, due to the large increase in carbohydrates, so that most dry roughages, with the exception of the legumes, have a low percentage of protein. Thus prairie hay, corn fodder, sorghum fodder, corn silage, sorghum silage and the cereal straws are very low in protein content. On the other hand legumes of good quality which include alfalfa, clovers, peas, beans and soybeans are relatively high in protein in the leaves, stems and seeds. Usually the most economical source of protein is home-grown legume hay. The richest sources of protein are by-product feeds such as soybean meal, cottonseed meal, linseed meal, corn gluten meal, corn gluten

feed, distillers' grains, brewers' grains, fish meal, meat and bone meal, and tankage.

Carbohydrates and Fats. Carbohydrates include the starches, crude fiber and sugars that are used by the cow for certain types of body repair, energy, and for production of milk. Roughages of various kinds, the cereal grains, roots, tubers and molasses are sources of carbohydrates.

Fats are compounds containing fatty acids that are used for many of the same functions as carbohydrates, especially for producing milk. As a source of energy, fats are 2¼ times as useful as carbohydrates. A grain mixture should contain not less than four per cent fat if the cow is to maintain a normal percentage of fat in the milk. Most common feeds contain enough fat, especially if some by-product of the oil seeds is a part of the ration. New methods of oil extraction are now coming into use which reduce the fat in by-product feeds to a low level and this may result in some shortage of fat in dairy rations.

Minerals. In most of Nebraska mineral deficiency is not a serious problem in the nutrition of cattle. There are, however, a few inorganic substances that are very important for the animal's health and proper body functions. Common salt is a necessity. While green pasture grasses are a good source of salt, additional amounts should be provided. A milk cow needs from one to two ounces of salt a day under most circumstances. This can be furnished by adding salt to the grain mixture, one per cent by weight. Boxes containing coarse salt, conveniently located but protected from the weather, are also desirable. Coarse salt is preferred to rock salt or salt blocks because the cow sometimes develops a sore tongue from the rock or block before her need for salt is satisfied.



Grain is usually fed in the barn at milking time.

There are regions in Nebraska which have an iodine deficiency, usually indicated by goiter (big neck) in cows or calves. The easiest and safest method of adding iodine to the ration is to use iodized salt in the grain mixture and in the salt or mineral boxes.

Calcium and phosphorus are two inorganic substances needed by cattle. Relatively large quantities of these minerals are needed for bone and teeth, for milk production, and for reproduction. Cows lacking in either or both of these minerals have a depraved appetite, may show a rheumatic condition, do not come in heat regularly, sometimes fail to conceive, and may give birth to weak or dead calves.

Cereals, particularly the corn plant, are deficient in these minerals in both the grain and the stalks or straw. Alfalfa and other legume hays are rich in calcium as are a number of the high protein concentrates. Calcium appears most commonly as limestone. Phosphorus commonly appears as a phosphate which is a combination of phosphoric acid with some other substance. Bone and teeth are composed largely of calcium phosphate. The phosphorus in the ration of a dairy cow can be supplied by such feeds as wheat bran or wheat middlings, cottonseed meal, tankage, meat and bone meal, and fish meal. For proper nutrition the relationship between calcium and phosphorus must not vary too widely or a deficiency of one may appear. In order to insure adequate quantities of both, steamed bone meal which contains each mineral in approximately the proper proportion may be added to the grain mixture in quantities varying from one to two per cent by weight. Steamed bone meal mixed with the salt in the proportion of one part bone meal to four parts salt can be used in the salt boxes to advantage, or if salt is provided in a separate box, then the mineral box may contain equal parts of bone meal and salt.

Other mineral deficiencies are not very common, but magnesium, manganese, iron and cobalt have been found to be lacking in a few places.

Vitamins. Much of the knowledge of vitamins has been gained from studies with small laboratory animals but enough research is now available to indicate that certain vitamins are essential for dairy cattle, with vitamin A the most important. Vitamin A in adequate quantities is essential for proper health and reproduction. Outward symptoms of its deficiency often can be observed as unthriftiness, rough coat of hair, small gain in weight, poor vision in semi-darkness, and susceptibility to infections, especially colds and pneumonia. Green forage is an excellent source of this vitamin as is green hay less than a year old. Artificially dried hays are a very potent source. Yellow corn stored less than a year is a fairly good source, as is properly preserved grass silage. Other cereal grains, various brown hays, all kinds of fodders and straws are poor sources of vitamin A. Care must be exercised, especially in the winter, to insure adequate quantities of this vitamin, since good-quality roughage is not always available.

Vitamin D is usually obtained from sunlight by animals in a normal environment. Where this vitamin is lacking, especially in young, growing animals, rickets may develop, commonly observed in the enlargement of joints, the arching of the back, and a stiffness of gait. Vitamin D interacts with calcium and phosphorus in building and repairing bone tissues. Sun-cured hay is a good source of vitamin D.

Vitamin E is concerned with the reproductive processes but since most green forage and many of the common concentrates appear to furnish adequate quantities of this vitamin the average cow seldom will show a

deficiency. A deficiency might develop where dry roughage of poor quality was fed and where the only concentrate was some cereal grain.

Vitamin C, or ascorbic acid, appears to be associated with successful reproduction. Cattle can produce ascorbic acid within their bodies, but it appears that if vitamin A is lacking there may actually develop a lack of vitamin C since the vitamins appear to function somewhat together. Ascorbic acid treatment apparently has restored normal breeding functions to some impotent bulls and some non-breeding cows. (For details consult local veterinarian.)

Water. Since the animal body is more than half water and milk is approximately 87 per cent water, it is evident that there should never be a lack of this vital substance. Several factors influence the quantity of water needed by a cow; among them are her size, the quantity of water in the feed, the quantity of milk being produced, and the atmospheric temperature. A large cow producing 100 pounds milk daily may drink as much as 350 pounds of water (over 40 gallons) in a day when receiving dry feed. In the winter on a ration of silage and hay, a 1000-pound cow producing 30 pounds of milk will consume between 60 and 80 pounds (seven to nine gallons) of water daily. Stated in another way, a cow will drink from two to six pounds of water for each pound of milk produced, depending upon the weather and the feed. It is not sensible, therefore, to limit the production of a milk cow by the failure to supply enough water. The ideal range of temperature for drinking water for cattle is between 40 and 60 degrees Fahrenheit. This means it may be necessary to warm the water in the winter time.

Summer Feeding with Pastures

PASTURE reduces to a minimum the labor required to feed and care for cows, insures that the manure is applied directly to the soil and, if not too costly, fits well into the farm plan. The main problem in feeding milk cows during the summer is furnishing enough good pasture. Grass should be permitted to get a good start before cattle are turned on it in the spring. For a short while they will eat very little, if any, hay although they will as a rule eat some grain. It is a good practice to let cows have a little dry roughage and some grain when grazing on pasture. This is especially important as the season advances. Care must be used not to over-graze pasture. The division of the area into small fields with freqeunt changing of cattle will usually provide more grazing.

Where a good stand of native pasture furnishes enough grazing it is not necessary to consider other pasture crops. However, in some sections of Nebraska other crops greatly improve grazing conditions.

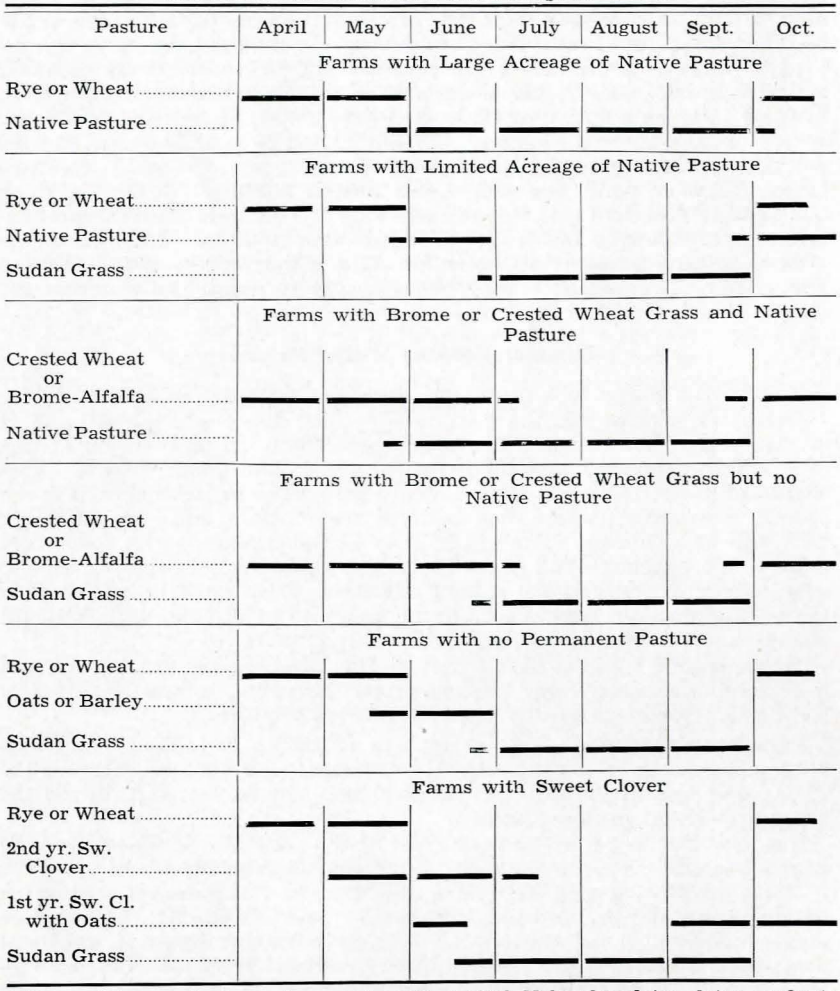
Permanent Pastures. Blue grass is a palatable, nutritious grass that withstands rather close grazing. It furnishes good pasture early in the spring and late in the fall. However it does not do too well during the dry, hot weather in mid-summer.

Bromegrass can be grown over most of the state and is especially well adapted to eastern Nebraska and on irrigated land elsewhere in the state. It starts growth early in the spring, lies more or less dormant during the middle of the summer, and continues growth late into the fall. Bromegrass is rather difficult to get started, but once established it makes an excellent permanent pasture. A few cases of bloat have been reported where brome-alfalfa mixture was pastured during mid-summer, when the brome is partially dormant and the alfalfa predominates.

Temporary Pastures. (See Tables 2 and 3.) Sweet clover has proved to be a very useful pasture crop in many sections of Nebraska. It furnishes considerable pasture the first year under favorable weather conditions, but should be pastured lightly that year in order not to reduce the yield the following year. If sweet clover is not pastured closely the second year, it grows up woody and is not palatable. Cattle should not be turned into sweet clover pasture until it is well started.

Caution must be exercised to guard against bloating. The first week that cattle are turned into sweet clover pasture it is a good plan to see that they are filled up on hay each morning before letting them on the

Table 2. A Well-Balanced Pasture Program—P–F–L.



These dates apply to eastern and south-central Nebraska; later dates apply to north-central and western Nebraska.

Table 3. Pasture Seeding.

Kind of Pasture	Time of Seeding	Rate of Seeding [1]	Method of Seeding
Brome—Alfalfa	Early spring or early fall.	10-14 lbs. brome grass 2 lbs. alfalfa	Drill or broadcast on firm seed bed. Roll before and after seeding.
Crested wheat grass	Early spring, early fall or winter	6 to 10 lbs.	Drill into stubble or weed cover, also on hard-packed summer fallow.
Blue grama	Late April to early May	10 to 12 lbs. processed seed	Broadcast with drill on firm seed bed and roll. Sudan or sorghum stubble is preferred. Spreading hay containing seed is also a good method.
Sudan grass	May—Early June	5 to 6 lbs. in rows 20 to 25 lbs. drilled	Grain drill, planter or lister.
Rye or Wheat	Aug.—Sept.[2]	1½ to 2 bu.	Grain drill.
Sweet clover	Early April	10–12 lbs.	Drill or broadcast with light seeding of barley or oats. Pasture off nurse crop.
Barley and Oats	April	6–8 pecks	Drill or broadcast.

[1] Seeding rates for eastern Nebraska. Usually reduced for central and west.
[2] Hessian fly-free date must be observed when planting wheat in eastern Nebraska.

sweet clover, so as to prevent over-eating and subsequent bloat. The practice of feeding a little grain is also helpful. It may be well to let a heavy dew dry off a little before turning animals into the pasture. If properly handled, sweet clover will make a fine pasture, a very satisfactory silage, and may even be used for hay, although for the latter purpose the stiff, hard stems are objectionable. Sometimes cows fed sweet clover pasture or sweet clover hay develop a condition in which their blood will not clot readily. Dehorning should be avoided while cows are eating sweet clover.

Sudan grass stands dry, hot weather well and furnishes more pasture per acre than any other temporary pasture crop, except in chinch bug areas. Under favorable conditions it will be ready in a month or so after it is planted, but it should not be pastured until it is 10 to 12 inches high. Sudan, like all the sorghum family, may under unfavorable conditions develop a substance which in the stomach of the cow turns to prussic acid, a deadly poison. Hot, dry conditions or frost that cause the plants to stop growing may cause this development. Danger of sudan grass poisoning can be reduced by using pure seed, feeding a hay or grain ration before turning on sudan, keeping stock on sudan after grazing has started, and exercising caution in pasturing sudan grass stunted by drouth or frost.

Small grains are sometimes used for pasture. All of these are annuals and consequently must be seeded each year. Wheat or rye planted in the early fall is often very useful for late fall pasture and again for early spring pasture. Wheat, while it may not make quite as heavy a growth, is often better than rye because it keeps coming up with finer stems and leaves after grazing. Barley or oats also make a good pasture in between the other crops.

Cost of Pasture. The cost of pasture depends upon the number of animals that can be properly carried, the length of the pasture season, the rental value of the land, the cost of preparing or caring for the land, cost of seed, maintenance of fences, and the price of labor. Land in pasture often gives a greater acre return with less labor than the same type of land in other crops.

Supplementary Feeding with Pasture. As the pasture season advances and the grass becomes short, cows should be fed grain to maintain their milk production. A grain mixture to supplement good pasture may be made up of equal parts ground corn and ground oats and fed at the rate of one pound of grain to each five or six pounds of milk produced. When the pasture becomes short the following grain mixture is suggested: ground corn, 400 pounds; ground oats, 200 pounds; soybean meal, 100 pounds. Feed one pound of grain for each four to five pounds of milk produced.

Silage is an excellent supplement to short pasture, and cows may be fed all they will consume. If there is no legume hay to feed and the pasture is so poor that silage is fed, the following grain mixture may be used: ground corn, 300 pounds; ground oats, 200 pounds; soybean meal, 200 pounds. Feed one pound of grain for each three to four pounds of milk produced.

Cows on a pasture that is fair to good will require one pound of a grain mixture for each four to six pounds of milk produced; if the pasture is poor to fair, cows should be fed one pound of grain for each three to four pounds of milk produced.

Soiling Crops. Soiling crops or soilage is the practice of growing green crops, harvesting and transporting them to a convenient place for feeding to animals. By this practice greater yields may be obtained from a given area of ground than by pasturing. However, soilage requires much labor, usually both horse and man labor, and unless these are available at low cost the system is not as economical as the use of pasture. It is also often difficult to arrange for a succession of crops that will be ready for feeding throughout the season. Probably a succession of crops beginning with wheat or rye, followed by sweet clover, oats, and then sudan grass, will carry through the summer in Nebraska to good advantage. This same rotation will be satisfactory for pasture.

Summer Silos. Any silo may be used for feeding in summer but smaller silos are sometimes used for that purpose, not being opened until the early summer. The small diameter is desirable in order that there may be a smaller surface of silage exposed to the air, since silage spoils rather rapidly in summer. A small trench silo is very satisfactory.

Winter Feeding or Feeding Without Pasture

FEEDING milk cows in the winter or when they are not on pasture is much more complicated than feeding in the summer when good pasture is available. In both cases, efforts should be made to furnish the proper nutrients in adequate quantities at the lowest cost. The basis of winter feeding should be farm-grown roughage which usually consists of hay, fodder, straw and silage. Since any roughage is bulky, it is usually desirable to obtain all roughage from the farm to save the labor and cost of transportation.

Roughage is divided into two general classes: dry roughage, which includes hays, dry fodder and straws; and succulent roughage which in-

cludes green grass and crops, green fodders, silage, green by-products of canning factories, wet beet pulp, beet tops, etc. Sometimes such feeds as tubers and roots are included with the succulent roughages.

The cow, being a ruminant, has the digestive apparatus that is well adapted to the economical utilization of roughage, and sound economy indicates that under ordinary circumstances she should be fed all the roughage that she will consume and that the grain fed should supplement the roughage. Roughage should be of good quality or its feeding value is greatly reduced. High quality hay is soft and fine with plenty of leaves and a bright green color. The green color indicates to a considerable degree the vitamin A content of the feed. Fodders and straws should be mature, of bright color, and not badly weathered if they are to be considered of good quality.

If fine quality legume hay is the chief roughage, a moderate-producing milk cow can eat enough to maintain her body and produce up to about 75 per cent of her ultimate capacity for milk production. A high-producing cow necessarily will limit her production because she cannot eat enough of bulky feeds to obtain the needed nutrients. An all-roughage ration that contains no legume hay will very definitely limit milk production because of the lack of protein. Thus, non-legume hays such as prairie and timothy, fodders such as corn and sorghum, cereal straws, silage or beet tops, while useful as a part of the ration, need to be supplemented with a grain mixture containing protein concentrate to provide a balanced ration for milk cows. If a certain proportion of the roughage is succulent in character, it appears to have a stimulating effect upon milk flow, which accounts for the excellent results obtained from the feeding of silage.

Balancing Rations by Protein Method

A PLAN for the easy balancing of rations, based upon the protein content of the roughage, has been devised. Roughages are divided, according to the percentage of digestible protein which they contain, into high, medium, and low protein groups. For each group a range of protein in the grain mixture is established. Then a grain mixture is made up that will contain a percentage of digestible protein within the range for the roughage which it supplements. With the roughage fed in quantities limited only by the appetite of the cow, and the grain mixture fed in proportion to milk yield, a balanced ration is obtained.

High-Protein Roughage. Ordinarily protein is the most expensive ingredient and the one most likely to be lacking in common feeds. As much protein as is practically possible, therefore, should be obtained from home-grown feeds, especially roughage. Plants that belong to the legume family produce hay with a rather high percentage of protein. The common legume hays are alfalfa, red clover, alsike clover, lespedeza, sweet clover, cowpea and soybean. While not entirely equal in feeding value, they may be grouped together for balancing rations. In western Nebraska or on upland farms where legumes are not grown a high-protein roughage may be produced by cutting small grain crops in the milk stage and curing for hay. Alfalfa and red clover hays are usually preferred by feeders because of their palatability and high feeding value. Cowpea and soybean hay, although coarser and stemmier, are usually relished by cows. Sweet clover, unless cut while short and tender, is likely to be stemmy and will not be eaten well. Usually it is not a good practice to depend en-

tirely upon sweet clover hay as the sole roughage because of the possibility of producing a serious condition in the cattle due to failure of the blood to clot. To balance with high-protein roughage, the grain mixture should contain between 10 and 12 per cent of digestible protein.

Low-Protein Roughage. This grouping includes: the non-legume hays such as prairie, millet, timothy, mature cereal, native grass, sudan grass; the various fodders such as corn and sorghum; the cereal straws; the several kinds of silage and such other material as beet tops. Here again there is a considerable variation in feeding value as between timothy hay, for example, and wheat straw (see Table 1), but all roughages in the class contain relatively small percentages of protein and hence are grouped together as being less valuable for feeding to milk cows. Within this group the hays have the highest feeding value, followed by the fodders if properly cured and not badly weathered, and silages. The cereal straws are at the bottom of the list in feeding value. Legume straws such as alfalfa, red clover, and soybean approach the low-protein hays in feeding value. Included in this group are such other products as beet tops and wet beet pulp, which are useful and economical feeds in certain sections where they can be obtained easily and economically. Roots and tubers also fall in this group and have a feeding value approximately comparable to silage. Beet tops may be used to a limited extent for feeding milk cows but some other roughage should be fed with them. Roots and tubers must be chopped for feeding to prevent choking the animal, and they have definite limits in good feeding practice. In the case of silage, beet tops and some root crops, especially turnips, it is advisable to feed after milking to prevent the transfer of an off-flavor to the milk. The percentage of digestible protein in the grain mixture that will balance with roughage of this class should range between 17 and 21.

Medium-Protein Roughage. When approximately equal quantities of roughage of the high protein and of the low protein groups are fed, the roughage is classified in the medium protein group. Alfalfa hay with corn silage, beet tops with alfalfa hay, clover hay with wheat straw, are but samples of combinations of roughage that would fall into the medium protein class. Here again there may be quite a range in the feeding value of various combinations, and when the protein percentage in the roughage is low, due to a larger proportion of non-legumes, the protein percentage in the grain mixture should be raised. The range in percentage of digestible protein in the grain mixture to balance with this group of roughages is 13 to 16.

Quantities of Roughage to Feed

THE quantity of roughage eaten by an animal depends upon its age, individuality and size, the quantity of milk being produced, the weather, the water supply, the palatability, quality and quantity of the roughage, and other feeds that are being consumed. Because of the variation in these factors it will be necessary to indicate only approximate quantities with a considerable range.

Hay or Other Dry Roughage the Sole Feed. Under such conditions a cow will consume between 2.5 and 4.0 pounds of dry roughage for each 100 pounds of live weight. This would mean that from 25 to 40 pounds of dry roughage would be eaten daily by a 1000-pound cow. Obviously a palatable roughage, such as fine quality alfalfa hay, will be consumed in larger quantities than an unpalatable one like wheat straw.

A rack provides a convenient method of feeding hay.

Hay or Other Dry Roughage Plus Silage the Sole Feed. When hay or other dry roughage is fed with silage but without grain, a cow will consume from 1.5 to 2.5 pounds of dry roughage when in addition she is eating 3.0 to 4.5 pounds of silage per 100 pounds of live weight. Obviously, an increase in the proportion of one type of roughage will reduce the quantity of the other type eaten.

Hay or Other Dry Roughage Plus Roots or Tubers the Sole Feed. When fed in this combination and without grain, a cow will consume between 1.8 and 3.0 pounds of dry roughage when eating from 3.5 to 6.0 pounds of roots or tubers per 100 pounds of live weight. Probably sugar beets or potatoes should not be fed in quantities exceeding 30 pounds daily.

Silage, Wet Beet Pulp, and Cannery Refuse the Sole Feed. If fed only these feeds a cow will consume between 5.0 and 7.0 pounds per 100 pounds of live weight daily. It is not desirable, however, to depend upon any of these feeds as the sole feed, a better plan being to feed a limited quantity of dry roughage, especially a legume hay.

Dry Roughage Plus Grain in Proportion to Milk Yield. When grain is fed in proportion to milk yield, varied according to the quantity of milk and the breed of cow (see Table 4), a cow will consume daily between 2.0 and 3.0 pounds of dry roughage for each 100 pounds of live weight.

Dry Roughage and Silage Plus Grain in Proportion to Milk Yield. If the ration consists of dry roughage and silage in addition to grain, the range of consumption daily per 100 pounds of live weight will vary from 0.5 to 2.0 pounds of dry roughage plus 2.5 to 4.5 pounds of silage.

Silage Plus Grain in Proportion to Milk Yield. With grain fed in proportion to milk yield, a cow will consume between 4.0 and 6.0 pounds of silage daily for each 100 pounds of live weight. It is more satisfactory to feed some dry roughage with the silage.

Succulent Roughage Other Than Silage Plus Grain in Proportion to Milk Yield. When beet tops, wet beet pulp, or other succulent roughage

is the sole roughage except for grain, a cow will consume between 3.5 and 6.0 pounds per 100 pounds of live weight. Here again, some dry roughage is desirable.

Grains or Concentrates

GRAINS of various kinds, and by-products of milling, oil-extraction, distilling or brewing are called concentrates, since in comparison with roughage they contain a larger proportion of digestible nutrients for each unit of weight. It is necessary to supply nutrients in more concentrated form if the milk cow is to have an adequate balanced ration because there is a daily intake limit of about 35 pounds of dry matter for a 1000-pound cow. With bulky feed a cow cannot consume enough roughage to furnish adequate nutrients for any considerable milk flow. Then, too, with the exception of pasture in its early stages of growth, or a legume roughage, it is impossible to obtain a balanced ration from roughage alone. Concentrates, therefore, are used to supplement the roughage and furnish the nutrients that are lacking, one of which is nearly always protein. There is a very wide range of nutritive values for the various concentrates, as will be noted by referring to Table 14. For the purposes of balancing rations by means of the protein method, only the percentage of protein is considered in making up the grain mixture to a certain standard. Despite that fact, efforts should be made to supply adequate minerals and to have several plant sources represented.

Rate of Feeding Grain

IT is recognized that there never will be any substitute for the careful eye of a good herdsman in feeding milk cows. Through the use of complicated calculations a rather exact quantity of each grain and other feed can be adjusted for each cow. Certain standards for the feeding of grain have been formulated that work well in practice and assure that under ordinary circumstances adequate nutrients will be supplied to meet the needs of the animal. In Table 4, "Guide for Feeding Grain," are suggested ratios for feeding grain in proportion to milk yield, and quantities of feed to use daily for certain levels of milk production of varying per-

Table 4. Guide for Feeding Grain.

Daily Milk Production	Milk Testing 3.0% to 4% Fat		Milk Testing 4.0% to 5% Fat		Milk Testing 5.0% to 6% Fat	
	Ratio, 1 lb. Grain to lbs. of milk	Grain To be Fed Daily	Ratio, 1 lb. Grain to lbs. of milk	Grain To be Fed Daily	Ratio, 1 lb. Grain to lbs. of milk	Grain To be Fed Daily
lbs.	*lbs. milk*	*lbs.*	*lbs. milk*	*lbs.*	*lbs. milk*	*lbs.*
15*	4.0	3.5	3.5	4.5	3.0	5.0
20	4.0	4.0	3.5	5.5	3.0	6.5
25	4.0	6.5	3.5	7.5	3.0	8.0
30	4.0	7.5	3.5	9.0	3.0	10.0
35	4.0	9.0	3.5	10.0	3.0	12.0
40	3.5	11.0	3.0	13.0	3.0	13.5
45	3.5	13.0	3.0	15.0	3.0	16.0
50	3.5	15.0	3.0	16.5	2.5	18.0
55	3.5	17.0	3.0	18.0	2.5	20.0
60	3.0	20.0	3.0	20.0	2.5	24.0
65	3.0	22.0	3.0	22.0		
70 or above	3.0–3.5	24.0	3.0	24.0		*

* With good quality legume roughage, grain need not be fed for milk production under 20 pounds daily.

centages of fat. Holstein cows will normally fall in the group producing between three per cent and four per cent fat in the milk, as will Ayrshires, although some of them will average more than four per cent fat in their milk. Brown Swiss probably should go in the class four per cent to five per cent fat although some of them may produce lower testing milk. Guernseys and most farm cows of Shorthorn or unknown breeding will produce milk that places them in the four per cent to five per cent class. Jersey cows and any other cows that produce high testing milk will fit into the last group. It will be noted that the ratio of grain to milk production does not always agree with the quantity of grain suggested. The reason for this difference is the desire to simplify the ratio column so as not to have a series of fractions. The limit of 24 pounds daily as the grain allowance for a cow is believed to be the limit that safely can be fed by most feeders, even though the production of the cow may be enough to justify more grain. Large cows can handle grain without the danger of indigestion much better than small cows.

Selecting Concentrates to Balance a Ration—Protein Method

THE protein method of balancing rations contemplates that the grain mixture will contain a certain specified percentage of digestible protein, and that when it is fed in proportion to milk production, along with adequate quantities of a particular class of roughage, the milk cow will receive a balanced ration. To make up such a grain mixture it is desirable to insure that its ingredients come from three or more plant sources.

Next in importance is that the digestible protein should be obtained from sources that are as economical as possible. In Table 14 a column will be found in which a protein factor is listed for each feed. When this factor is multiplied by the cost of 100 pounds of the feed, the result is the cost of 100 pounds of digestible protein in that feed. Feeds can be compared in this manner to determine which feeds furnish protein at the lowest cost. This factor is obtained by dividing 100 by the percentage of digestible protein taken as a whole number. Thus wheat bran has 13.1 per cent of digestible protein, $100 \div 13.1 = 7.63$, the factor for protein in wheat bran. If bran costs $30.00 per ton or $1.50 per cwt., then the cost of 100 pounds of digestible protein in bran is $7.63 \times 1.50 = \$11.45$. The cost of protein in a number of feeds can be calculated and in that manner the cheapest source of protein in the form of concentrates can be selected as source of the greater part of the protein.

Palatability is a factor in feeding that is sometimes overlooked. It is, nevertheless, of much importance since the more a good producing cow eats, up to the limit of her milk producing capacity, the greater will be the milk flow. At least a half of the grain mixture should be of concentrates that are palatable, such as wheat bran, corn and oats. Cane molasses is used frequently, either mixed with the grain or diluted and sprinkled over the roughage to improve the palatability and consequently to increase the feed consumption, although it has a high carbohydrate content.

Bulk in the grain mixture is believed to be of importance. A loose, bulky grain mixture is believed to be in such a form that it is somewhat more easily digested and is not likely to cause digestive difficulty.

The effect of feeds upon the animal body functions must be taken into account in selecting feed for a grain mixture. Some are constipating, others are laxative, while certain ones affect the color, texture and flavor of the milk or butterfat. Only limited quantities of feeds such as rye

which tends to produce a hard butter, or soybeans which tend to produce a soft butter, should be fed. A good rule is to use only moderate quantities of any feed that causes a marked effect upon the cow or her milk.

Practice in Making Grain Mixtures

AS was suggested, it is not practical to obtain great accuracy in calculating the quantities of digestible protein, digestible carbohydrates, and digestible fat needed to meet the needs of cows producing milk. When the cow has all the roughage of good quality that she will eat there is seldom

Table 5. High-Protein Roughage.

High-protein roughage consists of legume hays, such as alfalfa, the clovers, cowpea, soybean, etc.

Protein in Grain Mixtures, 10 to 12 per cent

	Digestible protein *lbs.*
Mix 1—Protein 11.55%	
200 lbs. Corn meal	14.2
100 lbs. Oats (ground)	9.4
100 lbs. Wheat bran	13.1
50 lbs. Linseed meal (O.P.)	15.3
450 lbs. mixture	52.0
Mix 2—Protein 11.39%	
500 lbs. Barley (ground)	46.5
100 lbs. Oats (ground)	9.4
100 lbs. Wheat bran	13.1
50 lbs. Soybean (ground)	16.4
750 lbs. mixture	85.4
Mix 3—Protein 10.49%	
300 lbs. Snap corn (ground)	17.7
100 lbs. Oats (ground)	9.4
100 lbs. Wheat bran	13.1
50 lbs. Cottonseed meal (43%)	17.5
550 lbs. mixture	57.7
Mix 4—Protein 10.95%	
400 lbs. Hominy feed	31.2
100 lbs. Oats (ground)	9.4
100 lbs. Wheat bran	13.1
50 lbs. Cottonseed meal (43%)	17.5
650 lbs. mixture	71.2
Mix 5—Protein 11.42%	
200 lbs. Corn meal	14.2
100 lbs. Oats (ground)	9.4
100 lbs. Alfalfa meal	10.8
100 lbs. Gluten feed	22.7
500 lbs. mixture	57.1
Mix 6—Protein 11.95%	
300 lbs. Corn and cob meal	18.0
300 lbs. Oats (ground)	28.2
300 lbs. Wheat (ground)	33.9
100 lbs. Soybean meal (solvent)	39.4
1000 lbs. mixture	119.5
Mix 7—Protein 10.94%	
400 lbs. Corn meal	28.4
100 lbs. Alfalfa meal	10.8
100 lbs. Wheat bran	13.1
50 lbs. Soybean meal (exp.)	18.8
650 lbs. mixture	71.1
Mix 8—Protein 11.49%	
500 lbs. Milo grain (ground)	43.5
100 lbs. Alfalfa meal	10.8
100 lbs. Wheat bran	13.1
50 lbs. Soybean meal (exp.)	18.8
750 lbs. mixture	86.2
Mix 9—Protein 11.16%	
200 lbs. Barley (ground)	18.6
200 lbs. Beet pulp (dried) (Mol.)	12.2
100 lbs. Wheat bran	13.1
50 lbs. Cottonseed meal (43%)	17.5
550 lbs. mixture	61.4
Mix 10—Protein 10.98%	
400 lbs. Milo grain (ground)	34.8
100 lbs. Alfalfa meal	10.8
100 lbs. Oats (ground)	9.4
50 lbs. Soybeans (ground)	16.4
650 lbs. mixture	71.4
Mix 11—Protein 10.02%	
500 lbs. Corn and cob meal	30.0
200 lbs. Oats (ground)	18.8
100 lbs. Wheat bran	13.1
50 lbs. Meat scraps (50%)	23.3
850 lbs. mixture	85.2
Mix 12—Protein 12.01%	
400 lbs. Snap corn (ground)	23.6
300 lbs. Rye (ground)	30.9
200 lbs. Wheat bran	26.2
100 lbs. Soybean meal (solvent)	39.4
1000 lbs. mixture	120.1

a deficiency in either digestible carbohydrates or fats, so a roughly balanced ration can be obtained by making up a grain mixture according to the protein method and feeding it in proportion to milk yield. A good plan is to make up a grain mixture of four concentrates, keeping in mind cost, bulk, palatability, number of plant sources, and effect upon the animal, so that the mixture will contain the percentage of digestible protein indicated by the roughage used (Tables 5, 6 and 7).

Table 6. Medium-Protein Roughage.

In medium-protein roughage approximately one-half of the roughage is of a high-protein group and the remainder is of the low-protein group. Examples: alfalfa hay and silage, alfalfa hay and corn stover, prairie hay and alfalfa hay.

Protein in Grain Mixtures, 13.0 to 16.0 per cent

	Digestible protein *lbs.*		Digestible protein *lbs.*
Mix 13—Protein 15.02%		Mix 19—Protein 14.10%	
200 lbs. Corn meal	14.2	200 lbs. Corn (ground)	14.2
100 lbs. Oats (ground)	9.4	200 lbs. Alfalfa meal	21.6
100 lbs. Wheat bran	13.1	300 lbs. Wheat bran	39.3
150 lbs. Linseed meal (O.P.)	45.9	100 lbs. Soybean meal (exp.)	37.7
550 lbs. mixture	82.6	800 lbs. mixture	112.8
Mix 14—Protein 14.91%		Mix 20—Protein 15.02%	
200 lbs. Barley (ground)	18.6	200 lbs. Milo grain (ground)	17.4
100 lbs. Oats (ground)	9.4	100 lbs. Alfalfa meal	10.8
100 lbs. Corn gluten feed	22.7	300 lbs. Wheat bran	39.3
50 lbs. Soybeans (ground)	16.4	100 lbs. Soybean meal (exp.)	37.7
450 lbs. mixture	67.1	700 lbs. mixture	105.2
Mix 15—Protein 15.37%		Mix 21—Protein 15.32%	
200 lbs. Snap corn (ground)	11.8	100 lbs. Barley (ground)	9.3
100 lbs. Oats (ground)	9.4	100 lbs. Beet pulp (dried) (Mol.)	6.1
200 lbs. Wheat bran	26.2	200 lbs. Wheat bran	26.2
150 lbs. Cottonseed meal (43%)	52.5	100 lbs. Cottonseed meal (43%)	35.0
650 lbs. mixture	99.9	500 lbs. mixture	76.6
Mix 16—Protein 14.18%		Mix 22—Protein 14.33%	
200 lbs. Hominy feed	15.6	200 lbs. Milo grain (ground)	17.4
100 lbs. Oats (ground)	9.4	100 lbs. Alfalfa meal	10.8
300 lbs. Wheat bran	39.3	300 lbs. Wheat bran	39.3
100 lbs. Cottonseed meal (43%)	35.0	100 lbs. Soybeans (ground)	32.8
700 lbs. mixture	99.3	700 lbs. mixture	100.3
Mix 17—Protein 14.70%		Mix 23—Protein 13.31%	
300 lbs. Corn (ground)	21.3	400 lbs. Corn and cob meal	24.0
100 lbs. Oats (ground)	9.4	100 lbs. Oats (ground)	9.4
100 lbs. Alfalfa meal	10.8	100 lbs. Wheat bran	13.1
100 lbs. Meat scraps (50%)	46.7	100 lbs. Meat scraps (50%)	46.7
600 lbs. mixture	88.2	700 lbs. mixture	93.2
Mix 18—Protein 15.10%		Mix 24—Protein 14.92%	
100 lbs. Corn and cob meal	6.0	200 lbs. Snap corn (ground)	11.8
200 lbs. Oats (ground)	18.8	100 lbs. Rye (ground)	10.3
100 lbs. Wheat (ground)	11.3	100 lbs. Wheat bran	13.1
100 lbs. Soybean meal (solvent)	39.4	100 lbs. Soybean meal (solvent)	39.4
500 lbs. mixture	75.5	500 lbs. mixture	74.6

For example, suppose alfalfa hay to be the sole roughage, then the digestible protein needed in the grain mixture will be between 10 and 12 per cent. Corn and oats are available on most farms so these home-grown feeds can be taken as the basis for the grain mix. They should be ground, for cows do not digest whole grain very efficiently. Suppose the other two feeds selected are wheat bran and linseed meal. That will mean that the grain mixture is selected from four plant sources, and with alfalfa hay the ration is furnished from five different plant sources. All the concentrates, corn, oats, wheat bran and linseed meal, are palatable. Oats

Table 7. Low-Protein Roughage.

Low-protein roughage consists of all non-legume hays, the straws and fodders.

Protein in Grain Mixtures, 17.0 to 21.0 per cent

	Digestible protein *lbs.*
Mix 25—Protein 18.16%	
100 lbs. Corn meal	7.1
100 lbs. Oats (ground)	9.4
100 lbs. Wheat bran	13.1
200 lbs. Linseed meal (O.P.)	61.2
500 lbs. mixture	90.8
Mix 26—Protein 18.43%	
100 lbs. Barley (ground)	9.3
200 lbs. Oats (ground)	18.8
300 lbs. Corn gluten feed	68.1
100 lbs. Soybeans (ground)	32.8
700 lbs. mixture	129.0
Mix 27—Protein 18.58%	
100 lbs. Snap corn (ground)	5.9
100 lbs. Oats (ground)	9.4
200 lbs. Wheat bran	26.2
200 lbs. Cottonseed meal (43%)	70.0
600 lbs. mixture	111.5
Mix 28—Protein 18.07%	
100 lbs. Hominy feed	7.8
100 lbs. Oats (ground)	9.4
300 lbs. Wheat bran	39.3
200 lbs. Cottonseed meal (43%)	70.0
700 lbs. mixture	126.5
Mix 29—Protein 18.18%	
250 lbs. Corn meal	17.7
200 lbs. Oats (ground)	18.8
100 lbs. Cottonseed meal (43%)	35.0
100 lbs. Meat scraps (50%)	46.7
650 lbs. mixture	118.2
Mix 30—Protein 19.73%	
150 lbs. Corn and cob meal	9.0
100 lbs. Oats (ground)	9.4
100 lbs. Wheat (ground)	11.3
200 lbs. Soybean meal (solvent)	78.8
550 lbs. mixture	108.5

	Digestible protein *lbs.*
Mix 31—Protein 18.63%	
100 lbs. Corn meal	7.1
200 lbs. Alfalfa meal	21.6
200 lbs. Gluten feed	45.4
100 lbs. Soybean meal (exp.)	37.7
600 lbs. mixture	111.8
Mix 32—Protein 18.71%	
200 lbs. Milo grain (ground)	17.4
300 lbs. Wheat bran	39.3
150 lbs. Linseed meal (O.P.)	45.9
100 lbs. Soybean meal (exp.)	37.7
750 lbs. mixture	140.3
Mix 33—Protein 19.75%	
100 lbs. Barley (ground)	9.3
100 lbs. Beet Pulp (dried) (Mol.)	6.1
300 lbs. Corn gluten feed	68.1
100 lbs. Cottonseed meal (43%)	35.0
600 lbs. mixture	118.5
Mix 34—Protein 19.45%	
100 lbs. Milo grain (ground)	8.7
300 lbs. Alfalfa meal	32.4
150 lbs. Cottonseed meal (43%)	52.5
100 lbs. Soybeans (ground)	32.8
650 lbs. mixture	126.4
Mix 35—Protein 19.38%	
100 lbs. Corn and cob meal	6.0
400 lbs. Wheat bran	52.4
100 lbs. Linseed meal (O.P.)	30.6
100 lbs. Meat scraps (50%)	46.7
700 lbs. mixture	135.7
Mix 36—Protein 19.00%	
200 lbs. Snap corn (ground)	11.8
100 lbs. Rye (ground)	10.3
100 lbs. Wheat bran	13.1
200 lbs. Soybean meal (solvent)	78.8
600 lbs. mixture	114.0

For thorough mixing, grain should be turned three times.

and bran are bulky, while corn meal and linseed meal are rather heavy, so at least half of the concentrates are bulky. Oats, wheat bran and linseed meal tend to be somewhat laxative in character, while corn is neutral and hay tends to be rather constipating.

To determine the cheapest source of protein, calculations will have to be made using the factors in Table 14. Consultations with that table will reveal that wheat bran and linseed meal are good sources of phosphorus, and that alfalfa hay is an excellent source of calcium. Both corn meal and bright, green alfalfa hay are good sources of vitamin A, so it appears that from a nutritional standpoint, the suggested combination will be satisfactory. The problem then is to mix the concentrates to obtain a grain mixture that will contain between 10 and 12 per cent of digestible protein. In this connection it should be mentioned that there appears a percentage of protein on all bags of commercially-sacked concentrates. That figure is the *total crude protein. Digestible protein* will be a smaller figure, and the average of many analyses is given in Table 14. This difference between *total protein* and *digestible protein* may vary from one to ten per cent, *the digestible protein always being lower.* Suppose, therefore, that a grain mixture is made up to feed with alfalfa hay. In consulting Table 14 it must be remembered that the percentage figures given

are in reality the pounds of digestible protein in 100 pounds of feed. To get the quantity in one pound divide by 100.

Quantity of Feed	Kind of Feed	Digestible Protein
lbs.		*lbs.*
200	Corn (ground)	14.2
100	Oats (ground)	9.4
100	Wheat Bran	13.1
50	Linseed meal (O.P.)	15.3
450		52.0

52.0÷450=0.1155 or 11.55 per cent of digestible protein.

This grain mixture contains a percentage of protein falling within the limits suggested—10 to 12 per cent (Table 5)—and, therefore, is a suitable one to use with alfalfa hay as the only roughage. To determine the cost of 100 pounds of digestible protein in the grain mixture: Divide 100 by the percentage of protein in the grain mixture, 11.55, (100÷11.55) to get 8.658, the protein factor for the mixture. Suppose that ground corn costs $1.10 per cwt.; ground oats cost $1.20 per cwt.; wheat bran costs $1.60 per cwt.; and linseed meal costs $2.25 per cwt. Thus the problem would be as follows:

	Cost
200 lbs. corn (ground) at $1.10 per cwt.	$2.20
100 lbs. oats (ground) at $1.20 per cwt.	1.20
100 lbs. wheat bran at $1.60 per cwt.	1.60
50 lbs. linseed meal at $2.25 per cwt.	1.13
450 lbs. costs	$6.13

1 lb.=$6.13÷450=$.0136 (1.36 cents)
100 lbs. = $.0136 × 100 = $1.36.
8.66 (factor) × $1.36 (cost of 100 lbs.) = $11.78 the cost of 100 lbs. of protein in the grain mixture.

If the roughage available were prairie hay, or corn silage and sorghum fodder for example (Table 7), then the grain mixture would have to contain more digestible protein, a range of 17.0 to 21.0 per cent. Using the same concentrates as before, it is evident that there must be some changes in the proportions of the ingredients. There are two ways of increasing the protein percentage, either by reducing the quantity of the ingredient or ingredients that contain a percentage of protein below the standard (17 to 21 per cent), by adding larger quantities of the ingredient that has a high protein percentage, or by both procedures.

Since corn contains the lowest percentage of digestible protein (7.1), that feed can be reduced first. Then if that does not bring about the desired result, additional linseed meal can be added.

Quantity of Feed	Kind of Feed	Digestible Protein
lbs.		*lbs.*
100	Corn (ground)	7.1
100	Oats (ground)	9.4
100	Wheat Bran	13.1
50	Linseed Meal (O.P.)	15.3
350		44.9

44.9÷350=0.1283 or 12.83 per cent of digestible protein.

Add:

150	Linseed Meal (O.P.)	45.9
500		90.8

90.8÷500=0.1816 or 18.16 per cent of digestible protein.

By reducing the corn and increasing the linseed meal, a grain mixture containing 18.16 per cent of digestible protein is obtained for balancing with the low-protein roughage. This grain mixture would be more costly per 100 pounds of feed as may be noted below:

	Cost
100 lbs. corn (ground) at $1.10 per cwt.	$1.10
100 lbs. oats (ground) at $1.20 per cwt.	1.20
100 lbs. wheat bran at $1.60 per cwt.	1.60
200 lbs. linseed meal (O.P.) at $2.25 per cwt.	4.50
500 lbs.	$8.40

$8.40÷500=.0168 or 1.68 cents per pound.
100 lbs. cost $.0168×100=$1.68.
100÷18.16=5.51 protein factor.
5.51×$1.68=$9.26 cost of 100 lbs. of protein in the grain mixture.

Suggested grain mixtures for the different types of roughage are listed under the different protein groups (Tables 5, 6 and 7). These represent only a few of the many possible combinations that can be made using common concentrates, but they are suggestive of mixtures that meet the requirements as previously laid down.

In general, corn meal, corn and cob meal, ground snap corn, hominy feed, ground grain sorghums, ground barley and ground wheat can be interchanged even though they are not of exactly equal value in terms of nutrients contained. Ordinarily very little wheat is fed to dairy cattle because of the higher cost as compared with corn, and also because the farmer in most parts of Nebraska can get more feeding value from an acre of corn than an acre of wheat. Wheat is well liked by dairy cattle and when it can be purchased at about the same price per pound, it can be used in place of half the corn. It is recommended that wheat be coarsely ground because when ground too fine it forms a pasty mass in the process of digestion. To some extent wheat bran and alfalfa meal can be used one for the other. Bran is higher in protein and in phosphorus, while alfalfa hay contains more calcium. Soybean meal, linseed meal, cottonseed meal, peanut meal and gluten meal can be interchanged within limits. Distillers' dried grains and brewers' grains have much in common from a feeding standpoint. In the grain mixtures listed, the ingredients have been limited to four concentrates. Better mixtures can be made up from six to eight concentrates which will insure a more complete balance of the essential amino acids in the protein. An example of such a mixture to balance with alfalfa hay and corn silage as the roughage is as follows:

Quantity		Kind of Feed	Digestible Protein	Total Digestible Nutrients
per cent	*lbs.*		*lbs.*	*lbs.*
25	250	Cornmeal (yellow)	17.75	201.50
25	250	Wheat bran	32.75	175.50
18	180	Oats (ground)	16.92	128.70
15	150	Gluten feed	34.05	116.10
8	80	Linseed meal (O.P.)	24.48	62.56
7	70	Soybean meal (exp.)	26.39	57.54
1	10	Salt (iodized)	.....	.....
1	10	Bone meal (steamed)	.....	.....
100	1000		152.34	741.90
Per cent			15.23	74.19
1 lb. contains			0.1523	0.7419

Accurate Balancing of Rations (Morrison Feeding Standard)

FOR the more accurate balancing of rations either for the herd or for individual cows, the total digestible nutrients as well as the digestible protein must be taken into account. In the case of a herd an average cow can be used, which likely will prove satisfactory since it is not practical to balance a ration for each individual cow. In order to balance a ration exactly, to the requirements for maintenance based upon weight of the animal must be added the requirements for the milk produced. The tables present standards formulated by F. B. Morrison and, in the case where there is a range given, represent the median figures.

To balance a ration determine first the weight of the animal, whether growing animal, milking cow, or herd bull. An average cow may be used to represent the average of the herd. From Table 8 or Table 9 the require-

Table 8. Daily Requirements for Milk Cows.*

Maintenance (Recommended)	Digestible Protein	Total Digestible Nutrients
	lbs.	*lbs.*
800 lb. cow	0.536	6.53
900 lb. cow	0.593	7.23
1000 lb. cow	0.650	7.93
1100 lb. cow	0.706	8.61
1200 lb. cow	0.762	9.29
1300 lb. cow	0.817	9.97
1400 lb. cow	0.872	10.63
1500 lb. cow	0.925	11.28
For each 100 lbs. of Live Weight Additional	0.065	0.65
Milk Production (Recommended)		
For each 1 lb. of 3.0% milk	0.043	0.276
For each 1 lb. of 3.5% milk	0.046	0.300
For each 1 lb. of 4.0% milk	0.049	0.324
For each 1 lb. of 4.5% milk	0.052	0.349
For each 1 lb. of 5.0% milk	0.056	0.373
For each 1 lb. of 5.5% milk	0.059	0.397
For each 1 lb. of 6.0% milk	0.062	0.422
For each 1 lb. of 6.5% milk	0.065	0.446

* From F. B. Morrison's, "Feeds and Feeding," 20th Edition by special permission of the Morrison Publishing Company, Ithaca, New York.

Table 9. Daily Requirements for Growing Cattle (Dairy).*

Weight of Animal (Median Figures)	Digestible Protein	Total Digestible Nutrients
lbs.	*lbs.*	*lbs.*
100	0.32	1.60
150	0.46	2.65
200	0.57	3.65
250	0.66	4.45
300	0.73	5.20
400	0.85	6.35
500	0.93	7.30
600	1.00	8.20
700	1.07	9.05
800	1.13	9.90
900	1.19	10.75
1000	1.25	11.50

* From F. B. Morrison's, "Feeds and Feeding," 20th Edition, by special permission of the Morrison Publishing Company, Ithaca, New York.

ment for maintenance or for growth can be obtained for an animal of the designated weight. In the case of the milk cow, to the maintenance needs in digestible protein and total digestible nutrients must be added the requirements for milk production as determined from the table. A 1200-pound cow producing 48 pounds of 4.0 per cent milk daily may be used to illustrate. Available for feeding are alfalfa hay, corn silage, ground corn, ground oats, wheat bran and linseed meal. Consulting Table 8 for requirements and Table 14 for analysis, problem may be solved as follows:

Daily Requirements	Digestible Protein		Total Digestible Nutrients	
	lbs.		*lbs.*	
1200 lb. cow maintenance	0.762		9.290	
48 lbs. of 4.0% milk	2.352		15.552	
Total requirements		3.114		24.842
Feed given				
10 lbs. alfalfa hay	1.060		5.030	
55 lbs. corn silage	.715		10.285	
Nutrients supplied by roughage		1.775		15.315
Nutrients to be supplied by grain mix		1.339		9.527
Grain Mix				
275 lbs. corn meal	19.5		221.7	
100 lbs. oats ground	9.4		71.5	
100 lbs. wheat bran	13.1		70.2	
150 lbs. linseed meal (O.P.)	45.9		117.2	
625 lbs.	87.9		480.6	
1 lb.		.141		.769
12 lbs. of grain mix		1.692		9.228
		+ .353		— .299

To balance a ration exactly, it is easier to make up a grain mixture with the same ratio between the protein and total nutrients (total digestible nutrients divided by the digestible protein) that exists after the nutrients in the roughage have been subtracted from the requirements.

Feeding Heavy Milk Cows

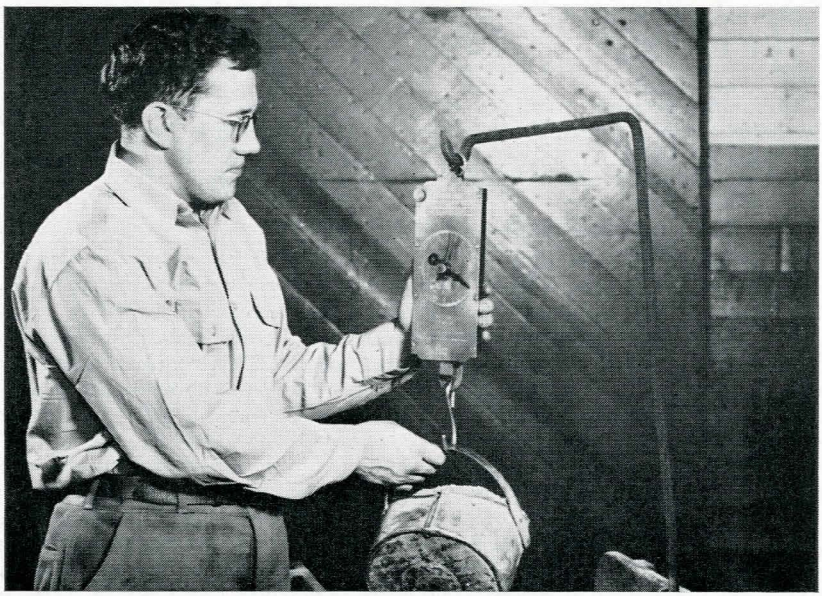
THE larger the production of milk and butterfat, the more knowledge and skill are needed to feed milk cows sufficiently, efficiently and economically. Lack of enough or of proper nutrients, or unskilled feeding, undoubtedly limits the production of many good cows. The first requisite of good feeding is to determine the cows' needs. This requires a knowledge of their weight and the quantity and quality of the milk being produced daily. Scales for weighing milk and some means, either scales or a tape, to determine the weight of the cows are desirable. The percentage of butterfat in the milk is important in determining the feed requirements as will be noted in Table 8. Besides, it will be necessary for the feeder to study the characteristics of each cow in order to determine her likes and dislikes, and whether she is a hearty eater or one whose appetite has to be pampered. Some cows can handle large quantities of roughage and others do not eat so heartily. The suggested rules for feeding will be found helpful; the best results can be obtained when the feeder knows

his cows and supplements rules with his own skill gained through experience. The feeding of grain at a higher rate than suggested is sometimes desirable and profitable when the price of grain is low and the price of milk or butterfat is high. Heavy feeding of grain necessitates great care and should be undertaken with caution.

Succulent feed has a desirable conditioning effect upon cattle. Usually such feed is very palatable and stimulates milk production. Pasture grasses and silage fall into this class, as do roots. Where available so that they can be used economically, roots are very valuable as feed and are worth more than the analyses indicate. For feeding, roots should always be chopped so as to prevent choke. In this connection, wet beet pulp is also very useful where it can be obtained fresh. Dried beet pulp, when mixed with the grain and the whole mass soaked with water to which some molasses has been added, makes a very palatable feed. Molasses (cane) can be fed in quantities of two to four pounds daily with good results but beet molasses is not as palatable. In order to stimulate appetite and to provide an especially complete balanced ration it is sometimes advisable to use six or even more concentrates in a grain mixture. Since so much of a cow's feed comes from the roughage, great care should be exercised to insure that heavy milking cows receive green, leafy, high-quality roughage.

Feeding Dry Cows

FREQUENTLY little attention is paid to the feeding of dry cows and they are allowed to shift for themselves with a limited quantity of poor roughage being the only feed. In the interval between drying off and the next freshening, which should be not less than six weeks, the cow



Weights of milk and grain are important in feeding.

must recuperate from the previous lactation, supply nutrients for the rapidly maturing fetus, and prepare for the oncoming lactation. This is the period when the cow needs *plenty of feed.* Any additional fat that the cow adds to her body is a reserve upon which she will draw after freshening. This reserve may be measured by appearance and by gain in weight. Just before calving, a cow should weigh from 10 to 15 per cent more than her average weight during a lactation, which means a gain of from 100 to 200 pounds for the average cow. Proper feeding during the dry period should help keep the cow in such good condition that she will produce to her maximum capacity year after year.

Good pasture is ideal feed for dry cows but even then a high-producing cow can well be fed two to three pounds of grain daily. In seasons when pasture is not available the dry cow should have an abundance of good legume hay, some succulent feed, and in addition one pound of grain daily for each 300 to 400 pounds of live weight. If grain is cheap, two pounds of grain daily for each 300 to 400 pounds of live weight can well be justified. The grain mixture used may contain about 14 per cent digestible protein. With poor roughage the grain fed should be increased. A cow at calving time should be in moderate to heavy flesh.

Feeding Cows at Calving Time

ABOUT a week before a cow is due to calve, the regular grain mixture should be changed to a mixture of three parts wheat bran and one part ground oats. If bran is not readily available, ground oats may be used instead. This grain may be fed daily in quantities varying from two to six pounds. Immediately after calving a wet mash made of two pounds of whole oats mixed with two pounds of wheat bran and warm water may be given to the cow. For the first week after calving the bran and ground oats may be fed, gradually changing to the regular grain mixture as the swelling in the udder recedes.

Feeding Heifers

AFTER heifer calves are weaned from milk there is often a tendency to let them shift for themselves. If they must depend upon poor roughage they may become stunted. Once stunted an animal seldom makes normal growth, and if it does the growth is made at a greater feed cost. At six months of age a heifer should consume from 1.5 to 2.0 pounds of silage and from 2.0 to 3.5 pounds of hay for each 100 pounds of live weight, and in addition should receive from 2.0 to 3.0 pounds of grain (12 to 14 per cent digestible protein) daily. This feeding practice may continue until about three months before calving when, unless the heifer is in very good condition, the quantity of grain fed daily should be increased.

Feeding Herd Bulls

ALL too often the herd bull gets little attention in the matter of feeding, receiving only picked-over hay and but little grain. A bull in service needs a balanced ration, and that means that if he is confined he will need some grain. In summer if a good pasture is available for his use he needs little additional feed. Frequently a bull is confined to a pen opening into a small exercise lot. Under such conditions special care should be taken in providing an adequate and balanced diet for the bull that his reproductive activities may be maintained at an efficient level.

Bulls that do not get much exercise should be fed hay in limited quantities to guard against the development of sluggishness and a large barrel which may slow them in service. Legume hay is to be preferred although one-half legume hay and one-half prairie or timothy is satisfactory. The quantity fed will depend to some extent upon the bull, but will range from 0.5 to 1.0 pound of hay daily for each 100 pounds of live weight. In addition he should be given from 0.5 to 0.75 pound of grain daily (14 per cent digestible protein) for each 100 pounds of live weight. Some bulls are easy keepers and some are not, and the feed can be adjusted to the individual bull. The condition of the bull should be considered and the grain adjusted so that he is in moderate but not heavy flesh. It is important to feed a bull a grain mixture reasonably high in protein and not just feed him corn, since maintenance of the reproductive functions requires considerable protein. Green, succulent grasses that are high in minerals and vitamins are very useful and the addition of a small quantity (one to three per cent) of blood meal, fish meal, or meat and bone meal to the grain mixture is advised. There is much difference of opinion about the feeding of silage to bulls. It probably is desirable to feed silage only in moderate quantities. One pound for each 100 pounds of live weight has been used successfully.

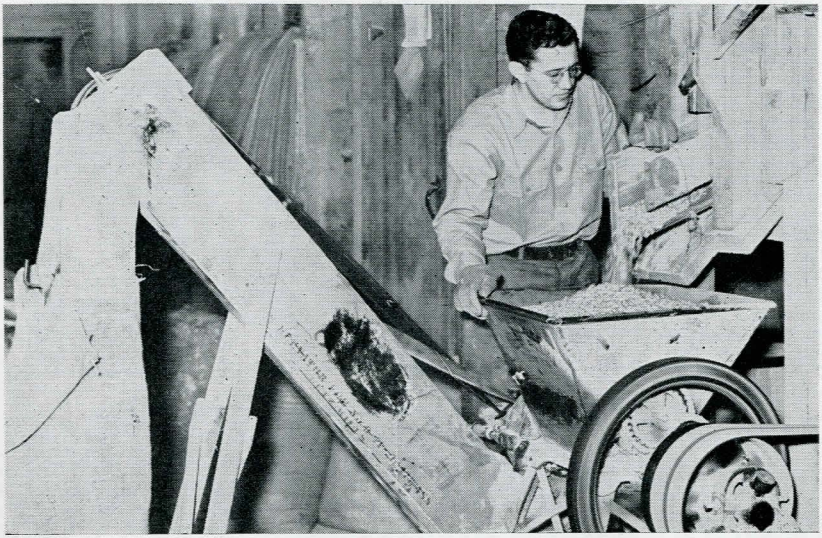
In the feeding of the young, growing bull special attention is required if he is to develop normally and become an efficient herd sire. It must be emphasized that he should gain in weight not less than 1.5 pounds daily from the time he is six months of age until he reaches three years of age. To make this gain he must have adequate feed which includes plenty of grain. Between the ages of eight months and three years not less than 10 pounds daily of a (14 per cent digestible protein) grain mixture will probably be needed. By keeping a check on the weight of the bull the grain can be adjusted either up or down depending upon his rate of gain and condition. Successful growth and development will be well repaid by his proper functioning as a herd sire.

Using the Tables

THE use of Tables 1 to 9 has been discussed previously. Table 10, giving the weight of a quart of various kinds of feeds, makes it possible to use a common type of measure for these feeds in place of weighing the

Table 10. Weight of Feeds.

Feed	One Quart Weighs	One Pound Measures	Feed	One Quart Weighs	One Pound Measures
	lbs.	*qts.*		*lbs.*	*qts.*
Alfalfa meal	0.6	1.7	Hominy feed	1.1	0.9
Barley (ground)	1.1	0.9	Linseed meal (O.P.)	1.1	0.9
Beans (field)	1.7	0.6	Molasses (cane)	3.0	0.3
Beet Pulp (dried)	0.6	1.7	Oats (whole)	1.1	1.0
Brewers' grains (dried)	0.6	1.7	Oats (ground)	0.7	1.4
Corn (ground)	1.5	0.7	Peas (field)	2.1	0.5
Corn and cob meal	1.4	0.7	Rye (ground)	1.5	0.7
Corn gluten feed	1.3	0.8	Soybeans	1.8	0.6
Corn gluten meal	1.7	0.6	Tankage	1.6	0.6
Cottonseed meal	1.5	0.7	Wheat (ground)	1.7	0.6
Distillers' dried grains (corn)	0.6	1.7	Wheat bran	0.5	2.0



Ground grain is digested more efficiently than whole grain.

feed. Some feeders prefer to give an animal so many pounds or quarts of each feed rather than to make up a grain mixture to balance with the roughage.

Table 11 gives the number of bushels of a number of common feeds that are contained in 100 pounds. Such a table is useful when dealing with farm-grown feeds in getting them on a common basis with commercial feeds.

Table 12 uses soybean meal (expeller process 43 per cent protein) as a standard, and at different price levels shows the highest price that may be paid for a number of similar feeds if protein is to be obtained at the same cost or at a lower cost. For example, with soybean meal at $2.50 per 100 pounds, alfalfa meal cannot exceed $.72 per 100 pounds if it is to supply protein at the same cost.

Table 13 presents a similar comparison using corn as the standard source of total nutrients. Thus at $.75 per bushel or $1.34 per 100 pounds for corn, barley to supply total nutrients at the same cost must not exceed $1.31 per 100 pounds.

Table 11. Number of Bushels in 100 Pounds of Feed.

Barley	2.08	Oats	3.13
Beans (field)	1.67	Peas (field)	1.67
Corn (shelled)	1.79	Rye	1.79
Corn (ear)	1.43	Soybeans	1.67
Feterita	1.79	Wheat	1.67
Hegari	1.79	Beets	1.67
Kafir	1.79	Carrots	2.00
Milo	1.79	Potatoes	1.67

To change the cost per bushel to the cost per 100 pounds of feed, multiply the cost per bushel by the number of bushels in 100 pounds of feed. Thus, if corn is worth $0.75 per bushel the cost of 100 pounds would be: .75×1.79=$1.34 per 100.

Table 12. Price Comparison of Concentrates as Sources of Digestible Protein.

Feed	Price Per 100 lbs.	Price Per 100 lbs.	Price Per 100 lbs.	Price Per 100 lbs.	Price Per 100 lbs.
with	*dollars*	*dollars*	*dollars*	*dollars*	*dollars*
Soybean meal (exp.) (43%) as a standard	1.75	2.00	2.25	2.50	2.75
Following feeds are worth					
Alfalfa meal (good quality)	0.50	0.57	0.64	0.72	0.79
Corn Gluten feed	1.05	1.20	1.35	1.50	1.65
Corn Gluten meal	1.69	1.94	2.18	2.42	2.66
Cottonseed meal (43%)	1.62	1.86	2.09	2.32	2.55
Distillers' dried grains (corn)	1.08	1.24	1.39	1.54	1.70
Fish meal	2.20	2.52	2.83	3.15	3.46
Linseed meal (O.P.)	1.42	1.62	1.83	2.03	2.23
Meat scraps (50%)	2.17	2.48	2.79	3.10	3.41
Soybeans	1.52	1.74	1.96	2.17	2.39
Soybean meal (sol.)	1.83	2.09	2.35	2.61	2.87
Wheat bran	0.61	0.69	0.78	0.87	0.95

Table 13. Price Comparisons of Feeds as Sources of Total Nutrients.

Feed	Price Per 100 lbs.	Price Per 100 lbs.	Price Per 100 lbs.	Price Per 100 lbs.	Price Per 100 lbs.
with	*dollars* (60c per bu.)	*dollars* (65c per bu.)	*dollars* (70c per bu.)	*dollars* (75c per bu.)	*dollars* (80c per bu.)
Corn (shelled) as a standard	1.07	1.16	1.25	1.34	1.43
Following feeds are worth					
Barley	1.04	1.13	1.22	1.31	1.40
Beet pulp (mol.) dried	0.99	1.07	1.15	1.23	1.32
Corn & cob meal	1.01	1.09	1.18	1.26	1.35
Hominy feed	1.13	1.23	1.32	1.41	1.51
Milo grain	1.06	1.15	1.24	1.33	1.42
Oats	0.95	1.03	1.11	1.19	1.27
Rye	1.06	1.15	1.24	1.33	1.42
Wheat	1.11	1.20	1.30	1.39	1.48
Alfalfa hay	0.67	0.72	0.78	0.84	0.89
Milo fodder	0.70	0.76	0.82	0.88	0.94
Corn silage	0.25	0.27	0.29	0.31	0.33
Sorghum silage	0.24	0.26	0.28	0.29	0.31

Table 14 presents analyses for digestible protein, total digestible nutrients, calcium and phosphorus. The vitamin content of many feeds is also included, together with the factors for determining the cost of 100 pounds of digestible protein and of 100 pounds of total digestible nutrients, the use of which has been explained.

Table 14. Analyses and Characteristics of Feeds—From F. B. Morrison's, "Feeds and Feeding," 20th Edition, by Special Permission of the Morrison Publishing Company, Ithaca, New York.

Feeding stuff	Digestible		Nutritive ratio 1:	Calcium or lime (Ca O in 100 lbs.)	Phosphates (P_2O_5 in 100 lbs.)	Vitamins			Factor for cost of 100 lbs. of protein and total nutrients. Multiply factor by cost per 100 lbs. feed.	
	Protein	Total nutrients				A	D	E	Digestible	
									Protein	Total nutrients
Concentrates	*per cent*	*per cent*		*per cent*	*per cent*					
Alcohol By-Product feed	20.1	59.9	2.0	....	....	....	....	....	4.97	1.67
Barley	9.3	78.7	7.5	0.05	0.38	0 to +	0	++	10.75	1.27
Beans (field)	19.9	75.6	2.8	0.14	0.45	0	0	—	5.02	1.32
Beet pulp (dried)	4.8	71.8	14.0	0.68	0.07	0	0	0	20.83	1.39
Beet pulp (dried molasses)	6.1	74.3	11.2	0.52	0.07	....	....	..	16.39	1.34
Beet pulp (wet)	0.8	8.9	10.1	0.09	0.01	....	....	....	125.00	11.23
Blood Meal or dried blood	70.7	75.9	0.7	0.33	0.26	....	.. .	....	1.41	1.32
Bone meal (steamed)	....	....	....	32.61	15.17	....	....	....	.....	.....
Brewers' grain (dried)	20.7	65.3	2.2	0.25	0.47	....	....	....	4.83	1.53
Brewers' grain (wet)	4.6	16.6	2.6	0.07	0.12	....	....	....	21.74	6.02
Buttermilk (dried)	32.1	85.5	1.7	1.36	0.74	+	0	+	3.11	1.17
Coconut meal (O.P.)	18.7	80.8	3.3	0.21	0.62	....	....	....	5.35	1.24
Corn (dent No. 2) yellow	7.1	80.6	10.3	0.01	0.27	++	0	++	14.08	1.24
Corn (snapped)	5.9	70.6	11.0	....	....	....	....	....	16.95	1.42
Corn and cob meal	6.0	75.9	11.2	....	0.23	....	....	...	16.67	1.32
Corn germ meal	14.5	79.5	4.5	..	..	....	....	....	6.90	1.26
Corn gluten feed	22.7	77.4	2.4	0.14	0.55	++[1]	0	0	4.40	1.29
Corn gluten meal	36.5	81.8	1.2	0.03	0.38	+++[1]	0	0	2.74	1.22
Corn oil meal (O.P.)	16.7	78.7	3.7	0.05	0.57	..	..	..	5.99	1.27
Cottonseed meal (43%)	35.0	75.5	1.2	0.24	1.11	0	0	—	2.86	1.32
Cottonseed meal (41%)	33.9	73.6	1.2	0.20	1.19	....	....	....	2.95	1.36
Distillers' dried grains (corn)	22.3	85.0	2.8	0.05	0.31	....	....	....	4.48	1.18
Feterita grain	10.1	79.7	6.9	....	....	....	....	....	9.90	1.25
Fish meal	47.5	67.6	0.4	5.37	2.98	0 to +	0 to +	—	2.10	1.48
Hegari grain	7.9	81.2	9.3	....	....	....	....	....	12.66	1.23
Hominy feed	7.8	85.2	9.9	0.03	0.57	++[1]	0	++	12.82	1.17
Kafir grain	9.1	80.1	7.8	0.04	0.30	....	....	....	10.99	1.25
Linseed meal (O.P.)	30.6	78.2	1.6	0.33	0.86	0	0	+	3.27	1.28
Malt sprouts	20.3	70.6	2.5	0.24	0.71	....	.	....	4.93	1.42

[1] Chiefly from yellow corn.

Table 14. Analyses and Characteristics of Feeds.—(Continued).

Feeding stuff	Digestible		Nutritive ratio 1:	Calcium or lime (Ca O in 100 lbs.)	Phosphates (P_2O_5 in 100 lbs.)	Vitamins			Factor for cost of 100 lbs. of protein and total nutrients. Multiply factor by cost per 100 lbs. feed.	
	Protein	Total nutrients				A	D	E	Digestible Protein	Digestible Total nutrients
	per cent	*per cent*		*per cent*	*per cent*					
Meat scraps (50%) or dry-rendered tankage with bone	46.7	71.2	0.5	10.96	5.16	....	....	....	2.14	1.40
Milo grain	8.7	79.9	8.2	....	0.34	....	....	....	11.49	1.25
Molasses (beet)	2.5	58.8	22.5	0.05	0.02	....	....	....	40.00	1.70
Molasses (cane)	0.9	56.6	61.9	0.56	0.06	0	0	++	111.11	1.77
Oats	9.4	71.5	6.6	0.09	0.33	0	0	++	10.64	1.40
Oat mill feed	4.0	42.6	9.7	0.26	0.18	....	....	....	25.00	2.35
Peas, field (culls)	21.0	79.4	2.8	0.07[2]	0.40[2]	....	....	....	4.76	1.26
Peanut meal (O.P.)	38.0	82.1	1.2	0.17	0.55	0	0	++	2.63	1.22
Rye	10.3	80.1	6.8	0.04	0.37	0	0	++	9.71	1.25
Skimmilk	3.5	8.6	1.5	0.14	0.12	0	0	+	28.57	11.63
Skimmilk (dried)	33.1	84.1	1.5	1.24	0.96	0	0	+	3.02	1.19
Sorghum grain, sweet	5.6	74.3	12.3	....	0.36	....	....	....	17.86	1.34
Soybeans	32.8	86.2	1.6	0.20	0.60	0	0	—	3.05	1.16
Soybean meal, expeller process	37.7	82.2	1.2	0.28	0.66	0	0	—	2.65	1.22
Soybean meal (solvent)	39.4	77.6	1.0	....	....	....	....	....	2.53	1.29
Tankage (55%) digester	51.5	74.2	0.4	7.21	3.85	0	0	—	1.94	1.35
Wheat	11.3	83.6	6.4	0.03	0.43	0	0	++	8.85	1.20
Wheat bran	13.1	70.2	4.4	0.12	1.32	0	0	++	7.63	1.42
Wheat, standard middlings	14.4	78.4	4.4	0.08	0.94	0	0	+++	6.94	1.27
Wheat gray shorts	15.0	78.9	4.3	....	....	....	....	....	6.67	1.27
Whey	0.9	6.4	6.1	0.05	0.04	0	0	+	111.11	15.62
Whey (dried) (milk sugar feed)	11.9	84.1	6.1	1.18	0.66	0	0	+	8.40	1.19
Green Roughage, Roots, Etc.										
Alfalfa	3.4	14.7	3.3	0.40	0.06	+++	0	+++	29.41	6.80
Beets, sugar	1.2	13.8	10.5	0.03	0.04	0	0	—	83.33	7.25
Beet tops	1.9	7.4	2.9	0.15	0.04	....	....	....	52.63	13.51

[2]Figures for field peas

Table 14. Analyses and Characteristics of Feeds.—(Continued).

Feeding stuff	Digestible		Nutritive ratio 1:	Calcium or lime (Ca O in 100 lbs.)	Phosphates (P_2O_5 in 100 lbs.)	Vitamins			Factor for cost of 100 lbs. of protein and total nutrients. Multiply factor by cost per 100 lbs. feed.	
	Protein	Total nutrients				A	D	E	Digestible Protein	Digestible Total nutrients
	per cent	*per cent*		*per cent*	*per cent*					
Blue grass (Ky)	2.4	18.6	6.8	0.16	0.08	....	....	....	41.67	5.38
Brome grasses (misc.)	3.0	20.8	5.9	....	0.10	....	....	....	33.33	4.81
Clover (red)	2.6	15.4	4.9	0.43	0.07	+++	0	+++	38.46	6.49
Clover (sweet)	3.0	14.0	3.7	0.32	0.10	....	....	....	33.33	7.14
Corn fodder (dent) (green)	1.2	16.3	12.6	0.06	0.05	....	....	....	83.33	6.13
Grama grass	2.0	20.6	9.3	....	....	....	....	....	50.00	4.85
Kafir fodder	1.3	15.5	10.9	0.06	0.04	....	....	....	76.92	6.45
Milo fodder	1.0	15.1	14.1	....	0.07	....	....	....	100.00	6.62
Oats (8 in. high)	3.9	9.2	1.4	....	....	....	....	....	25.64	10.87
Peas, field (misc.)	2.6	11.9	3.6	....	0.05	....	....	....	38.46	8.40
Peas and oats	2.4	14.1	4.9	0.07	0.07	....	....	....	41.67	7.09
Potatoes	1.1	17.3	14.7	0.01	0.05	0	0	—	90.91	5.78
Rye fodder, all analyses	2.3	16.2	6.0	....	0.07	....	....	....	43.48	6.17
Sorghum, sweet, fodder	0.8	17.3	20.6	0.12	0.05	....	....	....	125.00	5.78
Soybean fodder	3.2	15.1	3.7	0.29	0.09	....	....	....	31.25	6.62
Sudan grass	1.4	17.7	11.6	0.14	0.06	....	....	....	71.43	5.65
Wheat fodder (not over 10 in.)	4.3	13.5	2.1	....	....	....	....	....	23.25	7.41
Silages										
Alfalfa (high in water)	1.9	12.7	5.7	0.38	0.06	....	....	....	52.63	7.87
Clover (sweet)	3.5	16.1	3.6	0.41	0.13	....	....	....	28.57	6.21
Corn (dent, well matured)	1.3	18.7	13.4	0.07	0.06	+ to ++	0 to +	+	76.92	5.35
Corn (dent, without ears)	0.8	13.6	16.0	0.11	0.02	....	....	....	125.00	7.35
Sorghum (grain)	1.1	17.8	15.2	....	....	....	....	....	90.91	5.62
Sorghum (sweet)	0.8	15.1	17.9	0.07	0.04	+ to ++	0 to +	+	125.00	6.62
Soybean	2.6	15.0	4.8	0.31	0.10	....	....	....	3.85	6.67
Dry Roughages										
Alfalfa hay (all analyses)	10.6	50.3	3.7	1.43	0.21	++[3]	++[3]	+++[3]	9.43	1.99
Alfalfa hay (stemmy)	8.2	47.5	4.8	1.01	0.19	0 to +	—	—	12.19	2.10
Alfalfa meal (good)	10.8	53.9	4.0	1.31	0.17	....	....	....	9.26	1.85

[3] Good quality.

Table 14. Analyses and Characteristics of Feeds.—(Concluded).

Feeding stuff	Digestible		Nutritive ratio 1:	Calcium or lime (Ca O in 100 lbs.)	Phosphates (P_2O_5 in 100 lbs.)	Vitamins			Factor for cost of 100 lbs. of protein and total nutrients. Multiply factor by cost per 100 lbs. feed.	
	Protein	Total nutrients				A	D	E	Digestible	
									Protein	Total nutrients
	per cent	*per cent*			*per cent*					
Alfalfa straw	4.5	42.6	8.5	....	....	....	....	....	22.22	2.35
Barley straw	0.9	44.5	48.4	0.32	0.09	0	—	—	111.11	2.25
Bean straw (field)	3.0	45.2	14.1	1.67	0.13	....	....	....	33.33	2.21
Clover red (all analyses)	7.0	51.9	6.4	1.21	0.18	++	++	+++	14.28	1.93
Clover sweet (2d yr.)	10.5	49.9	3.8	0.95	0.19	....	....	....	9.52	2.00
Corn stover (no ears)	2.1	46.2	21.0	0.41	0.08	+	+	—	47.62	2.16
Cowpea hay	12.6	49.4	2.9	1.13	0.25	....	....	....	7.94	2.02
Feterita stover	1.8	49.3	26.4	....	....	....	....	....	55.55	2.03
Kafir fodder (dry)	4.6	54.1	10.8	0.47	0.17	+	+	—	21.74	1.85
Kafir stover (med)	1.7	47.7	27.1	....	....	....	....	....	58.82	2.10
Millet hay (common)	5.2	51.5	8.9	0.30	0.17	....	....	....	19.23	1.94
Milo fodder (dry)	4.3	53.0	11.3	....	....	....	....	....	23.25	1.89
Milo stover (dry)	1.1	48.8	43.4	....	....	....	....	....	90.91	2.05
Native hay (good)	4.9	52.0	9.6	....	....	....	....	....	20.41	1.92
Native hay (weathered)	1.6	36.6	21.9	0.26	0.21	....	....	....	62.50	2.73
Oat hay	4.5	46.3	9.3	0.22	0.17	....	....	....	22.22	2.16
Oat straw	0.9	44.1	48.0	0.36	0.13	0	+	—	111.11	2.27
Pea (field) hay	11.6	56.9	3.9	1.36	0.22	....	....	....	8.62	1.76
Pea (field) straw	3.2	51.8	15.2	1.58	0.10	....	....	....	31.25	1.93
Peas and oats hay	8.9	52.2	4.9	0.80	0.20	....	....	....	11.23	1.91
Prairie hay (good)	2.6	49.2	17.9	0.49	0.10	....	....	....	38.46	2.03
Prairie hay (mature or weathered)	0.6	47.1	77.5	0.53	0.05	....	....	....	166.66	2.12
Rye straw	0.7	41.2	57.9	0.28	0.11	....	....	....	142.86	2.43
Sorghum sweet fodder (dry)	3.6	52.7	13.6	0.49	0.14	....	....	....	27.78	1.90
Soybean hay (all analyses)	11.1	50.6	3.6	0.96	0.25	....	....	....	9.01	1.98
Soybean straw	0.9	36.5	39.6	....	0.13	....	....	....	111.11	2.74
Sudan grass hay (all analyses)	4.3	48.5	10.3	....	....	....	....	....	23.25	2.06
Wheat hay	3.2	46.5	13.5	0.18	0.21	....	....	....	31.25	2.15
Wheat straw	0.8	35.7	43.6	0.22	0.07	0	—	—	125.00	2.80