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Feeding the Dairy Herd

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EXTENSION CIRCULAR 612

Feeding the Dairy Herd

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Feeding the Dairy Herd

By Ervin Kurtz, Extension Dairyman, assisted by
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Importance of Feed

Dairy cows, in order to make milk in large quantities, must be supplied with liberal amounts of the raw material from which milk can be made. **That means good feed.**

The average production of South Dakota milk cows for 1961 was 5,700 pounds of milk and 205 pounds of butterfat. Much of this relatively low production is due to poor feed and lack of enough feed. Production and feed records shown in table 5 reveal that one way to get increased production is to give the cows more feed.

Feed is the greatest single item of expense in producing milk. It accounts for about half the total yearly cost of keeping a cow.

Since feed is such an important part of the expense in producing milk, the herd owner probably has the greatest opportunity to reduce his production costs and increase his net profit by studying how he can supply his cows with the food nutrients they need at the lowest cost.

Profitable Feed Market

Dairy cows, capable of high production, provide a profitable, steady market for home grown farm feeds and make use of farm labor to the best advantage.

Nearly any South Dakota dairy farmer can plan a farm program that will supply almost the entire dairy ration and at much less cost than from purchased feeds.

Good alfalfa-brome pasture, alfalfa hay, silage, or haylage, corn, oats, and other farm grains will furnish a large percentage of the nutrients necessary. The exception would be that cows producing more than 50 pounds of milk a day may need a small amount of protein supplement in addition to the farm grains. These crops must be properly harvested, stored, and processed and fed liberally.

Big Eaters, Good Producers

Good dairymen do not condemn a cow because she is always hungry and a big eater, as that usually indicates a heavy producer.

A cow uses a certain amount of her feed for keeping up her body, for growth, and for nourishing the unborn calf. The more she eats above what is required for these functions, the more milk she can produce.

If a cow owner tries to save on costs by giving his cow less feed than she needs for her maintenance and her milk production, she will still use the amount necessary for her maintenance and reduce her

milk production to the amount she can make with the feed left. The following chart shows approximately how a cow uses her feed.

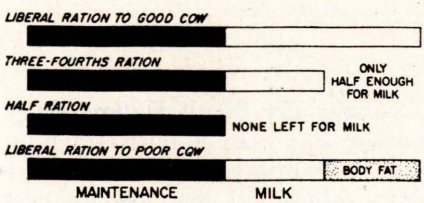


Figure 1—Uses of feed by dairy cows.

Cows' Nutrient Needs

In order for a dairyman to provide a practical, economical ration for his cows, it is necessary for him to know their nutrient needs and also be familiar with the feeds which will supply those needs at the lowest cost.

The cow must have certain nutrients in the proper proportion if she is to give the best results. She has no means of obtaining these nutrients except from the feed given her by her owner. She uses the feed to maintain her body, furnish energy, provide for growth, develop the unborn calf, and produce milk. The relative value of different feeds and combinations of feeds is determined by the amount of nutrients they furnish that the cow can use for her body and for milk production.

The nutrients necessary for the various functions listed are water, carbohydrates, fats, proteins, minerals, and vitamins. These nutrients are all important and a shortage of any of them will affect the quantity of milk but will have little effect upon the composition.

Water

Water is the cheapest food and one of the most important; yet, lack of enough water reduces production in many dairy herds.

Water makes up more than half of the animal body and milk is 87% water. It controls the temperature and is a major constituent of blood, which carries the digested food materials to all parts of the body and carries waste products away.

Milking cows require more water than any other farm animals. They need from 3 to 5 gallons of water for each gallon of milk produced. This means that the cow should get from 2½ to 4½ gallons of water to drink per gallon of milk, besides what she gets in her feed. A heavy producing cow with free access to fresh water will drink from 20 to 35 gallons a day but perhaps only 8 to 10 gallons a day when she is not making milk.

Dairymen can go to considerable expense and effort to make sure their cows are not limited in their production because of lack of water. Experiments have shown that automatic drinking cups increased production from 3.5 to 4.0% over watering twice daily. They also revealed that cows drank one-third of their water at night.

Cows will not consume enough water if they have to drink from an exposed tank full of floating ice in the winter. If drinking cups are not available the cows need to be watered twice a day. The tank should be in a location protected from the wind and a tank heater or other means used to keep the water free from ice.

Carbohyrdates

Farm grains and roughages are composed very largely of carbohydrates. They include the starches, sugars, and the woody or fibrous parts of the plants. Carbohydrates are divided into two groups. Crude fiber is the group that is woody, largely insoluble, and indigestible. It has little food value. Wheat straw is a good example of a feed composed mostly of crude fiber.

The other group is called nitrogen-free extract and is much more soluble and digestible. It includes the starches and sugars. Corn is a good example of this group. Feed companies usually label the carbohydrates in dairy feeds as nitrogen-free extract and crude fiber. The higher the percentage of crude fiber the less the food value.

Carbohydrates are used to maintain body temperature, to provide energy for muscular activity and for milk production. If the cow gets more than she needs for these functions, she stores it as fat on her body. In South Dakota, corn and small grain are the main sources of carbohydrates in addition to the roughages.

Fats

Fats and carbohydrates serve the same purpose in the animal body although there is two and one-fourth times more energy in the fats than in carbohydrates. Fat is often listed on feed-bag labels as "ether extract."

All farm-grown feeds contain fat, usually, in sufficient quantity for the dairy cow. The concentrate part of the ration should contain a minimum of 3.5 to 4.0%, since the roughages are lower in fat content and the whole ration should contain 2.5 to 3.0% fat for good production.

Proteins

Proteins are absolutely essential in the cow's feed. She is unable to make protein from any other food nutrients found in farm feeds. They are used in the formation of skin, hair, bones, horns, hoofs, blood, muscular tissue, and the casein or curd and albumin in milk. The body of the mature cow is about 17% protein.

Although no other food nutrients can take the place of protein, if the cow receives more protein than she needs, the nitrogen is excreted and the remainder of the protein used for the same purposes as carbohydrates and fats.

Proteins are usually the most expensive of the food nutrients and are most often found lacking in the dairy cow's diet. The proportion of proteins to carbohydrates and fats for high production should not be less than 1 to 6.

Proteins are composed of different combinations of amino acids. About five or six of these acids are necessary for the growth and life of the dairy cow. Only a few feeds contain all of those acids, but all of them can be built up from feeds containing nitrogen by bacterial action in the paunch, or rumen.

The cheapest sources of protein in South Dakota are good legume or legume grass pastures, good leafy alfalfa hay, and legume silage or haylage.

If dairy cows are fed 20 pounds or more of good leafy alfalfa hay, plus 20 pounds of corn silage, together with a mixture of farm grains at the rate of 1 pound of grain to 4 pounds of milk, they will get sufficient protein to produce up to 50 pounds of milk a day testing 3.5% butterfat without the addition of protein supplement.

Minerals

Dairy cows need minerals. About 5% of the cow's body consists of minerals which are found mostly in the skeleton. She also needs minerals to make milk, which is about 0.7% mineral matter.

Fortunately, South Dakota dairy cows, which have good pasture, legume hay, and farm grains, get practically all the minerals they need except sodium, chlorine, and possibly iodine and phorphorus. Iodized salt will supply all of these minerals except phosphorus and is recommended for South Dakota.

A survey made by the Dairy Department revealed that in nearly one-half of the 51 counties reporting, some symptoms of iodine deficiency had been found. These symptoms were "big neck" in calves and lambs and the birth of hairless pigs.

Salt is very important, and since it cannot be stored in the body, it should be supplied daily. Iodized salt should be mixed with the grain feed at the rate of 1½ pounds to each 100 pounds of feed, but even when this is done a trough or box of loose iodized salt, protected from rain, should be provided where the cows have free access to it. Cows will not usually get enough salt if it is provided only in blocks.

Calcium and phosphorus make up the largest quantity of the minerals in milk and the bones. South Dakota soils are rich in calcium and the cows get enough of this mineral from the pasture, hay, and other roughages. This is especially true if alfalfa or other legume hay is fed.

Phosphorus is not as plentiful as calcium in farm-grown feeds. Some South Dakota soils are low in phosphorus content. The application of phosphorus to these soils will usually result in increased yields as well as higher phosphorus content in the crops.

Steam bone meal is an excellent source of phosphorus and calcium. Many dairymen mix 1 to 2 pounds

Table 1. Feeds Listed According to Digestible Protein Content

Roughages		Concentrates	
High protein	Low protein	High protein	Low protein
Alfalfa	Prairie hay	Soybean meal	Corn
Sweet clover	Wheat grass	Cottonseed meal	Wheat
Soybeans	Timothy	Linseed meal	Oats
Red clover	Brome	Corn gluten meal	Barley
	Sorghum	Ground soybeans	Rye
	Sudan		Middlings
	Millet		Bran
	Corn silage		

to each 100 pounds of the concentrate ration to make sure their cows get all of this mineral they need. Other dairymen provide a box of steam bone meal, protected from rain, where the cows can get it at will.

The minerals mentioned above are especially important in the dry cow's ration. At that time she is building up the skeleton of the calf and should be storing up minerals for heavy production after calving.

Many dollars are wasted each year by South Dakota dairymen in the purchase of expensive mineral feeds. A simple mixture of steam bone meal and iodized salt will supply all the mineral they need in addition to what they get in their regular ration.

Vitamins

Vitamins are extremely important for the growth and health of all animals, but are present in small amounts in feeds compared to other nutrients. Of all the known vitamins needed, only vitamin A and D may be lacking in dairy cow rations since all the others can be made by the cow in her own paunch or are abundantly supplied in the food which she eats. Even vitamins A and D are usually supplied to the dairy cow in sufficient quantities if she has good pasture, green leafy hay, and corn or grass silage.

Vitamin A is essential to the health and growth of all animals. The dairy cow makes vitamin A in her own digestive system from carotene which is abundant in green pasture grasses, silage, and green-cured hay. Farm grains contain little or no carotene.

Cows are able to store vitamin A when it is abundant and use it when the supply decreases. The vitamin A in milk increases and decreases according to the supply which the cow gets. It is highest when the pasture is at its best and lowest in the latter part of the winter feeding period, just before the pasture season starts.

Much of the carotene in the green grasses and legumes is lost in the hay curing process. That is why it is so important to retain as much of the green color as possible in the hay. When it is bleached too long in the sun or gets wet, little of the carotene is left. Carotene also decreases in storage whether in the stack or mow. Grasses and legumes usually contain more carotene when made into silage than when stored as hay.

Vitamin A is especially important for young calves. Lack of sufficient amounts in their feed causes them to be more susceptible to respiratory diseases, such as pneumonia, and their resistance to other diseases is decreased. Colostrum milk often contains ten times or more vitamin A than common milk and fortifies the calf against diseases. Skimmilk contains little vitamin A, as most of it is in the butterfat. Calves should be taught to eat hay as soon as possible because of its vitamin A content.

Under normal conditions dairy cows will usually get enough vitamin A from the pasture, silage, and hay they eat, but if they are compelled to subsist on bleached out

grass and low quality roughage for a long period, they may show unthriftiness, a breakdown of the nervous system, lack of muscular control, shy breeding, abortions, weak or dead calves, and even permanent blindness.

Vitamin D is necessary for the cow, as it enables her to assimilate calcium and phosphorus more efficiently. It is often called the "sunshine vitamin," because it can be obtained from the action of sunlight or from sun-cured roughages. Cows are able to store this vitamin in their bodies.

The lack of vitamin D in young animals often results in rickets. The symptoms are stiffness, enlarged joints, arched backs, and loss of appetite. It most often shows up when calves are kept in the barn all winter with little sunlight.

The best source of vitamin D for calves is sunlight and sun-cured hay. If it is necessary to confine the calves in the barn with little sunlight, they should receive cod liver oil or other fish oils in their feed to supply vitamin D.

In South Dakota, satisfactory rations containing practically all the nutrients described in preceding paragraphs, can be supplied from home grown feeds.

Other Ration Requirements

A satisfactory ration, in addition to supplying the required nutrients, must have certain other characteristics:

Palatability. Cows must like their feed, otherwise, they will not eat enough to supply them with the nutrients they need.

Variety. It is not so important that cows have a great variety of feeds, but, with equal costs, variety is desirable as it usually improves palatability.

Bulk. The cow's digestive system is designed to handle large amounts of bulky feeds. The concentrate ration should be fairly bulky unless fed on the silage and, of course, she should be given all the good roughage she will consume.

Economy. Home grown feeds, if of good quality, are usually the cheapest; then, if each cow is fed her grain feed according to her production, the ration should be economical.

Supplying the Nutrients

Roughages

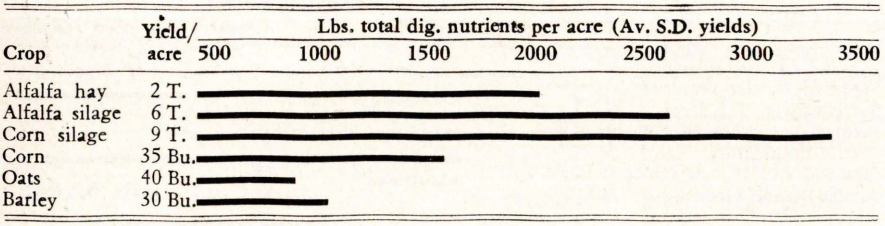
Good high quality roughage is the foundation of economical dairy feeding. The dairy cow is designed to consume large quantities of roughage which are broken down and made digestible by the bacteria in her paunch. It is then converted into the body needs of the cow and into milk, the most nearly perfect of human foods. No other farm animal is as efficient in utilizing pasture, hay, silage, and other roughages for the production of food for humans.

Home grown roughages are the cheapest feed for the dairy cow since they can produce more nutrients per acre and require less labor than grains. With good legume hay, silages, and pasture, the dairy feeding problem is largely solved.

Pastures

Most dairymen will not be able to feed their cows economically un-

Figure 2. Average yields per acre of feed crops under good management in the dairying area of South Dakota.



less they have good pastures and a planned pasture program that will provide such pastures over as long a season as possible. No other crop offers the majority of dairymen such possibilities for improvement and profit.

Good pasture supplies the cheapest feed that can be given to a dairy cow. The cost of feeding a cow in the barn is from two to three times as much as it is when she is on good pasture. Good pasture will furnish from one-third to one-half the feed nutrients a cow needs in a year at about one-eighth the annual feed cost.

Greater returns

Good pastures mean young, succulent grasses and legumes, grown on well fertilized crop land. Growing such pastures is a challenge to the skill of any dairyman. He can afford to spend considerable time and effort in selection of the proper grass and legume mixtures, fertilization, and preparation of the seedbed. With good cows, he will obtain greater returns in milk per acre than from cultivated crops and there will be less erosion and loss of soil fertility.

Poor pastures, which get weedy, dry up, and get tough in the summer, do not produce cheap feed. Likewise, corn stalks make very poor pasture for milk cows in the fall. At first they get too much corn then nothing but stalks. The stalks are high in undigestible fiber and very low in feed value. The cows will nearly always decline in milk flow even when they get a good grain ration.

Planning problem

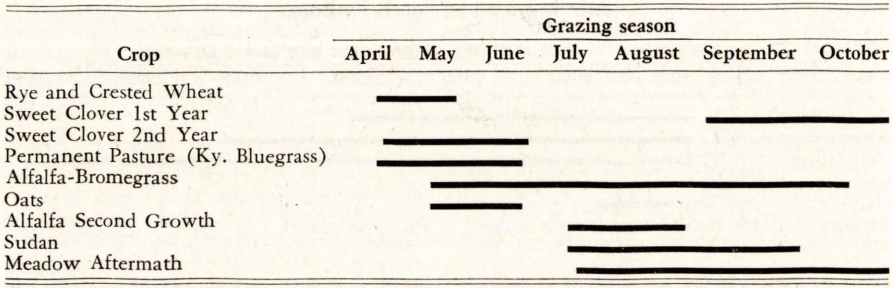
The big problem in planning a pasture program is to provide succulent, palatable forage from early in the spring to late in the fall. This is difficult because of the different stages of growth of different pasture crops. The pasture calendar (Fig. 3) gives the usual periods of growth of various pasture crops.

It is a good practice to provide a feed rack full of good hay in the barn lot even with the best of pasture. The cows like the hay, and if the pasture starts to dry up, they will eat more hay. With such a practice only the heavier producers will need grain. A rack of hay out in the alfalfa or alfalfa-brome pasture may help to prevent bloat.

Kinds of pasture

Pastures are usually classified as permanent, rotation, or temporary.

Figure 3. Pasture calendar.



Permanent pasture. Many farms contain some land that can only be used for pasture because of roughness, rocks, sloughs, or streams. The grasses usually consist of bluegrass, prairie grass, or slough grass. They dry up in early summer and become tough and unpalatable. They are unsuitable for dairy cows during the summer months. Many permanent pastures can be greatly improved by renovation, fertilization, and the seeding of legumes and more desirable grasses.

Rotation pasture. They are made up of legumes, tame grasses, or legume-grass mixtures. They are a part of a long crop rotation on good crop land and occupy the land for 3 or more years in each rotation. They provide the dairy cow with an abundance of excellent forage of high feeding value over much of the pasture season.

Temporary pasture. These pastures usually consist of annual crops such as small grains and sudan grass which can fill up the gaps in early spring and the hot summer months when other pasture crops are short.

Rye. Seeded early in the fall, rye will furnish some grazing in late fall and makes about the earliest spring pasture. Undesirable flavors in the milk are sometimes caused by rye pasture but can be largely avoided by taking the cows off the pasture 3 hours or more before milking.

Oats. If sown early, oats make about the best spring seeded crop. When sown as a nurse crop they can be pastured without harming the new seeding if the cows are kept off in wet weather.

Sudan grass. This crop is an ideal temporary pasture for the hot summer months when other grasses dry up and get tough and unpalatable. A small acreage sown right after corn planting, at the rate of 25 to 30 pounds per acre, should be ready for grazing by the middle of July. It is very palatable and cows will milk well on it.

Sudan grass is not entirely devoid of danger from prussic acid poisoning, but so seldom do livestock losses occur that it is widely used as a hot weather pasture crop. Some varieties contain less prussic acid than others. The following precautions should be observed: (1) Use clean seed with no mixture of sorghum. (2) Allow 18 inches of

growth before pasturing. (3) Give cows a good fill of other feed before turning on for the first time. (4) If the sudan becomes stunted from drought, try one or two of the least valuable animals on it for several hours before turning in the whole herd. (5) Avoid pasturing new growth after a hard frost.

Sweet clover sown with small grain can be used for late pasture the first fall after seeding and provides an abundance of forage the second year. It is a good practice to sow rye in the sweet clover the first fall to provide earlier spring pasture and to help prevent bloat.

Alfalfa makes an excellent palatable pasture but it should not be grazed closer than 5 or 6 inches at any time and the cows should be removed during most of the month of September so that plant food can be stored up in the roots for the next year's crop.

There is always some danger from bloat in pasturing alfalfa or sweet clover and every precaution should be taken to prevent it. Do not turn the cows in when the forage is wet with dew or rain. Provide a feed rack full of good hay in the barnyard, and see that they have a good fill before going to pasture. Mow one or two swaths around the pasture so the cows will eat more dry feed. Do not compel the cows to walk too far for water.

Alfalfa-bromegrass is the popular pasture mixture for South Dakota. Three pounds of alfalfa and 10 pounds of bromegrass is the recommended rate per acre. It yields more excellent forage than either alfafa or bromegrass alone, is very palatable, and there is less danger from bloat when the bromegrass makes up at least half of the forage.

Reed canary grass will stand water coverage that would kill other grasses. It is especially adapted to wet soils. It is not as palatable as many other grasses but is a great improvement over slough grass.

Ree wheat grass is a heavy yielder, palatable, and resistant to drought. Its use has been somewhat limited because of the difficulty in growing seed.

Bromegrass makes a good pasture, as it starts growth fairly early in the spring, is resistant to drought, yields well, and is very palatable. It grows more vigorously when seeded with legumes, as it is a heavy user of nitrogen.

Crested wheat grass starts growth earlier in the spring than any other permanent grass. It is resistant to drought and quite productive but becomes dormant for a lengthy period during the summer months. There is some danger of crested wheat grass causing a bitter flavor in milk.

Dry roughages

Hay is the main source of winter roughage for dairy cows in South Dakota. This is likely to continue for some time in spite of the rapid increase in the use of grass silage or haylage.

Hays vary widely in feeding value, depending upon the kinds, stage of maturity when cut, method of curing, and the weather when harvested.

Early cut hay is higher in protein content, lower in crude fiber, more

palatable, and when it retains its leaves and green color, is much superior in feeding value to coarse, stemmy, bleached, or late cut hay, regardless of its variety.

Field cured hay loses from 20 to 25% of its food nutrients during the harvesting process in good haying weather and up to 40% in wet weather.

The longer the hay remains in the field the more food nutrients are lost, therefore, it should be cured and gotten into storage as rapidly as possible.

Legume hays such as alfalfa, red clover, sweet clover, and soybeans are much superior to nonlegumes as roughages for dairy cows because they are much higher in protein and calcium and more palatable.

Alfalfa ranks at the top of the list as a hay for dairy cows in South Dakota. It yields the heaviest and is the most palatable. When harvested at an early stage, from bud to one-tenth in bloom, the leaves make up one-half the weight and contain three-fourths of the protein. A loss of leaves means a reduction in the protein content of the remaining hay. The leaves have about two and one-half times as much protein as the stems and are far more digestible.

At the Bureau of Dairy Industry Experiment Station, Beltsville, Maryland, it was found that there was a loss of 38% of the leaves in field cured alfalfa under good haying conditions without rain. If the alfalfa yielded 2 tons per acre and half the weight was leaves, that would mean a loss of 760 pounds of leaves per acre or 170 pounds of protein. It would take nearly five bags of linseed oil meal to replace this loss of protein. In another experiment, where the hay got wet, the loss was about doubled.

Haying methods that save leaves also save the green color and carotene. The importance of such methods cannot be over-emphasized.

Red clover gives the greatest yields and most protein per acre if cut when about half in bloom. It is not as palatable and is somewhat lower in protein than early cut alfalfa.

Brome and alfalfa mixture makes a good hay for dairy cows if it is at least one-half alfalfa and is cut at the recommended time for alfalfa. It is a heavy yielder and very palatable, although somewhat lower in protein than alfalfa alone.

Sweet clover makes a fair roughage if cut before it gets stemmy and coarse. It is difficult to cure and save the leaves. It should never be fed as the only roughage, as it sometimes contains a factor which prevents blood from clotting.

Soybeans. The hay from soybeans is equal to alfalfa in protein but is stemmier, less palatable, and much harder to cure. Soybeans make a good emergency hay crop but are usually more profitable when harvested as beans.

Non legumes, such as, prairie hay, crested wheat grass, bromegrass, timothy, sudan grass, millet, oats, and sorghum fodder are relatively low in protein and minerals and not good feeds for milk production. If they are fed, because of a lack of alfalfa or other legumes, much more

protein supplement will have to be included in the grain mixture to make up for lack of protein in the roughage.

Dairymen in South Dakota find alfalfa almost a necessity in making up an economical ration for their dairy cows.

Silage

Silage is the main source of succulent feed in the winter time for dairy cows in South Dakota. It has certain advantages over dry roughage: (1) there is less loss of food nutrients in harvesting; (2) silage is so palatable that cows will eat more total roughage and require less concentrates than with dry roughage; (3) there is less waste in feeding as it will all be cleaned up; (4) crops can be made into silage when the weather will not permit curing them into hay or dry fodder; (5) silage is much more uniform in quality than hay because of the difficulty in getting hay stored without rain.

In spite of the advantages of silage over dry roughage, it is not absolutely necessary for good production. Cows will produce almost as much milk if fed liberal amounts of excellent alfalfa hay and are provided with watering cups. Unless the hay is of excellent quality, however, they will give more milk if fed silage in addition.

Corn silage has been the principal source of succulent feed for dairy cows in South Dakota for years. It is a heavy yielder, easily preserved, higher in total digestible nutrients than other silages, and very palatable. It is, however, low in protein and mineral content. Corn silage will yield approximately twice as much total digestible nutrients per acre as would the grain, were it allowed to mature.

Sorghum has been used to considerable extent for silage in South Dakota and could be used more to good advantage, especially in dry years. It has many of the qualities of corn silage in yield, ease of preservation, and palatability but is lower in feeding value.

Hay crop silage. The use of hay crops such as alfalfa, alfalfa-brome mixture, and sweet clover as silage has developed in South Dakota within the last few years.

The greatest reason for the use of hay crops as silage is the difficulty in getting the first cutting stored as hay without great damage and loss of nutrients from wet weather.

South Dakota farmers, however, have found that hay crop silages have some other advantages over silages from other crops. (1) When well preserved it comes nearer to duplicating good pasture than any other crop. (2) It is available for supplementing short pastures in the summer and if stored in upright silos, they can be refilled with corn silage in the fall. (3) It is higher in protein and mineral content than corn or sorghum silage and less protein supplement is required in the grain ration.

There are some disadvantages in making hay crop silage, especially from the legumes as compared with corn and sorghum. (1) It is more difficult to make good silage because of the lack of sugar to promote proper fermentation. (2) It is lower in

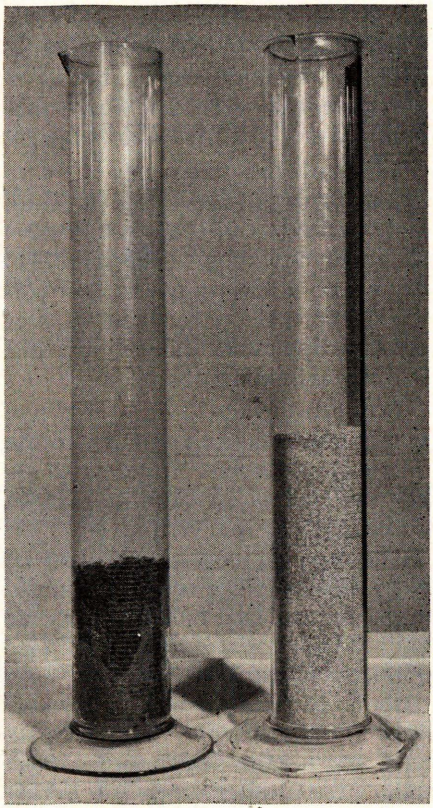


Figure 4. Dry matter in feed consumed daily by dairy animals—left, silage; right, haylage.

total digestible nutrients than corn silage.

Haylage

Interest in making and feeding alfalfa haylage is increasing considerably. General suggestions are presented here for handling this form of roughage.

Haylage is partially dried alfalfa—usually 35 to 50% moisture—which is chopped and handled similarly to alfalfa silage except that it is wilted more in the field before ensiling.

Research at South Dakota State College shows minimum field losses of nutrients with the haylage system. Many times first cutting alfalfa loses much of its feeding value as a result of rains after it is cut. Much of this loss occurs after the alfalfa dries lower than 40% moisture, when leaves and carotene disappear; thus total losses are less for haylage than for hay.

In addition, milk production, dry matter consumption, and body weight gains favor alfalfa haylage when compared with other methods of handling, but especially silage. Alfalfa haylage can be handled mechanically and use of silos can be extended. Freezing problems are lower with haylage than with silage and less weight needs to be handled than with silage. Haylage has a more desirable odor than higher moisture alfalfa silage.

The following suggestions should be helpful to those who are interested in putting up haylage.

1. Cut the alfalfa at bud to early bloom stage of maturity.
2. Wilt the alfalfa. If dried in a swath and crimped, most rapid drying occurs. However, reduced field trips can be made by cutting with a swather. Sometimes windrow curing is difficult, especially where the stand is thick and the weather is humid and rainy.
3. If not windrowed, rake when the alfalfa plants are tough, about 50% moisture.

4. Chop the haylage fine, using sharp cutter knives set for as short cut as possible. Long-cut material may be difficult to unload, to blow, and to unload from storage mechanically.

5. Haylage can be successfully made at 30 to 50% moisture. About 30 to 40% moisture appears best in sealed storage. Low moisture levels usually result in high field losses. High moisture means silage which does not have the palatability of haylage. Also, more moisture needs to be handled, foul odors occur, etc.

6. Use covered trucks or trailers to reduce wind losses. Allow for air escape from trucks or trailers using fine screens near the top.

7. Store the alfalfa in structures as air-tight as possible. This is extremely important.

8. In open-topped silos a mechanical distributor works best. Coning-up in the center (not at one side) in the silo, with frequent leveling is next best.

9. Fill as fast as possible, without long delays, to exclude air. Do not leave haylage overnight on trucks or trailers as this means double air removal by carbon dioxide replacement of plant cell respiration and less efficient preservation.

10. Any air intake such as cracks in silos and poor doors may cause trouble in spoilage. Some silos may need to be replastered or treated with some of the newer plastics, etc. Seal the large cracks in wood silo doors. A plastic sheet 2 mil thick, 3 feet wide, unrolled on the inside of the doors at filling time has been very effective in reducing losses.

11. In open tower silos top the silo with heavier, wetter alfalfa to aid in settling and sealing. Seal with a plastic cap. This can be weighted with low-cost material chopped fine. The plastic must be tight to the silo wall. Dig down about 2 feet at the silo wall and cover over the plastic so that the cap is coneshaped and is covered 2 feet deep at the silo wall.

12. It may be best to seal haylage for 3 or 4 weeks for fermentation to take place. However, for summer feeding immediate feeding after filling has been successful. A mechanical silo unloader with uniform removal daily works best.

13. Herd size or number of animals eating haylage should be so that 3 or 4 inches of haylage is removed daily from open-topped units. Considerable height of haylage is essential to good compaction and air removal at filling time.

14. Don't put low moisture alfalfa in trench, bunker, or slat cribbing, bale or pile silos. Haylage requires much more air-tight conditions, better packing, etc., than is possible with such silos.

15. Haylage can be fed as part or all of the forage. Alfalfa haylage is exceptionally high in protein.

Feeding only haylage may waste protein. A good ration for cows producing 50 to 60 pounds of milk is 20 pounds alfalfa haylage, 5 to 10 pounds of good alfalfa or alfalfa-brome hay, 50 pounds of corn silage, and 15 to 20 pounds of concentrate mixture about 12% crude protein. If more haylage is fed, reduce the protein in the grain mixture.

16. Alfalfa haylage is high in calcium, relatively low in phosphorus. One percent of the grain ration should consist of a high phosphorus mineral.

17. Very little if any grain should be fed to dairy heifers when high quality haylage and corn silage are fed. Some low protein, poor quality roughage such as corn stalks or grass hay can be utilized along with alfalfa haylage for yearling heifers.

18. Feed haylage as much of the year as possible. This reduces the costs of storage and mechanical handling per ton and per year. A big advantage of haylage is that it can be cut more nearly at the best stage of maturity in contrast to green-chopping or pasturing.

Grains

Food nutrients cost about twice as much per pound in grains as in harvested roughage and about six times as much as in good pasture. Economical feeding, therefore, requires that the nutrients the cows need be furnished as far as possible from good roughage and pasture.

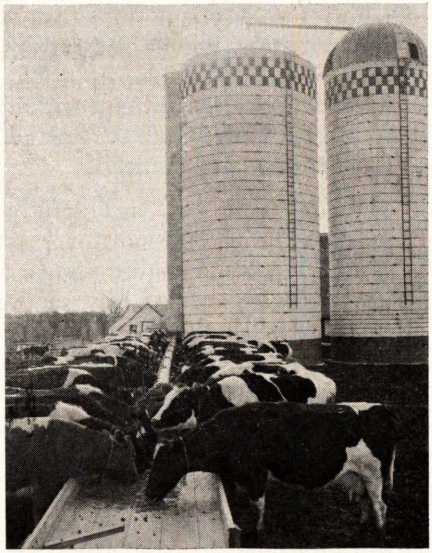


Figure 5. Distributing feed through use of an auger.

High producing cows, however, cannot eat enough roughage to get all the nutrients they need because of its bulkiness. Therefore, some of the nutrients must be supplied from grains and other concentrates.

The common farm grains grown in South Dakota, if fed with liberal amounts of good alfalfa hay, legume, and corn silage, will supply all the food nutrients needed for the dairy herd except for those producing more than 50 pounds of milk a day. These heavier producers may need some extra protein, which can be furnished by cracked soybeans, making the entire ration home-grown.

Corn is very palatable, higher in total digestible nutrients than other common farm grains, and usually supplies these nutrients at lower cost. It should, therefore, make up approximately one-half of the dairy

cow's ration. It is lower in protein content than other farm grains and should not be fed as the only concentrate. Corn and cob meal contains about 90% as much food nutrients as ground shelled corn. Many dairymen prefer to feed it rather than ground corn, as the cobs add bulk and the shelling operation is saved.

Oats make one of the best farm grain dairy feeds. They are bulky, cooling, and palatable. Slightly lower in total digestible nutrients than corn but higher in protein, they are excellent to mix with corn in the ration.

Barley has much the same feeding value as corn. It is a little more bulky and higher in protein. It fits into the ration very well as a substitute for corn.

Wheat has much the same feeding value as corn but is higher in protein. It is somewhat pasty and heavy and should be mixed with other bulkier feeds. Not over one-third of the ration should be wheat.

Rye is about equal to corn and wheat in feeding value but is quite unpalatable and heavy and should not make up more than one-fourth of the grain mixture.

Grain sorghum is about equal to corn as a feed for dairy cows. Unless it is ground, however, as much as half of the seeds may pass through the animal undigested.

Soybeans when cracked or ground are equal to linseed meal in protein and make an excellent home-grown feed to mix with other farm grains for dairy cows when the roughage is low in protein. The high content of oil in the beans seems to have no harmful effect upon the cows.

All farm grains should be coarsely ground for dairy cows. If not ground, much of the feed value is lost by the grain passing through the digestive system undigested. Different grains can be readily mixed without much additional labor while the grinding and shoveling are being done.

By-product feeds

There are many by-products on the market which are excellent to mix with farm grains for dairy cows when not too high in price.

Wheat bran is one of the very best by-product feeds available as it is palatable, bulky, laxative, cooling, and contains more phosphorus than other farm grains. It has about

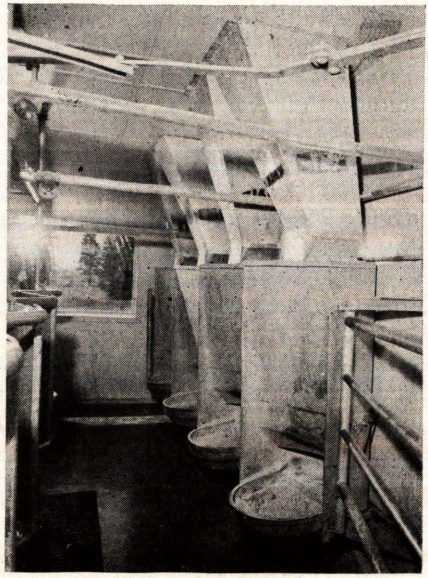


Figure 6. Grain can be portioned out in the milking parlor.

the same feeding value as oats and can replace oats in the concentrate mixture.

Soybean oilmeal is the ground cake which is left after the oil has been pressed out or extracted from the beans. It is very high in protein and is very valuable to mix with farm grains to bring up the protein content when that is necessary.

Linseed oilmeal is the product left when oil is extracted from flax seed. It is slightly laxative and used widely by dairymen to increase the protein content of grain mixtures.

Cottonseed meal is another high protein feed obtained after the oil is extracted from cottonseed. It can be used with farm grains the same as other high protein feeds.

Corn gluten meal is a by-product of the manufacture of starch and glucose. It is high in protein and can be used with farm grains for balancing dairy feed mixtures.

Corn gluten feed has only about 60% as much protein as corn gluten meal but can be used if the price is not too high.

Dried beet pulp is obtained by drying what is left of the beets after the sugar has been extracted. Molasses is sometimes mixed with the dried pulp to make dried molasses beet pulp. These feeds are very palatable, bulky, slightly laxative, and keep well in storage. They are about equal to oats in carbohydrates but are low in protein. The dry pulp is usually soaked with water before feeding. Because of their palatability, bulkiness, and cooling effect, these feeds are especially useful as part of the ration for dry cows, for fitting animals for show, and for cows on official test. When good silage is available it is questionable whether dried beet pulp can be used economically for the producing herd.

Molasses is a by-product of the cane and beet sugar factories. The lowest grade is called "black strap" and it has about 75% of the feeding value of corn. It is useful as an appetizer but generally the nutrients purchased in molasses are more expensive than those in home-grown grains.

Prepared dairy feeds

Ready mixed dairy feeds are plentiful on the market. A large proportion of them are of excellent quality but some are inferior.

The dairyman with a small herd, who must purchase all or nearly all his concentrate feed, can well consider the use of ready mixed dairy feeds. If he has a larger herd and is feeding a larger quantity of grain, he should compare the cost of a dairy mixture made up at the mill or at home from farm grains with the cost of ready mixed feeds.

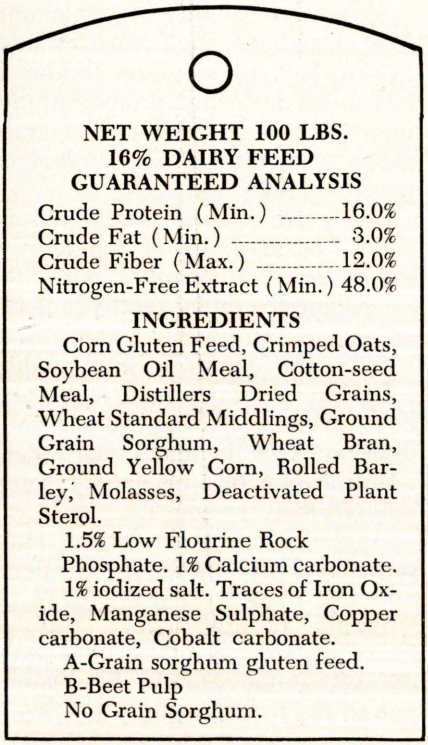
Cut protein costs

The dairyman who raises his own farm grains, such as oats, barley, and corn, needs only a small amount of high protein feed to balance his grain mixture. This can usually be obtained at the lowest cost in home-grown cracked soybeans, soybean oilmeal, linseed oilmeal, cottonseed meal, or corn gluten meal. The cost of a pound of digestible protein in the above feeds as compared to the cost in the ready mixed feed should determine the selection (see table 9).

South Dakota, as well as many other states, has laws governing the sale of commercial feeds. The manufacturer is required to give the minimum amount of each principal nutrient in the feed as well as the name of the ingredients in the mixture. This is done by printing the information on each bag or on a tag attached to each bag.

Check feed analysis

Dairymen should read carefully the analysis on the tag or sack before purchasing commercial feed. When these feeds are used with farm grains to increase the protein content, the cost per pound of protein should be considered. The percent of fiber is another important factor. Fiber is the woody part of plants and very low in feed value. A feed which is high in fiber is usually low in digestibility.



NET WEIGHT 100 LBS.
16% DAIRY FEED
GUARANTEED ANALYSIS

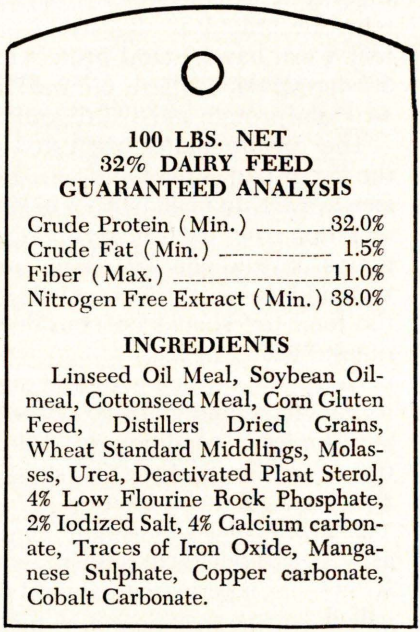
Crude Protein (Min.) 16.0%
Crude Fat (Min.) 3.0%
Crude Fiber (Max.) 12.0%
Nitrogen-Free Extract (Min.) 48.0%

INGREDIENTS

Corn Gluten Feed, Crimped Oats, Soybean Oil Meal, Cotton-seed Meal, Distillers Dried Grains, Wheat Standard Middlings, Ground Grain Sorghum, Wheat Bran, Ground Yellow Corn, Rolled Barley, Molasses, Deactivated Plant Sterol.

1.5% Low Flourine Rock Phosphate. 1% Calcium carbonate. 1% iodized salt. Traces of Iron Oxide, Manganese Sulphate, Copper carbonate, Cobalt carbonate.

A-Grain sorghum gluten feed.
B-Beet Pulp
No Grain Sorghum.

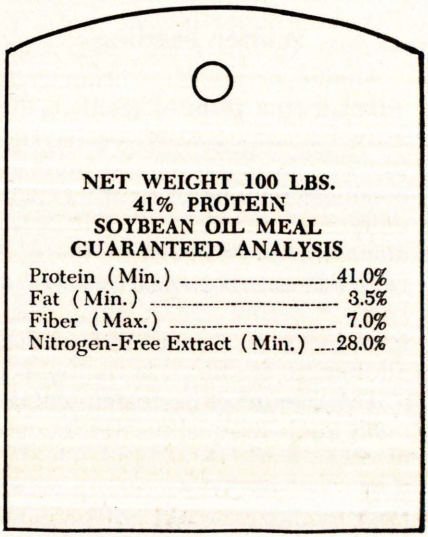


100 LBS. NET
32% DAIRY FEED
GUARANTEED ANALYSIS

Crude Protein (Min.) 32.0%
Crude Fat (Min.) 1.5%
Fiber (Max.) 11.0%
Nitrogen Free Extract (Min.) 38.0%

INGREDIENTS

Linseed Oil Meal, Soybean Oilmeal, Cottonseed Meal, Corn Gluten Feed, Distillers Dried Grains, Wheat Standard Middlings, Molasses, Urea, Deactivated Plant Sterol, 4% Low Flourine Rock Phosphate, 2% Iodized Salt, 4% Calcium carbonate, Traces of Iron Oxide, Manganese Sulphate, Copper carbonate, Cobalt Carbonate.



NET WEIGHT 100 LBS.
41% PROTEIN
SOYBEAN OIL MEAL
GUARANTEED ANALYSIS

Protein (Min.) 41.0%
Fat (Min.) 3.5%
Fiber (Max.) 7.0%
Nitrogen-Free Extract (Min.) 28.0%

Figure 7—Sample commercial feed tags

The percentage given for the different nutrients on these feed tags are for total nutrients. Only 75% of the total nutrients are usually digestible. Oats have 12% total protein but only 9.4% digestible protein. Corn has 8.7 total protein and 6.7 digestible. Soybean oil meal has 44.0 total protein and 37.0 digestible.

The carbohydrates are listed on the tag or bag as fiber and nitrogen-free extract. In making up a balanced ration from dairy feeds and farm grains only about 75% of the protein and total nutrients given on the feed tag should be considered digestible.

Dairy cows which get good quality roughage and grain do not need any "tonics," "conditioners," "appetizers," or "regulators," in spite of the claims made for them.

Healthy cows will usually do just as well without them, and if a cow is sick, a veterinarian should be called.

Winter Feeding

Alfalfa or alfalfa - bromegrass, either in the form of good quality leafy hay or as silage or haylage, provide the basis for the most economical feeding of South Dakota dairy cows in winter. If fed as hay alone, the cows should be given all they will eat. It is good practice to keep it before the cows in large feed racks in a protected yard in addition to feeding it in the barn.

The amount of hay eaten will depend upon its quality, the amount of other feeds eaten, and whether the cows have free access to water. Poor quality hay will not be eaten in large amounts and will limit production regardless of the amount of grain fed.

The dairy cow should be fed at least 2½ pounds of roughage (hay equivalent basis) for each 100 pounds of body weight—25 pounds per day for a 1,000-pound cow. Hay-equivalent basis means that, if hay and silage are fed together, 3 pounds of silage or pasture will replace 1 pound of hay. Six-tenths pound of concentrates will furnish as much total digestible nutrients as 1 pound of hay or 3 pounds of silage.

More protein supplement will be needed in the grain ration, unless the silage is limited to 25 or 30 pounds per day, which will enable the cows to consume 20 or more pounds of alfalfa hay.

When low quality or nonleguminous roughage, such as corn silage, prairie hay, or sorghum fodder is fed, much more high protein supplement must be added to the grain mixture to make up for the lack of protein in the roughage.

The grain or concentrate mixture should be made up of homegrown grains as far as possible. It should be palatable, bulky, and economical.

After cows eat all the high quality roughage possible, then feed each cow grain according to her production. This is much more economical than dishing out the same amount to every cow.

Ayrshires, Brown Swiss, Holsteins, and Milking Shorthorns need about 1 pound of grain for 4 or 5 pounds of milk. Cows of these breeds, giving less than 18 pounds of milk a day, should be able to get all the food nutrients they need

from good roughage. Guernseys and Jerseys should get 1 pound of grain for each 3 to 3½ pounds of milk. If they produce less than 15 pounds per day, they will usually need no grain.

No hard and fast rule will work with all cows. It is up to the dairyman to use his judgment in varying the amounts of grain given according to the condition and stage of lactation of each individual cow. Extreme caution is necessary in feeding heavy producing cows which require more than 15 pounds of grain a day.

1. Regulate the protein content according to the kind and quality of the roughage fed (see table 2).

2. Make up a grain mixture which will supply the digestible protein and total digestible nutrients at the lowest cost.

3. Purchase high protein feeds to go with homegrown grains if necessary.

4. Make up a mixture which is bulky and which the cows like.

To determine the total digestible protein in grain mixtures:

1. Multiply the pounds of each grain by the percent of digestible protein in that grain (see table 6).

2. Add the results.

3. Divide the total by the number pounds of mixture.

4. Multiply the results by 100 which will give the percent in the mixture.

Example	Lbs.	% D.P.	Lb. dig. protein
Corn and Cob Meal	500	5.4	27.0
Ground Oats	400	9.4	37.6
Soybean Oil Meal	100	37.0	37.0
	1000		101.6

101.6 ÷ 1000 = .1016
.1016 x 100 = 10.16% digestible protein

Summer Feeding

Pastures are the main source of summer feed for dairy cows in South Dakota. Many pastures, however, do not supply sufficient good forage through a long grazing season.

Dairymen have hardly scratched the surface in taking advantage of the possibilities of producing cheap feed from luxuriant pastures, but progress is being made. The season can be stretched and the gaps filled. It takes a carefully planned program, suited for each farm, using permanent, temporary, and rotation legume-grass pasture crops, fertilized, and in some cases irrigated, with proper pasture management.

The summer feeding problem is greatly simplified if good pastures are available. Grazing should not start until the grass is from 4 to 6 inches high. The cows should be changed gradually from barn feeding to the new pasture feed in order that they may become accustomed to it.

Research at South Dakota State College shows increased returns when different management practices are used. A dairyman can expect a 15% increase in milk production for rotation and strip grazing as compared to continuous graz-

ing; 16% for fertilizer application; 11% for green-chopping; and 28% for storing forage (haylage) in gastight silos.

Producers can benefit from dry-lot feeding when the milking herd reaches 25 cows. For a 10-cow herd, the labor and machinery cost will be approximately $20 an acre for dry-lot feeding as compared to $7 to $10 per acre for the 25-cow herd. The labor and machinery cost for pasture grazing will amount to approximately $4 an acre.

Heavy producing cows need some grain even though the pasture is good. A 1,200-pound cow producing 50 pounds of 3.5 milk a day will need to eat 150 pounds of nutritious grass a day to provide her with the nutrients she needs. Since she can seldom eat that much grass in a day, it is advisable to feed the heavy producers about 1 pound of a grain mixture for each 5 to 7 pounds of milk produced. A large rack full of good hay in the barnlot or a supplement feed of grass silage will reduce the amount of grain needed, and will increase the amount of roughage consumed.

Feeding the Dry Cow

All dairy cows need a rest or dry period from 6 to 8 weeks before freshening. The lower producers will usually be dry that long before calving. It is more difficult to dry off the high producers. The first step in turning these cows dry is to take away their grain, feed them nonlegume hay, and limit the supply of water. After the milk has been reduced to 20 pounds a day or less, milking can be stopped entirely, provided the udder is healthy and free from mastitis. If mastitis is present, special precaution and treatment are necessary.

Sometimes the udder will fill to such extent it causes pain. In that case milk only often enough to relieve her but milk her dry.

During the dry period the cow should be fed liberally on the same grain ration the herd gets. Probably no grain gives greater results in milk production than that fed when she is dry. She is building up her body, perhaps depleted from the previous lactation, nourishing the fetus, and storing fat to be used after she freshens. Heavy producing cows do not usually eat enough to keep up their body weight for the first few weeks of calving, and the stored fat will be used for milk production. Research has shown that for each 62 pounds of grain fed during dry periods, 100 pounds more milk was produced during the next lactation.

In addition to grain, the dry cow should have all the good roughage she will eat, such as alfalfa hay, grass or legume grass silage, and good pasture. As calving time approaches, it is not advisable to feed heavily on corn silage if it contains a large amount of corn. Steamed bone meal should be added to the grain ration at the rate of 2 pounds per 100 pounds of the mixture.

Feeding the Fresh Cow

When the cow's udder begins to spring, reduce the grain but continue to feed her good quality roughage. Have a record of her breeding so that you will know the

approximate date of calving, but watch her closely. The last few days before she freshens, take her grain away and feed her lightly on wheat bran or ground oats.

As soon as possible after the calf is dropped, give the cow all the lukewarm water she will drink. After giving her bran or ground oats, she will require no more feed for 12 hours except some nice bright hay. After 12 hours and for 2 or 3 days she may receive wheat bran or ground oats, with a little linseed oil meal and salt added, plus alfalfa hay and a small amount of grass silage. Wheat bran and oats should make up more of the grain ration than normal for the first 2 weeks.

It is advisable to start the cow on 4-6 pounds of grain mixture per day and increase at the rate of a pound every 3 or 4 days, taking 3 or 4 weeks to get her on full feed, according to production.

The importance of the feed, care, and attention of the cow, when dry, and at calving time can not be over emphasized, as she is facing a hard year's work and should be in perfect condition.

Calf Feeding to 6 Months

The period from birth to 6 months of age is a most critical time in the life of dairy calves. Carefulness in feeding during this period will help reduce death losses.

Calves are usually allowed to nurse 2 or 3 days, then changed to pail feeding. Either open pails or nipple pails are satisfactory, provided they are kept clean. Nipple pails have the advantage of causing the calf to drink slowly and digestive upsets are less likely to occur.

It is very important that the calf gets the colostrum or first milk. It enables the calf to resist diseases and is slightly laxative, thus aiding digestion.

No matter what method of feeding is followed later, calves should get normal amounts of whole milk for 3 or 4 weeks. Calf losses are usually highest during this period of early milk feeding, but can be reduced by the following precautions:

1. Avoid over-feeding (1 pound of milk to each 10 or 12 pounds of body weight per day is about right).

2. Feed only warm milk (90° to 100°F).

3. Feed only fresh milk.

4. Feed at regular hours.

5. Scrub pails thoroughly after each feeding.

6. Reduce milk by half if there are indications of scours.

There are about three different systems of calf feeding used by dairymen:

1. The nurse cow method by which the calves get their milk from a nurse cow until they are about 4 months old.

2. The liberal milk feeding method, where separated milk is available. The calves are changed from whole milk to separated milk at a month old and continue to get separated milk until they are 4 to 5 months old.

3. The limited milk feeding method where the calves get whole milk 4 weeks and then are weaned from milk entirely.

In the first two methods the calves are taught to eat a concentrate mixture at about 2 weeks of age. It is fed free choice but limited to 4 pounds daily until the calf is about 6 months old.

A satisfactory concentrate mixture may consist of 30 pounds coarsely ground corn, 30 pounds wheat bran, and 10 pounds linseed meal or soybean oil meal, plus 2 pounds steamed bone meal and 1 pound iodized salt.

With the limited milk feeding method the calves are taught to eat a calf starter at about 2 weeks of age. It is fed free choice until the calf is 4 months old, but limited to 4 pounds daily. There are many good commercial calf starters on the market which should be fed according to the manufacturer's directions. At 4 months of age the calf is changed to the concentrate ration.

Calves will usually start to eat hay when they are about 2 weeks old. They should receive only green colored, sun-cured hay of the highest quality, generally the leafier the better. Fine stemmed second cutting clover or alfalfa are about the best. If the calves show signs of scouring, the amount of hay should be reduced or good quality grass hay should be mixed with the clover and alfalfa.

Calves can make good use of excellent pasture after they are 4 months old but should receive, in addition, their concentrate mixture and hay. They should be supplied with shade, shelter, salt, and fresh water and should not be pastured with older cattle until they are a year old.

Feeding Heifers

Heifers should receive a concentrate ration in addition to good quality hay and pasture until they are about a year old. With good roughage or good pasture, 2 or 3 pounds of concentrate a day should be sufficient. If the roughage or pasture is poor quality, the heifer may need 4 or 5 pounds of concentrate daily.

Heifers 6 to 12 months of age should be fed 8 to 15 pounds of silage when not on pasture. It is good practice to keep a rack full of good quality hay in the feed lot even when they are on good pasture.

When one-half or more of the roughage is legume hay, pasture, or silage, the following concentrate mixture is satisfactory: 500 pounds corn and cob meal, 400 pounds ground oats, 100 pounds soybean oil meal or linseed oil meal. If the legumes make up less than half the roughage, the concentrate mixture should contain 200 pounds soybean oil meal or linseed oil meal and 400 pounds of corn and cob meal and 400 pounds of ground oats. One pound of salt and 2 pounds of steamed bone meal should be added to each 100 pounds of either mixture.

Heifers will make satisfactory growth from 1 year of age up to 3 or 4 months before calving without concentrate feed if they re-

ceive an abundance of good legume hay or legume hay and legume silage or corn silage. They should also get a mixture of steamed bone meal and salt, free choice.

If the roughage is not of first quality, the heifers will need a small amount of concentrates to keep them growing properly. The daily allowance will not need to be more than 2 to 4 pounds up to 3 or 4 months before calving. At this time the concentrate should be increased to 4 or 5 pounds daily in order to supply enough nutrients for the development of the fetus and to put the heifer in good condition for high production during the first lactation. In general, the concentrate fed to the milking herd will be satisfactory for the heifers.

Computing Cow Rations

It is important to feed good producing cows balanced rations. It is not necessary, though, for dairymen to figure a balanced ration for each individual cow in the herd based on feeding standards. The suggestions for feeding on pages 20 to 22 and the grain mixtures for different roughages in table 2 will provide rations that are sufficiently well-balanced. It is good practice, however, to balance a ration for a typical cow in the herd as a guide to feeding the whole herd.

In balancing a ration for a dairy cow, it is necessary to determine the amount of nutrients she will require for her body maintenance and for the production of her milk. Through much experimental feeding work and many digestion trials, the amounts of digestible protein and total digestible nutrients required to keep cows of different size, at a normal weight, have been determined (see tables 3 and 4).

Balanced Rations

The first step in balancing a ration for a dairy cow is to estimate her weight and calculate the amount of nutrients required to keep her at a normal weight.

The second step is to determine the amount of nutrients required each day for her milk production. Adding the amounts needed for these two purposes will give the total daily requirements.

For example, we will take a cow weighing 1,200 pounds and giving 50 pounds of 3.5% milk daily. Referring to tables 3 and 4, we find that she will need:

	Digestible protein	Total digestible nutrients
For maintenance	0.76	9.30
For production		
50 x 0.046 & 0.30	2.30	15.00
Total	3.06 lb.	24.30

Now that we have the total nutrient requirements for our cow, the next step is to select a practical ration, home-grown as far as possible, which will supply the nutrients required at the lowest cost.

We will suppose that we have available good alfalfa hay, corn silage, corn, and oats. Limiting the corn silage will permit the cows to eat more hay. This will reduce the cows' protein supplement needs.

Feeding the roughage at the rate of 1½ pounds of hay and 3 pounds

Table 2. Suggested Grain Mixtures to Feed with Different Kinds of Roughages

	Nonlegume	Mixed	Mixed
Kind of Roughage	Corn silage, corn stover, sorghum silage, prairie hay, sudan hay, oat hay, millet hay, other nonlegume.	Corn silage, stover, sorghum silage, prairie hay or other nonlegume with alfalfa, clover or soybean hay.	Top quality alfalfa hay and silage (limit silage to 3 lbs. per 100 lbs. of body weight).
Grain Mixture	**Pounds** C. & C. Meal ..... 400 Gr. oats ..... 300 S. Bean O. Meal ..... 300 Steamed B. Meal ..... 20 Salt-Iodized 15	**Pounds** C. & C. Meal ..... 500 Gr. oats ..... 300 S. Bean O. Meal ..... 200 Steamed B. Meal ..... 15 Salt-Iodized 15	**Pounds** C. & C. Meal ..... 500 Gr. oats ..... 500 Steamed B. Meal ..... 15 Salt-Iodized 15
Protein Content	**Percent** Total ..... 19.8 Digestible 16.1	**Percent** Total ..... 16.1 Digestible 12.1	**Percent** Total ..... 9.7 Digestible 7.4
Kinds of Roughage	**Legume** Good quality alfalfa, Sweet clover, Soybean, Hay.	**Legume-Silage & Hay** Alfalfa or alfalfa brome silage, alfalfa hay.	**Pasture** Brome - alfalfa, sweet clover, rye, bluegrass or other permanent pasture.
Grain Mixture	**Pounds** C. & C. Meal ..... 500 Gr. oats ..... 500 Steamed B. Meal ..... 15 Salt-Iodized 15	**Pounds** C. & C. Meal ..... 500 Gr. oats ..... 500 Steamed B. Meal ..... 15 Salt-Iodized 15	**Pounds** C. & C. Meal ..... 400 Gr. oats ..... 500 Steamed B. Meal ..... 15 S. Bean O. Meal ..... 100 Salt-Iodized 15
Protein Content	**Percent** Total ..... 9.7 Digestible 7.4	**Percent** Total ..... 9.7 Digestible 7.4	**Percent** Total ..... 13.4 Digestible 10.6
Amount to Feed	Feed Holstein, Brown Swiss, Ayrshire or Milking Shorthorns 1 lb. of grain mixture to 4 to 5 lbs. of milk. Feed Jerseys and Guernseys 1 lb. of grain to 3 to 3½ lbs. of milk. With good roughage, the first four breeds will usually need no grain if giving less than 18 lbs. of milk per day and the Jerseys and Guernseys will need no grain if they produce less than 15 lbs. per day.		Jerseys and Guernseys 1 lb. feed to 4-5 of milk. Holstein, Brown Swiss, Milking Shorthorn, 1 lb. feed to 5-6 lbs. milk.
Substitute for C. & C. Meal	Ground corn, barley, grain sorghum, pound for pound. Ground wheat may replace one-half of an equal weight of corn and cob meal.		
For Ground Oats	Wheat bran, barley, or wheat middlings, pound for pound.		
For Soybean Meal	Linseed oil meal, crushed soybean, cottonseed meal, or gluten meal.		

This chart is intended as a guide to proper feeding of dairy cattle. It is not a set of hard and fast regulations. The feeder must use good judgment and intelligence in catering to the likes and dislikes of individual cows. Dry cows need grain to get in good flesh before freshening. Thin cows need more grain than the chart calls for.

of silage daily for each 100 pounds live weight, as given in the third mixture, table 2, we have 18 pounds of alfalfa and 36 pounds of silage as the amount of roughage which the cow will consume. Consulting the feed analysis, table 6, we find that the alfalfa and silage would contain the following amounts of nutrients.

	Digestible protein	Total digestible nutrients
18 lbs. alfalfa (18 x 10.9 & 50.7)	1.96	9.126
36 lbs. corn silage (36 x 1.2 & 18.3)	.432	6.588
Total nutrients	2.39	15.714

Subtracting the nutrients supplied by the roughage from the total nutrients required by the cow we have:

	Digestible protein	Total digestible nutrients
Total required	3.06	24.30
Supplied in roughage	2.39	15.71
To be supplied in grain ration	.67 lbs.	8.59 lbs.

These nutrients will have to be furnished by the grain.

Taking 12.5 pounds as the daily amount for this 50 pound cow and using the grain mixture to be fed with alfalfa and silage as given in

Table 3. Daily Maintenance Requirements of Dairy Cows*

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

*From Morrison's "Feeds and Feeding," 22nd Edition—by permission of the author.

Table 4. Requirements for Milk Production*

Milk production	Digestible protein	Total digestible nutrients
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," 22nd Edition—by permission of the author.

table 2, we can find the amount of nutrients in the grain mixture from the feed analysis in table 6.

	Digestible protein	Total digestible nutrients
500 lbs. corn & cob meal	27.00	366.00
500 lbs. gr. oats	47.00	350.50
1000 lbs. total	74.00	716.50
Totals ÷ by 1000 gives amount supplied by each lb.	.0740	.7165
12.5 lbs. grain (12.5 x .0740 and .7165	.93	8.96
Amount supplied by roughage	2.39	15.71
Total supplied	3.31	24.67
Total required	3.06	24.30
Difference	.25	.37

The amount of digestible protein and of total digestible nutrients in this ration is close enough to the exact requirements to be entirely satisfactory.

Additional Factors For Efficient Dairying

1. A good breeding program for high production.
2. Good care and management.
3. Production of high quality milk.
4. Personal interest of the dairyman.
5. Good cropping practices.

Breeding program

In order to carry on a successful and profitable business, dairymen must have good cows with the inherent ability to produce large quantities of milk.

The surest, safest, and most economical way to get good cows in South Dakota is for the herd owner to breed and develop them himself through a sound breeding program.

One of the most important jobs of a dairy herd owner is the selection of the herd sire. This job has to be repeated about every 3 years.

A proven sire that has demonstrated his ability to get high producing offspring is the first choice to increase production.

The son of a good proven bull, from a high producing dam would be second choice.

High production, good type, strongly attached udders, long life, and regular breeding are very important in the females on the sire's side as well as the dam's side of the pedigree. The above characters in the dam and her sisters and the half sisters of the bull to be selected should be especially considered.

Artificial breeding relieves the herd owner of the job of selecting his own sires and is a sure way of having his cows bred to bulls carefully selected for high production.

The basis of a sound breeding program is accurate and continuous production and breeding records on each cow in the herd. This can best be accomplished by membership in the Dairy Herd Improvement Association.

There are now 216 herds (7,238 cows) enrolled in 15 standard D.H.I.A.'s and 294 herds with 6,683 cows in the Owner-Sampler program in South Dakota. Production records enable the herd owner to cull low producers, select replacement heifers from high producers,

and check on the ability of the sire to transmit high production. The D.H.I.A. cows averaged 392 pounds of butterfat in 1961, while the average production of all cows in the state was only 210 pounds.

The much greater returns, above feed cost, from high producing cows as compared with low producing cows is shown in table 5. These records were compiled from the South Dakota Dairy Herd Improvement Association's results.

Care and management

Disease and other physical ailments are responsible for heavy losses in dairy herds throughout the state. Herd health is, therefore, of the utmost importance if long life, regular breeding, and a high level of production are to be maintained. Practical dairymen are constantly on the watch to detect any symptoms of diseases or ill health in their dairy animals.

Tuberculosis has been largely eliminated from dairy cattle.

Brucellosis or Bangs Disease is still prevalent but is on the decrease in states where both dairy and beef cattle owners, together with state sanitary officials, extension agents, agricultural colleges and other livestock interests have combined in an aggressive, well organized program to wipe it out.

Mastitis causes great loss to the dairymen and is found in a large percentage of dairy herds.

Udder injury is largely responsible for mastitis. Careful herd management to prevent its occurence is much more effective than the use of drugs after the animals are affected. The following practices will help to avoid udder injury and mastitis:

1. Wash the udder of each cow before milking. Use a warm chlorine or disinfectant solution and a clean towel for each cow.
2. Use the strip cup before milking each cow.
3. Be sure milking machine is in the proper working order.
4. Keep hands and equipment clean when milking.
5. Do not attach milking machine until the milk is let down.
6. Remove teat cups as soon as the animal is milked out.
7. Do not leave excessive quantities of milk in the udder (machine strip).

Table 5. South Dakota D.H.I.A. Records for 1961

No. records	Production per cow, lbs.	Av. feed cost	Av. return above feed cost	Feed cost per 100 lbs. milk
75	B.F. 182, Milk 3600	$ 84	$122	$2.33
97	B.F. 303, Milk 6300	112	230	1.78
1103	B.F. 325, Milk 8300	135	232	1.63
1869	B.F. 361, Milk 10200	163	245	1.60
2312	B.F. 420, Milk 11600	179	296	1.54
595	B.F. 478, Milk 13900	185	355	1.33

8. Avoid excessive variation in routine.
9. Provide adequate bedding in stalls, barns, or sheds.
10. Prevent injuries to the udder by avoiding such conditions as slippery floors, mud holes, high door sills or similar obstructions.
11. Have cows that are infected with mastitis treated, but do not rely on treatment alone; sanitation and good management are important in controlling mastitis.
12. If it is necessary to treat an infected udder, do not sell the milk from the treated cow for at least 72 hours.

Calf scours is another great source of loss to the dairyman. Prevention, by proper care and feeding, is more effective than treatment after the calf becomes affected.

Keep cows comfortable, and contented. Treat them kindly, milk them regularly, and follow the same routine at the same time each day.

Keep the barn dry with good ventilation, insulate walls, and install electric ventilating fans if necessary.

Practice fast milking.

Keep production, breeding, and feeding records on each cow, preferably through D.H.I.A.

Cull out low producers, crippled cows, and those with damaged udders.

Long dry periods, caused by failure to calve every 12 or 13 months, result in low average production in many herds. Sterile cows and irregular breeders should be included in the culling process.

Do not let heifers get thin and stunted, but grow them out to good size at freshening time.

Well-grown Jerseys and Guernseys can be bred to freshen at 24 months, Holsteins, Ayrshires, Brown Swiss, and Milking Shorthorns at 26 to 28 months.

Do not allow calves to suck each other, as it often results in blind quarters and badly shaped udders.

Give all cows a 6 to 8 week rest period before calving and feed them well so they will be in good condition when the calf is dropped.

Do not breed cows until at least 60 days after freshening.

Labor accounts for about 30% of the cost of milk production. Good help is scarce and hard to get. Plan or remodel the barn to save steps. Use feed carts, barn cleaners, and silo unloaders. Loose housing, with milking parlors, where carefully planned and managed, reduces labor.

High quality milk

Milk must be of the highest quality in order to be marketed to the best advantage.

Clean handlers, clean cows, clean well-ventilated barns, clean utensils, and quick cooling all contribute to high quality in milk and milk products.

Wild onions, pepper grass, as well as rye pasture often cause off-flavors in milk. Keep the cows off such pastures for at least 3 hours before milking. Strong smelling silage may also cause bad flavors if fed shortly before milking.

If all milk produced was of high quality, the consumption of all dairy

products would be increased. This would benefit both the dairy producer and the consuming public.

Personal interest

A good dairyman must like cows, appreciate them and their contribution to human welfare, and enjoy working with them and providing for their comfort and sustenance. He must be patient, gentle, and regular in his habits, always striving through good breeding, liberal feeding, and careful management, to raise the level of production and improve the type of his herd, as well as market a high quality product.

Table 6. Protein and Total Digestible Nutrient Content of Various Feeds

Feeds	Total protein	Digestible protein	Total digestible nutrients
Concentrates	%	%	%
Barley	12.7	10.0	77.7
Beet pulp (dried)	8.8	4.1	68.7
Beet pulp (wet)	1.5	.8	8.8
Beet pulp molasses (dried)	8.9	5.9	72.4
Brewers grains (dried)	27.5	22.0	67.1
Buttermilk	3.5	3.3	9.1
Buttermilk (dried)	31.8	28.6	83.1
Corn dent No. 2 grade	8.7	6.7	80.1
Corn and cob meal	7.4	5.4	73.2
Corn gluten feed	24.8	21.3	74.1
Corn gluten meal	43.2	36.7	79.7
Cottonseed meal (45% grade)	45.6	37.4	75.1
Distillers dried grains (corn)	26.1	19.1	84.0
Distillers dried grains (rye)	24.4	14.6	59.1
Milo grain sorghum	10.9	8.5	79.4
Linseed oil meal	35.2	30.6	75.5
Linseed oil meal (37% or over)	37.5	32.6	78.0
Millett (proso)	11.9	8.4	76.9
Molasses (blackstrap)	3.0	0.0	53.7
Oats	12.0	9.4	70.1
Oats (lightweight)	12.0	8.3	59.8
Oats (hull-less)	16.2	14.6	91.9
Rye	12.6	10.0	76.5
Skimmilk	3.6	3.4	8.7
Skimmilk (dried)	33.1	29.8	79.8
Soybean seed	37.9	33.7	87.6
Soybean oilmeal	44.0	37.0	77.9
Wheat (average all types)	13.2	11.1	80.0
Wheat bran	16.4	13.3	66.9
Wheat standard middlings	17.2	14.3	77.2

Table 6. Protein and Total Digestible Nutrient Content of Various Feeds (Continued)

Feeds	Total protein	Digestible protein	Total digestible nutrients
Dry Roughage	%	%	%
Alfalfa hay	15.3	10.9	50.7
Alfalfa hay (leafy)	16.0	11.7	51.2
Alfalfa hay (stemmy)	12.3	8.2	46.3
Alfalfa hay (brown)	17.3	9.2	44.0
Alfalfa-bromegrass hay	11.8	7.6	47.9
Bromegrass hay	10.4	5.3	49.3
Bromegrass hay (before bloom)	10.9	5.6	50.4
Clover hay (red)	12.0	7.2	51.8
Corn fodder	6.8	3.3	53.9
Corn stover	5.8	2.0	45.5
Millet hay (foxtail)	8.2	4.9	50.0
Oat hay	8.2	4.9	47.3
Oat straw	4.1	0.7	44.8
Prairie hay	6.0	2.0	45.1
Russian thistle hay	8.9	5.8	37.9
Sorghum fodder	6.2	3.3	52.4
Soybean hay	14.6	9.8	48.6
Soybean straw	3.9	1.1	38.6
Sudan grass hay	8.4	4.7	51.8
Sweet clover hay	13.5	9.5	47.3
Timothy hay	6.6	3.0	49.1
Succulent Feeds	%	%	%
Alfalfa green	4.6	3.5	14.8
Beet pulp (wet)	1.5	0.8	8.9
Bluegrass (green)	5.5	4.1	20.7
Brewers grains (wet)	5.7	4.6	19.6
Bromegrass (pasture)	5.1	3.9	18.3
Corn cannery refuse (ears removed)	1.6	0.6	12.2
Potatoes	2.2	1.3	17.4
Sorghum sweet	1.5	0.8	17.3
Sudan grass (pasture stage)	3.3	2.4	14.3
Silages	%	%	%
Silage (alfalfa not wilted)	4.1	2.6	13.5
Silage (alfalfa wilted)	6.3	4.3	21.5
Silage (grass plus legume wilted greatly)	7.0	4.8	29.5
Silage (corn)	2.3	1.2	18.3
Silage (corn and sorghum)	1.9	1.0	16.4
Silage (feterita)	2.6	1.4	17.1
Silage (sorghum sweet)	1.6	0.8	15.2
Silage (soybean not wilted)	4.2	2.9	14.6

Cropping practices

Successful and profitable dairying is closely connected with efficient production of farm crops and grassland.

The herd owner needs to be a good farmer with a knowledge of adapted crop varieties, grass mixtures, crop rotation, fertilization, and soil conservation, which will enable him to get high yields of grain, roughage, and pastures. These home-grown feeds usually provide the lowest cost rations for his herd.

To determine the cost per pound, divide the cost per 100 pounds by 100. Example: Oats at 70 cents per bushel would be $2.19 per 100 pounds or 2.19 cents per pound.

Table 7 can be used to deter-

Table 7. Cost of 100 Pounds of Feed at a Given Price and Weight per Bushel

Price per bushel	Cost per 100 pounds when a bushel weighs				
	32 lbs.	48 lbs.	56 lbs.	60 lbs.	70 lbs.
$0.50	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
1.55	4.84	3.23	2.77	2.58	2.21
1.60	5.00	3.33	2.86	2.66	2.28
1.65	5.16	3.43	2.95	2.74	2.35
1.70	5.32	3.53	3.04	2.82	2.42
1.75	5.48	3.63	3.13	2.90	2.49
1.80	5.64	3.73	3.22	2.98	2.56
1.85	5.80	3.83	3.31	3.06	2.63
1.90	5.96	3.93	3.40	3.14	2.70
1.95	6.12	4.03	3.49	3.22	2.77
2.00	6.28	4.13	3.58	3.30	2.84

mine the cost of feed mixtures as follows: The feed mixture consists of 15 bushels of oats at 70 cents per bushel and 7 bushels of ear corn or corn and cob meal at $1.50 per bushel. What is the cost of the mixture per pound? Consulting the table we find that oats at 70 cents per bushel is 2.19 cents per pound and ear corn at 1.50 per bushel is 2.14 cents per pound.

Table 8. Comparative Cost per Pound of Total Digestible Nutrients in Feeds

Total digestible nutrients in 100 lbs. of feed	Cost of feed per ton in dollars																					
	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
	Cost of 1 pound of digestible nutrients in cents																				
Roughages																					
Alfalfa hay ---- 50.3	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	1.0	1.1	1.3	1.5	1.7	1.9	2.1	2.3	2.5	2.7	2.9										
Soybean hay---- 49.0	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.1										
Prairie hay----- 49.6	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(dry) 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
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
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

Table 9. Comparative Cost per Pound of Digestible Protein in Feeds

	Digestible protein in 100 lbs.	Cost of feed per ton in dollars																							
	of feed	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	44	48	50	60	70	80	90	100
	Lbs.	Cost of 1 pound of digestible protein in cents																							
Roughages																									
Alfalfa hay	10.5	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	7.0	8.5	9.9	11.3	12.7	14.1	15.5	17.1	18.3	19.7	21.1													
Soybean hay	9.6	5.2	6.2	7.3	8.3	9.4	10.4	11.4	12.5	13.5	14.6	15.6													
Prairie hay	2.1	23.8	28.6	33.3	38.1	42.9	47.6	52.4	57.1	61.9	66.7	71.4													
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	25.0	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	33.8	40.6				
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	26.5	32.0				
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	22.5	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	18.2	21.8				
Protein supplements																									
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	7.4	9.0	10.4	11.8	13.3	14.2
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	6.7	8.0	9.4	10.8	12.1	13.4
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	7.5	9.0	10.6	12.0	13.6	15.0
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	6.6	8.0	9.2	10.6	11.8	13.2
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	6.8	8.2	9.5	11.0	12.3	13.6
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	11.4	13.6	16.0	18.2	20.5	22.8

Cover photo: This herd, grazing on alfalfa pasture, is owned by R. L. Cotton, Parker, South Dakota. The two cows in the foreground have been rated Excellent. (Photo courtesy Holstein Friesian Association of America.)

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