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FEEDING COWS FOR MILK PRODUCTION

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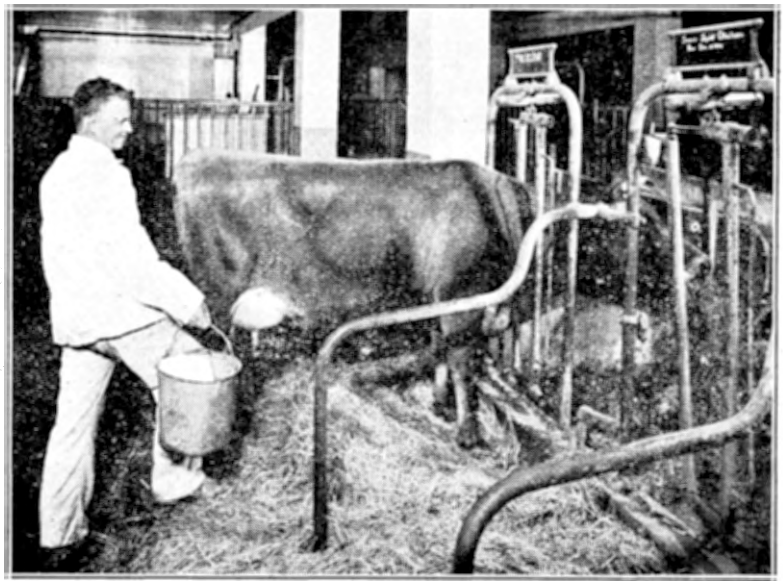

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FEEDING COWS FOR MILK PRODUCTION

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FEEDING COWS FOR MILK PRODUCTION

A. H. KUHLMAN and JOHN W. BOEHR

1. INTRODUCTION

Many of the problems encountered by dairy farmers are concerned with the feeding of milk cows. Since the cost of feeds is the largest single item of current expense involved in milk production it is evident that a well-planned feeding program is an important factor in the dairy enterprise.

Feeding practices vary greatly, for nearly every farmer uses a system which differs from those of his neighbors. The cost of feeding milk cows is so high on many farms that often the entire returns from the sale of milk or cream barely pay for the feeds used. To make dairying profitable it is necessary to follow a systematic and economical feeding program.

A single standard method of feeding cows for economical production has not been devised which will fit all or even very many of the conditions found on dairy farms. It is the purpose of this publication to explain the general principles underlying the feeding of milk cows and to suggest some feeding practices which are suitable for Oklahoma conditions. The use of home grown feeds with some purchased concentrates when desirable is considered as fundamental in economical feeding. This discussion is also based on the assumption that the cows have been bred for milk production and are managed properly. Although it is recognized that general rules of feeding will not fit every instance exactly, a general guide may be of help in aiding a dairy farmer to solve his own problem.

2. MILK PRODUCTION IS ONE OF SIX PURPOSES FOR WHICH COWS USE FEED

The feed consumed by dairy cows is used for various purposes. A mature cow when dry uses most of her feed for body maintenance and the production of body fat. After freshening, at least one-half of the feed consumed by a good milk cow is used for milk production. Rations for heifers and immature cows should also provide sufficient nutrients for these purposes and in addition should enable these animals to make normal growth. Since the cows in any given herd vary greatly in age, condition, and stage of lactation, there is considerable difference in the uses made of the feed by individual cows. The good feeder constantly considers this fact in his feeding practices. The important purposes for which feed is used in the body of the cow include the following:

1. Body maintenance
2. Milk production
3. Growth
4. Body fat
5. Exercise and work
6. Reproduction

Body Maintenance: A considerable portion of the feed consumed by a dairy cow, when in milk, is used to merely maintain the body. Heavy producing cows use about 40 percent of their feed for body maintenance. If cows have inherited a strong tendency to produce milk they will yield considerable milk even when they are underfed. In such cases body tissue is used for milk production, and as a result cows lose in condition. Eventually these reserves must be restored by more liberal feeding or a long dry period or else production will suffer during the following lactation period.

Milk Production: The use of feeds for milk production is one of the most important functions of the dairy cow. The amount of feed determines, in a large measure, the yield of milk and butterfat obtained. A good cow in full flow of milk requires two to three times as many nutrients as when she is dry. The best dairy cows are those which consume relatively large quantities of feed in excess of the amounts required for body maintenance. Dairy cows differ from beef cows primarily because the former use most of this excess feed in milk production while the latter use most of it in increasing body fat.

Growth: Because heifers normally will continue to grow for several years after they reach milking age, the ration for heifers in milk should always make provision for this condition. About one-third more nutrients are required for normal growth than for body maintenance. Since rations for milk cows are commonly calculated to provide only sufficient nutrients for body maintenance and milk production, many young cows are temporarily and often even permanently stunted in growth. While the demands of the gestation period seldom interfere with normal growth of heifers, milk production involves a tremendous strain on the young cow. This condition is often manifested in herds by the lack of size of the cows which have reached maturity. Liberal feeding of young cows and a rest of three months instead of the customary two months between the first and second lactation will enable heifers to make satisfactory growth.

Body Fat: A dairy cow when properly fed will seldom become too fat while she is producing a good flow of milk. Since many of the best cows tend to lose some weight during the early part of the lactation period, it is entirely proper and even necessary that this loss should be regained. For this reason it is quite desirable that cows should improve moderately in condition as the lactation advances. A good dairy cow will utilize this reserve fat during the period of high production in the next lactation.

Exercise and Work: A small portion of the feed consumed by well managed cows is used in the work required in grazing, in taking the feed out of the manger or rack, in walking to and from pasture or water and in fighting flies. Some of the energy used in this way serves a beneficial purpose because some exercise is necessary in maintaining the health and vigor of dairy cows. If, however, a cow is forced to spend a large portion of her time and to use much of her feed in such physical exercise milk production is bound to suffer. Good feeding practice recognizes the fact that economical milk production is best attained when maximum use is made of the feed consumed in converting nutrients into milk.

Reproduction: The development of the calf during the gestation period is ordinarily not greatly affected by the ration of the cow. The growing fetus does not make very great demands on the cow as far as utilization of feeds is concerned. Most of the development of the calf occurs during the last few months of the gestation period which is usually also the dry or rest period of the cow. The cow which is fed properly during the dry period to be in proper condition of flesh at calving time will also receive ample feed to produce a normal calf.

3. DAIRY FARMERS CAN AND SHOULD PRODUCE THE THREE CLASSES OF DAIRY FEEDS AT HOME

The most useful feeds for milk production are those which furnish liberal quantities of protein, carbohydrates, fat, minerals and vitamins. The common feeds furnish one or more of these nutrients in various amounts. Some of the feeds included in this discussion are not ideal feeds for dairy cows. The Oklahoma farmer is, however, interested in those crops which he can produce most successfully under his climatic and soil conditions. Since the dairy cow provides a home market for many of these crops the farmer is concerned with the best methods of using them in feeding his cows.

The amounts of the various nutrients in feeds useful to the dairy cow are determined by chemical analyses and digestion trials. These nutrients are used for various purposes in the body of the dairy cow. Proteins are found in every part of the body, including the muscles, bones, body fluids and glandular organs. Proteins are also used in maintaining the body, in the growth of young animals, in the production of milk and the development of the fetus. Heat and energy are largely provided by the burning of carbohydrates and fats in the body of the animal. Body fat, butterfat and milk sugar are also derived from these nutrients. The minerals including lime, phosphorus, common salt and others, aid in digestion, build and maintain the skeleton and supply the minerals found in milk. Vitamins are necessary for normal growth and development of all animals. Feeds rich in vitamins enable cows to produce milk of high vitamin content. On account of the structure of the digestive tract in cattle, a certain amount of bulk is desirable in the ration of the dairy cow. Crude fiber, which is represented by the woody portion of plants and seeds, furnishes bulk and aids in digestion. Since much energy is required to digest crude fiber, only a limited amount should be included in the ration because the cow may actually use more energy in digesting this material than she obtains from it.

Three groups including eight general classes of feeds are commonly used for milk production. These may be classified as follows:

I. Dry Roughages
   - Legumes
   - Non-legumes
   - Miscellaneous roughages

II. Succulent Feeds
   - Pastures
   - Silage
   - Root crops
   - Soiling crops

III. Concentrates
   - Farm grains
   - Milling by-products

Dry Roughages

Legumes: Because legumes are rich in protein and important minerals, hays of good quality made from these crops are excellent feeds for dairy cows and form the basis of most good dairy rations. Farm grains, other concentrates and grass

hays contain only small amounts of lime. Since the legumes are especially rich in calcium, liberal use of these roughages will furnish some of the minerals needed by dairy cows. In addition to calcium, legumes also contain phosphates and other minerals. If the ration of a dairy cow must be restricted to a single feed, a good legume hay will meet the requirements better than any other single feed. Recent experiments have shown that soils which are low in minerals will produce crops which also tend to be low in minerals. Therefore applications of lime and phosphorus to some soils will not only increase the yield but will also improve the feeding value of the hay by increasing its mineral content.

Alfalfa is the most popular legume because of its large yields and high feeding value. This perennial crop furnishes as many as four cuttings during favorable seasons. The leaves are considerably higher in feeding value than the stems. Fine stemmed, leafy green hay is the most satisfactory for feeding dairy cows.

Soybeans have become an important crop in many sections of Oklahoma. When cut at the proper time and properly cured, fine stemmed and leafy soybean hay is equal to the best grade of alfalfa. However most varieties of soybeans are coarse and stemmy. There is considerable waste in feeding soybean hay because dairy cows refuse to eat the coarse portions of the plant. Among the varieties of soybeans used in this state are the Virginia in the northern section and the Laredo, which is a very dependable variety in all sections where soybeans are grown successfully.

During recent years mungbeans have been grown in many sections of Oklahoma. Because this crop can withstand unfavorable conditions of drouth and extremely hot weather, will produce a fair yield on thin upland soils and is not molested by rabbits, it will enable farmers to provide a legume hay under conditions where soybeans, alfalfa or other legumes can not be produced. Mungbean hay tends to be coarse and while its feeding value is somewhat less than that of alfalfa hay, it is a better feed than the common grass hays. In two feeding experiments conducted by the dairy department at Oklahoma A. and M. College mungbean hay was 85 to 90 percent as valuable as alfalfa hay for milk cows.

Cowpeas are often considered the most adaptable legume grown in Oklahoma. Cowpeas may be planted after cereal crops have been harvested, between corn rows at the time of last cultivation and by themselves as any other crop. When

properly handled and cured, cowpeas make hay of excellent quality which usually equals alfalfa hay in feeding value. In protein content, choice cowpea hay exceeds alfalfa but losses due to shattering of the leaves and the presence of coarse stems often reduce the feeding value considerably. Since the cowpea is an annual plant it is well adapted to tenant farms where alfalfa is seldom grown. The difficulties encountered in making this crop into hay are so great that the cowpea hay found on most farms is quite inferior to average alfalfa hay.

Although used extensively as a pasture, sweet clover is seldom used as a hay crop. It resembles alfalfa in some respects but the stemmy nature of sweet clover often makes it difficult to cure. Molds often develop and make the hay unfit for feed. Although many farmers have encountered disappointment in using sweet clover hay, this crop merits some consideration because fine-stemmed sweet clover hay properly cured is as valuable as alfalfa in feeding dairy cows.

Peanut hay is used extensively where the nuts are grown as a cash crop. The hay produced in this way is really a by-product and is obtained at a very moderate cost. This hay is lower in feeding value than other legumes but is higher in protein and minerals than grass hays. Although peanut hay has some merits, dairymen are cautious in feeding it because, like some other legumes, it imparts undesirable flavor and texture to butter.

Non-legume Roughages: Roughages classified as non-legumes are lower in protein and minerals than legumes but are used extensively in this state. Sudan grass hay, kafir and sorghum roughages as well as prairie hay are included in this class. They furnish bulk, carbohydrates, a small amount of protein and vitamin A, if the color of the hay is green. The wide use of these roughages is due to the ability of the farmer to produce them at low cost, and because in many instances he is not able to grow alfalfa and has not yet learned to grow other legumes which are suitable to his conditions.

Prairie hay which is usually a mixture of bluestem, Indian, grama, reed, and other native grasses contains about one-third as much protein as legume hay. Its protein content, as in all grasses, is higher when cut early. Prairie hay is also more palatable and is fed with less waste when harvested before it is too mature.

Sudan grass cut after the first heads appear makes a very desirable feed for dairy cows. As in prairie hay, the protein content is higher and the hay is less woody when cut early. Heavy yields are often obtained from Sudan grass. Fields cut early for hay may later be used for pastures in favorable seasons.

Fodders and stovers obtained from corn, cane, kafir and other grain sorghums are often over-rated as feeds for milk cows. These feeds usually suffer great losses if cutting is delayed too long or while they are in the shock or stack. Fodder consists of the entire dried plant including the grain while stover is the term applied to material remaining after the ears of corn or the heads of the sorghums have been removed. Fodders when carefully harvested and properly cured have about the same feeding value as prairie hay, and when the grain content is high they may be worth more than prairie hay. The stovers are lower in protein and digestible nutrients than fodders. Cane or sorghum hay made from broadcast seedings, if well cured, is very palatable, fine-stemmed and fully as valuable as prairie hay.

Oats and other cereal crops are sometimes used for making hay. Cut when the grain is in the early milk stage, and properly cured, these crops furnish a bright green hay of good quality, which is also palatable and nutritious. Success in the use of these roughages is chiefly dependent on careful harvesting, curing and protection against the weather. If these conditions are fulfilled these roughages may be considered as feeds suitable for milk production.

Miscellaneous Roughages: Straw of the farm cereals, grain hulls obtained as by-products of various milling operations, cottonseed hulls, peanut shells, hay from Russian thistles and other weeds, all contain considerable amount of nutrients according to the chemists' analyses. Often unusual conditions have forced farmers to feed these materials to dairy cows and while they enable a farmer to tide over a very unfavorable season, because they serve as life savers for the herd, their feeding value is likely to be overestimated. The common fault of these feeds is that the high percentage of crude fiber which they contain is greatly out of proportion to the low percentage of nutrients. Profitable returns are seldom obtained because the digestion of these feeds imposes a burden on the cow instead of yielding nutrients which stimulate milk production.

Fig. 1.—Good native pasture provides succulent and cheap feed for milk production.

Succulent Feeds

Pasture: During the season when good pasture grasses are growing rapidly milk can be produced more economically from pasture than from any other ration. Good grass is about an ideal ration for dairy cows because it provides nutrients in right proportions for milk production, has a beneficial effect on the digestive system, aids in the assimilation of minerals and furnishes some of the water which cows need.

Maximum milk yield is obtained most easily during the winter months if the ration possesses as many of the characteristics of good grass as possible. Winter cereal pasture, silage and root crops, in part, provide the means which make winter rations resemble good pastures.

Native pasture is used more extensively in maintaining dairy cattle in Oklahoma than any other single source of feed. While grasses are growing rapidly, pasture furnishes a ration which is almost ideal for milk production. The chief fault, even of good pasture, is that high producing cows can not consume enough of the fresh grass to supply the nutrients necessary for a heavy milk flow. This is due to the high water content of fresh grass and its extremely bulky nature. How-

ever, a more serious criticism of native pastures is based on the fact that many grasses grow very early in the spring, go to seed early and furnish very little forage after midsummer.

The results obtained in a study of the value of native pasture including a total of 98 cows and four pasture seasons made by the dairy department of the Oklahoma Experiment Station show that the greatest returns were secured from native pasture during the months of May and June. If the value of the pasture during May and June is represented as 100 percent, its value was 85 percent in July, 70 percent in August and only 34 percent in September. The farmer who expects to maintain high production during these months must therefore supply additional feed. The use of supplementary pastures is one of the cheapest means of furnishing additional feed. Two such crops in common use in many parts of Oklahoma are sweet clover and Sudan grass.

Sweet clover is a valuable crop because it is available in early spring and continues to furnish a large amount of feed until early summer. Most cows must become accustomed to eating sweet clover, but after they have once become used to it they consume it readily. There is perhaps less danger from bloat on sweet clover pasture than with any other legume pasture but many farmers use the precaution of feeding dry hay or straw liberally before the cows are first turned out.

Sudan grass may be planted in small fields at intervals of several weeks to supply pasture from the middle of summer to late fall. Sudan grass is very palatable and with an average rainfall will produce a heavy yield. A proper combination of sweet clover, Sudan grass and other suitable tame grasses and crops used with native pasture will aid in maintaining a good milk flow during the summer months. Wheat, rye, winter oats and winter barley are often used to furnish late fall, winter and early spring pasture.

Bermuda grass is undoubtedly used more extensively in this state than any other tame grass and has replaced many native grasses in permanent pastures. Dallis grass, redtop, the lespedezas, yellow hop clover, bur clover, black medic and white or Dutch clover, are giving satisfactory results in some sections of the eastern part of the state where the rainfall and climatic conditions are favorable for the growth of these plants.

Fig. 2.—In sweet clover pasture are found the minerals, the proteins and the vitamins cows need for efficient milk production.

Silage: Corn is the leading silage crop in many sections of the United States, because of the ease with which it can be grown, and the yield and palatability of the silage made from it. Varieties of kafir, cane and darso have been developed for various sections of Oklahoma which will produce heavier and more dependable yields than corn. In many areas these crops will not only produce greater yields than corn but they will also produce silage which is more uniform than the silage made from corn under unfavorable seasonal conditions. Usually kafir silage is only 90 to 95 percent as valuable as corn silage but the heavier and more uniform yield obtained often makes it a more profitable silage crop. In a three-year comparison of cane and kafir silage at the Oklahoma Experiment Station these feeds gave equally good results when fed to milk cows.

Root Crops: Tenant farmers and the owners of small farms often find it inadvisable to build a silo. Under such conditions succulent feed can be provided in the form of root crops. The long red Mangel-wurzel or the Golden Tankard stock beet may be used for this purpose. In a three-year comparison of corn silage and mangels conducted at this station when cows were fed three pounds of silage and five pounds of mangels daily for each 100 pounds of body weight with alfalfa hay and a concentrate mixture, approximately similar milk yields were

obtained on the two rations. Mangels contain less dry matter than silage and for this reason a thousand pound cow was fed 50 pounds of roots and a small additional amount of concentrates daily in place of 30 pounds of corn silage.

Although silage and root crops have considerable merit as succulent feeds, the Oklahoma farmer should carefully consider whether or not he can provide the nutrients required by his dairy herd more economically in dry roughages and concentrates alone or in a combination of these with succulent feeds.

Soiling Crops: A soiling crop is any crop which is cut when green and fed immediately without curing or storing it. While the use of crops in this manner is an old custom in many regions it is seldom practiced in Oklahoma. The use of such green crops as are available on the farm in late summer when pastures are in poor condition may often be the means of preventing a rapid decline in milk production. Green corn, any of the sorghums, Sudan grass and green alfalfa are some of the crops which may be used for this purpose. Feed used in this way will usually bring good returns because it is much easier and more economical to maintain a good milk flow than it is to increase it after cows have once declined in production.

Concentrates

Concentrates for dairy cows include the entire group of farm grains and milling by-products used in feeding cows for milk production.

Farm Grains: It is fortunate that the common farm grains which are excellent sources of nutrients for milk cows are grown so extensively in Oklahoma. Corn, oats, grain sorghums, barley and soybeans are especially valuable because they supply nutrients in concentrated form, which are also readily digested.

Usually the market price of wheat prohibits its use as a feed, but when prices are unfavorable ground wheat may be substituted for corn or kafir in any good concentrate mixture.

Farm grains supply carbohydrates, fats, proteins and since as a class grains are richer in phosphorus than the roughages, a combination of roughages and grains will supply calcium and phosphorus, two elements needed by milk cows.

Corn, wherever it can be grown economically or purchased at a reasonable price, holds first place as a feed among the grains. It is not only palatable and high in feed value but

readily digested. Under favorable soil and moisture conditions a heavy yield of nutrients per acre is obtained. Corn is very high in carbohydrates but low in protein and mineral matter. Corn is considered so highly as a feed that it is often used as a standard with which other feeds are compared. For many years corn has been valued very highly in rations for milk production.

The sorghums which include such varieties as kafir, darso, milo, feterita, etc., constitute a large and valuable class of feeds. These grains may replace corn in any good concentrate mixture. As a class these feeds are not quite as palatable as corn, contain a little more protein than corn and in general are worth about nine-tenths as much as corn in feeding value. For practical purposes any of the grain sorghums may replace corn pound for pound in a good concentrate mixture without materially changing the feeding value of the resultant mixture.

Although corn cobs have very little feeding value due to large amounts of crude fiber and the small amounts of nutrients which they contain, the use of corn-and-cob meal is often a good practice. In actual feeding experiments corn-and-cob meal, when used in place of corn meal in dairy rations yielded about the same returns. The ground cobs contributed only small amounts of nutrients but they increased the bulk of the ration, which apparently aided the digestive processes. Kafir head chops are available on many farms and can be used to advantage where a substitute for corn is needed. This feed, like corn-and-cob meal, may also be used in mixtures which lack bulk.

Oats are valuable in milk production, because they are high in protein and minerals and being bulky have always been considered highly in mixtures in which corn or other heavy feeds are used. Although differing slightly in protein content, oats and wheat bran are often used interchangeably in simple farm mixtures.

Although not grown extensively in this state, barley can replace corn or the grain sorghums when it can be produced more economically than these feeds.

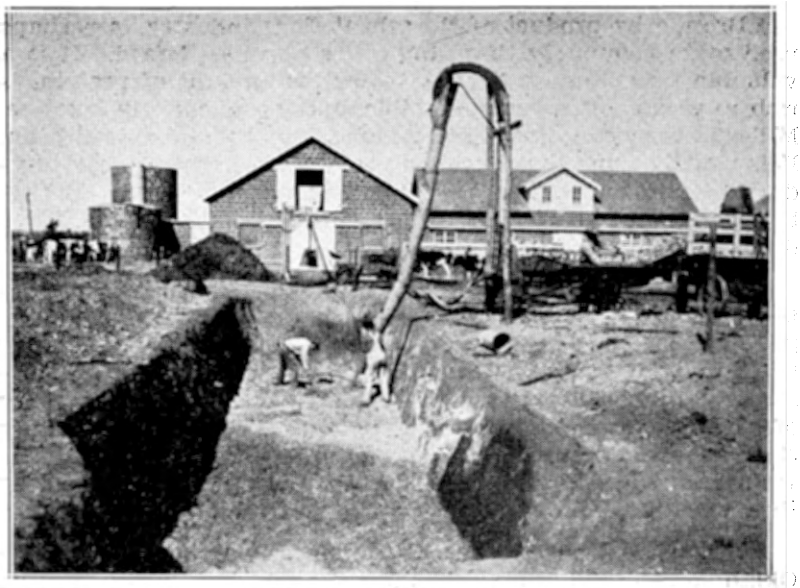

Fig. 3.—The trench silo provides an economical means of preserving a succulent dairy feed for winter or drouth periods when it cannot be obtained from other sources.

Soybeans are now grown quite extensively because many farmers desire a home-grown concentrate which is rich in protein. Soybean seed contains about 36 percent total protein and may therefore be used to replace part or all of the high protein concentrates used in dairy mixtures. Soybeans also contain considerable phosphorus and oil. Freshly ground soybeans are quite palatable to cows, but due to their high oil content it is advisable to grind only small amounts at a time because the ground beans soon become rancid in warm weather.

Milling By-products: On account of the extensive use of non-legume roughages in Oklahoma, concentrates rich in protein must be used in large amounts in order that the rations fed to dairy cows will furnish the necessary amounts of protein. The leading by-products suitable for this purpose are cottonseed meal, linseed meal, peanut meal and soybean meal. As a class these feeds differ from all farm grown concentrates, excepting soybean seed, in that they are higher in mineral and protein content, contain less carbohydrates and somewhat more crude fiber than the grains. Since mill feeds are usually more costly than farm grains only such amounts should be included in the ration as are needed to supply the required amount of protein.

Bran, a by-product of the wheat flour industry, is perhaps used more commonly than any other purchased feed. It is a valuable feed because it contains a fair amount of protein, is rich in phosphorus, very palatable, bulky and slightly laxative. Mill-run bran contains slightly more flour than standard bran. It is usually somewhat lower in protein but higher in carbohydrates, and commands a little higher price than bran. If carbohydrates can be furnished more cheaply in other feeds, standard bran is preferred to mill-run.

Shorts or standard middlings are made up of the finer portions of bran, a small amount of flour and some of the germs. Shorts are richer in both protein and carbohydrates than bran, but they are a heavy instead of a bulky feed. In mixtures consisting largely of farm grains shorts should not be used in place of bran because of their pasty character. When corn is high shorts are sometimes fed in dairy rations, but they should always be used with bulky feeds and should not make up more than one-third by weight of the concentrate mixture.

Because cottonseed meal is produced in large quantities in Oklahoma, it usually furnishes protein more economically than any other concentrate which can be purchased in this state. Used in correct proportions with farm grains, cottonseed meal enables the farmer to provide well balanced rations even when he uses non-legume roughages like prairie hay, cane hay, Sudan grass hay and other similar roughages which are produced so extensively on the farms of this state.

In the past various opinions have been held by large numbers of livestock raisers concerning injurious effects resulting from the use of cottonseed meal. Results obtained in an extensive experiment conducted by the dairy department of the Oklahoma Experiment Station during the past ten years show quite conclusively that when an average grade of prairie hay is used none of the symptoms of so-called cottonseed meal "injury" are likely to develop. Most of the cows in milk in this experiment have consumed from five to seven times as much cottonseed meal daily as high producing cows would require if cottonseed meal were used as the chief protein concentrate in a good dairy mixture. The breeding records of these cows fed large quantities of cottonseed meal are fully as good as those of cows fed a normal ration. Udder troubles have not been encountered more often than is the case in any well managed herd. On the basis of the results obtained in this experiment, a dairy farmer, who uses a roughage which is at least as good in

vitamin A content as an average grade of prairie hay and has an average pasture may safely use as much cottonseed meal as is necessary to furnish the proper amount of protein in the ration.

While excessive amounts of cottonseed meal have not produced injurious results it is usually not economical to feed more cottonseed meal than is required, because high protein feeds are usually the most expensive part of the ration. Cottonseed meal is also valuable in dairy rations because, with the exception of bran, it is richer in phosphorus than any of the common dairy feeds.

Whole-pressed cottonseed cake, also commonly called cold-pressed cottonseed cake or "Caddo cake" as the first name implies, is the by-product obtained when the entire uncrushed, unheated seed is subjected to great pressure for the purpose of expelling the oil. Since the cake contains a larger proportion of hulls to meal than normal meal it also has a correspondingly lower feeding value. Whole-pressed cake or the meal obtained by grinding it usually contains about 26 percent total protein, 20 to 21 percent digestible protein and 71 percent total digestible nutrients. Since the composition of this product as supplied by different mills varies somewhat, the protein content may be used as a guide to its feeding value. It can often be used advantageously and economically.

Cottonseed feed is a mixture of finely ground hulls and cottonseed meal. Its feeding value is determined chiefly by the amount of protein it contains.

Considerable quantities of cottonseed are fed to livestock when feed prices are low or when there is a wide spread between the selling price of cottonseed and cottonseed meal. Although cottonseed meal is obtained from cottonseed, and the amounts of total digestible nutrients in the two products are approximately equal, there is a big difference in feeding value. This difference is primarily due to three important factors. Cottonseed contains slightly more than twice as much crude fiber as cottonseed meal and about twice as much oil as the meal. Choice cottonseed meal, however, contains almost three times as much digestible crude protein as the seed.

The large amount of oil in cottonseed is not only an uneconomical feed, but it is likely to cause cows to go "off feed," and cream obtained from cows fed cottonseed, churns into a hard, tallowy butter. In general whenever a ton of cottonseed can be

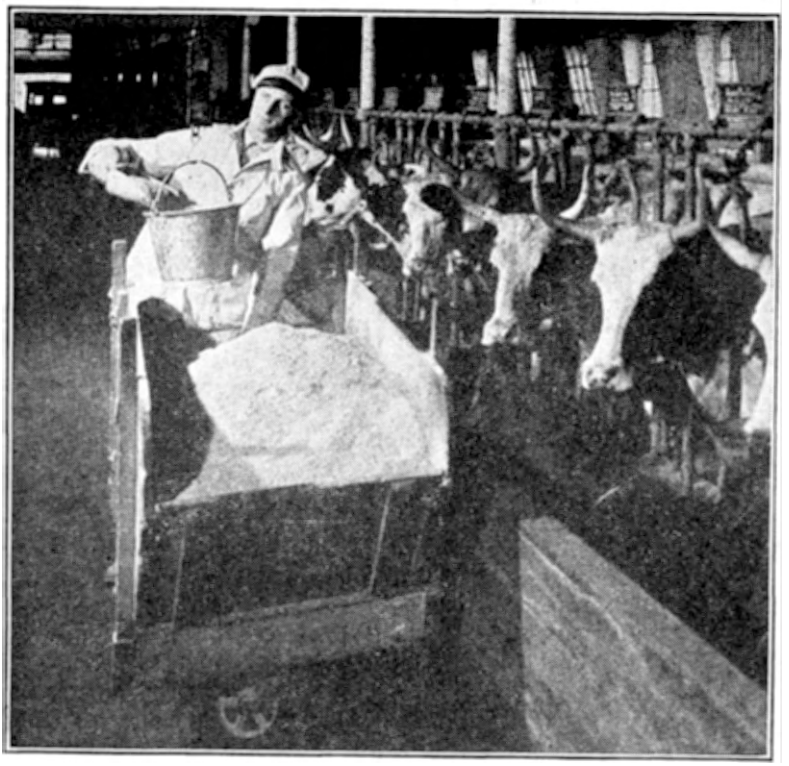

Fig. 4.—Ground farm grains should be the basis of the concentrate ration which should be weighed and fed in proportion to production.

exchanged for a half ton of cottonseed meal it is desirable to use cottonseed meal. The Louisiana Experiment Station also recommends that when cottonseed is used it should be used with some other protein feed, legume hay and green feed and constitute not more than one-third of the ration.

Peanuts are grown extensively in some sections of this state. Peanut meal or cake is a by-product obtained when peanuts are used for the production of oil. Peanut feed is another by-product obtained in the same process. It differs from the meal or cake in that it contains both meal and shells, or hulls, and therefore is lower in feeding value than meal. The feeding

value of these feeds depends entirely on the amount of shells included. Peanut meal is palatable and can be used as a high protein concentrate in dairy mixtures.

Linseed meal is valued highly because of its conditioning effect on cattle. It is not as high in protein as cottonseed meal and in Oklahoma cottonseed meal is a much cheaper source of protein.

4. WITH A GOOD HERD, PROPER FEEDING MEANS MOST DOLLARS

Proper feeding of good dairy cows is more important in economical milk production than any other single factor. Rules governing the general practices of feeding will contribute to economy in the management of a dairy herd, and the maintenance of normal condition in the members of the herd so that maximum production may be obtained.

Two general rules should be observed in feeding dairy cows. One provides that roughages should be fed in proportion to the size or body weight of the animal. The other directs that concentrates should always be fed in accordance with the yield and richness of the milk produced.

Rules for Feeding Roughages

It is good dairy practice to always feed a cow all the roughages she will consume without waste. Although individual cows vary somewhat in their ability to consume roughages, observation and experience actually show that when concentrates are fed according to yield and fat test of the milk produced most cows will usually consume rather definite amounts of roughages daily. The following rules are based on this fact and may be used as a guide in feeding roughages.

1. Feed two pounds of dry hay or dry fodder for each 100 pounds body weight, or
2. One pound of dry hay and three pounds of silage for each 100 pounds of body weight, or
3. One pound of dry hay and five to six pounds of mangels for each 100 pounds of body weight.

Rules for Feeding Concentrates

If roughages are fed according to the rules just stated the cow in milk should be fed a concentrate mixture. The nature of the mixture fed is determined by the kind of roughage used. If the entire roughage consists of good legume hay a mixture of several farm grains is satisfactory. The amount of protein in

the concentrate ration must be sufficient to supplement the protein in the roughage. Suggestions of suitable mixtures for various roughages are given in the following section.

The following rules may be used as guides in feeding concentrates:

1. Feed one pound of concentrates for each three pounds of Jersey milk.
2. Feed one pound of concentrates for each four to four and one-half pounds of Holstein milk.

Cows producing more than one pound of butterfat daily should receive one to two pounds additional of concentrates. If the butterfat yield is two pounds daily, three to four pounds of concentrates should be added to the amounts prescribed by these rules.

3. If the butterfat yield of the cow is known, feed as many pounds of concentrates daily as the cow produces pounds of butterfat weekly.
4. If very choice alfalfa or other hay of excellent quality is available and consumed in larger quantities than the amounts suggested in the rules for feeding roughages smaller amounts of concentrates are necessary. Under such conditions concentrates may be fed as follows:

Feed Jerseys one-half pound of concentrates for each pound of milk produced above 16 pounds, and Holsteins two-fifths pounds of concentrates for each pound of milk produced above 22 pounds.

5. FEED WISELY: FEED FORMS HALF THE BUTTERFAT COST

Under average conditions the cost of feeds represents about 50 percent of the total cost of producing milk or butterfat. This is true not only for cows of average productive ability but applies to all cows. The dairy farmer should, therefore, realize that careful attention to the selection and use of feeds for dairy cows is closely associated with economy of production.

Rations which are economical, palatable, bulky, highly digestible, well balanced and complete as to proteins, carbohydrates, mineral matter and vitamins are desirable in feeding the dairy herd. Variety in the ration, obtained by using feeds obtained from at least three or four different plants, is an important consideration because it tends to increase palata-

bility and provides proteins from several sources. Not all proteins are equally valuable but a mixture of several feeds is quite likely to provide the various proteins which are needed.

The decision to use a given combination of feeds should be made only after consideration has been given to the feeds which are available on the farm, or can be purchased at reasonable prices. In general it is good feeding practice to build the feeding program around the feeds which are already on the farm. The kind of roughages on the farm will determine the general nature of the concentrate mixture which should be fed. If legume hays which are high in protein are available, much less protein needs to be supplied by the concentrates, and consequently a cheaper grain mixture can be used than if all the roughages are grass hays.

While the available roughages will determine the general nature of the concentrate mixture which should be fed, it is equally important that the mixture should consist of home-grown grains. Unless choice legume hay is used, farm grains must be supplemented by some purchased feeds which are rich in protein because farm grains are rather low in this necessary nutrient. The farmer who uses only low grade roughages must spend more money for high-priced protein feeds than the farmer who grows legume crops for hay.

The following suggestions show several combinations of common Oklahoma feeds which may be used with different kinds of roughages which are commonly used in this state. These mixtures illustrate very well how a dairy farmer can make use of the roughages and grains which he raises in providing a ration which will supply the required nutrients. A study of the rations also emphasizes the saving in purchased protein fed which can be effected by providing either a combination of some legume and some good grass hay, or better still, by growing sufficient legumes so that only legume hay need be fed.

The approximate percentages of total protein and digestible protein are given for each of the groups of concentrate mixtures listed below. Many farmers buy commercial or ready-mixed dairy feeds. Feed regulations prescribe that the total protein content of such commercial feeds must be specified on tags or on the sacks in which these feeds are sold. Similar information concerning home-mixed feeds enables the farmer to compare the value or cost of his mixture with market prices of commercial feeds and also serves as a guide in buying the commercial feeds which are best suited for use with his roughages.

Concentrate Mixtures to be Fed with Different Kinds of Roughages

Choice Legume Hay

Concentrate mixtures suitable for use with choice legume hay should contain 10 percent to 12 percent total protein and 8 percent to 9 percent digestible protein. The following four mixtures fulfill these requirements:

No. 1		No. 2	
Ground kafir	100 lbs.	Kafir Head Chops	100 lbs.
Ground Oats	100 lbs.	Ground Oats	100 lbs.
Corn-and-cob Meal	100 lbs.	Ground Corn	100 lbs.
No. 3		**No. 4**	
Ground Corn	100 lbs.	Ground Oats	100 lbs.
Ground Darso	100 lbs.	Ground Corn	200 lbs.
Ground Oats	200 lbs.	Ground Wheat	100 lbs.

Average Legume Hay

Concentrate mixtures suitable for use with average legume hay should contain 14 percent to 16 percent total protein and 12 percent to 13 percent digestible protein. The following combinations, numbered from 5 to 8, are examples of such mixtures.

No. 5		No. 6	
Ground Corn or Kafir	400 lbs.	Ground Kafir or Corn	400 lbs.
Ground Oats or Bran	400 lbs.	Ground Oats	200 lbs.
Cottonseed Meal	100 lbs.	Bran	200 lbs.
		Cottonseed Meal	100 lbs.
No. 7		**No. 8**	
Ground Kafir or Corn	200 lbs.	Ground Kafir or Corn	400 lbs.
Ground Oats	600 lbs.	Ground Oats or Bran	400 lbs.
Cottonseed Meal	100 lbs.	Freshly Ground Soybeans	100 lbs.

Part Legume and Part Non-Legume Roughages

Concentrate mixtures suitable for use when the roughages consist of about equal parts average legume hay and a non-legume roughage, or average legume hay and silage or mangels, should contain 16 percent to 18 percent total protein and 14 percent to 15 percent digestible protein. Four examples of satisfactory mixtures of this group are as follows:

No. 9		No. 10	
Ground Corn or Kafir	400 lbs.	Ground Kafir or Corn	400 lbs.
Ground Oats or Bran	400 lbs.	Ground Oats	200 lbs.
Cottonseed Meal	200 lbs.	Bran	200 lbs.
		Cottonseed Meal	200 lbs.
No. 11		**No. 12**	
Ground Kafir or Corn	200 lbs.	Ground Kafir or Corn	400 lbs.
Ground Oats	600 lbs.	Ground Oats or Bran	400 lbs.
Cottonseed Meal	200 lbs.	Freshly Ground Soybeans	200 lbs.

Non-Legume Roughages

Concentrate mixtures suitable for use with non-legume roughages, such as prairie hay, cane hay, Sudan grass hay, sorghum fodder, etc., should contain 18 percent to 22 percent total protein and 16 percent to 18 percent digestible protein. The following are satisfactory mixtures of this kind:

No. 13		No. 14	
Ground Corn or Kafir	400 lbs.	Ground Kafir	400 lbs.
Ground Oats or Bran	400 lbs.	Ground Oats	200 lbs.
Cottonseed Meal	300 lbs.	Bran	200 lbs.
		Cottonseed Meal	300 lbs.

No. 15		No. 16	
Ground Kafir or Corn	200 lbs.	Ground Kafir or Corn	400 lbs.
Ground Oats	600 lbs.	Ground Oats or Bran	400 lbs.
Cottonseed Meal	300 lbs.	Freshly Ground Soybeans	300 lbs.

Use Home Grown Grains in Mixtures

Various substitutions of home grown grains may be made in the suggested rations. Ground darso, feterita, hegari and milo may be substituted for ground corn or kafir in any of the mixtures listed above. Although these feeds are not exactly alike in composition, the differences are not sufficiently great to change materially the feeding value of the resultant mixture if any one of these feeds is used in place of corn or kafir. Similarly, oats and bran may be used interchangeably in some of the mixtures. While either bran or oats may be used in these rations, a better mixture is obtained if both feeds are included, provided the total amount of the two ingredients does not exceed the amount specified for the given mixture.

Minerals for Dairy Cows

Cows should have access to common or stock salt at all times. A thousand-pound cow requires about three-fourths of an ounce of salt daily for her body and about three-tenths of an ounce in addition for each 10 pounds of milk produced. In addition to salt the cow needs two other minerals, calcium and phosphorus, in greater amounts than those provided in most common feeds. These minerals can be supplied cheaply in the form of finely ground limestone and steamed bonemeal. A mineral mixture consisting of equal parts by weight of finely ground limestone, steamed bone meal and common salt is satisfactory where a simple mixture is needed. Two or three pounds of this mixture should be carefully mixed in each 100 pounds of concentrates fed. In addition some salt should also be kept available in the yard or pasture at all times.

6. GOOD FEED NEEDS LITTLE PREPARATION BUT IT PAYS TO GRIND GRAINS

Although many practices concerned with the preparation of feeds for dairy cows have been popular at various times in the past, all of them excepting grinding have been discarded as unprofitable. Two exceptions namely, the soaking of dried beet pulp with water for six to twelve hours and soaking or steaming bran in making a bran mash for cows which have just calved, or which are sick, are still found in some herds. There are however, many dairymen who believe that the beneficial influences of both of these feeds are obtained fully as well when these feeds are used in their natural or dry condition.

Grinding Grains: In order to facilitate digestion, farm grains used in mixtures for cows should always be ground. A cow is able to return coarse feeds like grass, and other roughages from her paunch to be chewed again and reduced to a condition in which more complete digestion can occur, but she is not able to masticate whole grains and seeds very efficiently. This has been recognized by beef cattle feeders for many years by the fact that active, growing pigs are used to follow steers receiving shelled corn, ear corn or snapped corn. Young calves seem to be able to handle shelled corn and whole corn and whole oats more efficiently than cows. When the market value of grains is extremely low grinding may not be economical, but in such cases provision should be made for salvaging the undigested grain by hogs or poultry.

Percentage Composition of Common Feeds

The following table shows the composition of some of the feeds commonly used by Oklahoma farmers. It enables the dairyman to compare the values of the feeds he may have on hand or can purchase economically, and serves as a guide in making substitutions in the mixtures listed on pages 22 and 23.

When such crops as corn or the sorghums are used in making silage large quantities of grain are included in the material put into the silo. Although silage cutters are well adapted to the purpose for which they have been designed they are not efficient in preparing these grains for utilization by cows. Furthermore it would not be economical nor desirable to cut silage crops so finely that all of the grains would be ground.

	Dry matter	Total crude protein	Digestible crude protein	Total digestible nutrients	Crude fiber	Calcium Ca	Phosphorus P
Legume Roughages:							
Alfalfa hay	90.4	14.7	10.6	50.3	29.0	1.43	0.21
Cowpea hay	90.4	18.6	12.6	49.4	23.3	1.13	0.25
Mungbean hay	90.3	9.8	7.3	49.2	24.0	---	---
Peanut hay							
Without nuts	91.4	9.7	6.3	57.8	23.3	1.13	0.13
Mowed	91.4	10.6	6.9	58.4	23.8	1.27	0.13
Soybean hay	90.8	14.8	11.1	50.6	28.4	0.96	0.25
Non-legume Roughages:							
Johnson grass hay	90.1	6.5	2.9	50.3	30.4	0.87	0.26
Kafir fodder, dry	91.1	8.9	4.6	54.1	26.8	0.47	0.17
Prairie hay	90.4	5.7	2.6	49.2	30.3	0.49	0.10
Sorg. fodder, dry	89.2	6.4	3.6	52.7	25.8	0.49	0.14
Sudan grass hay	89.2	8.8	4.3	48.5	27.9	---	---
Miscellaneous Roughages:							
Corn cobs	90.4	2.3	0.4	46.2	32.0	0.01	0.02
Corn husks	76.3	3.1	0.4	34.9	25.3	0.14	0.11
Cottonseed hulls	90.6	3.9	0.8	43.7	46.6	0.13	0.10
Oat straw	89.6	4.0	0.9	44.1	36.1	0.36	0.13
Peanut shells	92.3	6.7	3.2	27.3	60.3	0.31	0.07
Wheat straw	90.1	3.8	0.8	35.7	35.7	0.22	0.07
Silages and Roots:							
Corn	28.3	2.3	1.3	18.7	6.9	0.07	0.06
Darso	26.9	1.9	1.0	15.6	6.5	---	---
Kafir	30.2	1.9	1.0	17.3	8.7	0.06	0.05
Sorghum (cane)	25.1	1.5	0.8	15.1	7.0	0.07	0.04
Mangels (roots)	9.4	1.4	1.0	7.3	0.8	0.01	0.03
Turnips (roots)	9.5	1.4	1.3	8.5	1.1	0.06	0.04
Farm Grains:							
Barley	90.4	11.8	9.3	78.7	5.7	0.05	0.38
Corn, No. 2 dent	85.2	9.4	7.1	80.6	2.2	0.01	0.27
Darso	89.9	10.6	7.7	82.4	2.8	0.01	0.21
Kafir	88.6	11.2	9.1	80.1	2.3	0.04	0.30
Kafir head chops	89.1	10.0	7.6	76.9	6.9	---	---
Oats	91.1	12.0	9.4	71.5	10.6	0.09	0.33
Soybeans	90.2	36.9	32.8	86.2	4.5	0.20	0.60
Wheat	89.8	13.1	11.2	83.6	3.0	0.03	0.43
Milling By-Products:							
Cottonseed, whole pressed	92.9	26.9	21.8	70.8	24.3	0.17	0.64
Cottonseed meal, 43% protein	93.5	43.2	35.0	75.5	10.6	0.24	1.11
Cottonseed meal, 41% protein	92.8	41.9	33.9	73.6	10.8	0.20	1.19
Linseed meal, o. p.	91.3	35.2	30.6	78.2	8.0	0.33	0.86
Peanut-oil-meal	93.4	42.7	38.0	82.1	8.9	0.17	0.55
Peanut oil feed	93.5	33.2	26.8	73.1	17.7	---	---
Soybean oil meal	91.7	44.3	37.7	82.2	5.6	0.28	0.66
Wheat bran	90.6	15.8	13.1	70.2	9.5	0.12	1.32
Wheat brown shorts	90.1	17.8	15.1	76.3	6.2	0.08	0.82

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In studies made at the Oklahoma Experiment Station several years ago it was found that 68 percent of the corn in corn silage was present as whole kernels. A considerable portion of the whole and some of the broken kernels passed through the digestive tracts of dairy cows and unless these voided grains are salvaged by pigs or poultry they represent a loss. About 8.5 percent, by weight, of all the grain in corn silage was voided in the manure. This is a smaller loss than occurs in feeding shelled corn to cattle and may be readily salvaged by pigs and poultry on most farms.

A more serious problem is involved when sorghum crops are used in making silage. When kafir silage was fed to dairy cows 49.5 percent of the whole grain was voided in the manure and when sweet sorghum silage was fed this loss represented 33.9 per cent of the whole grain in the silage. Preliminary results obtained in a comparison of darso silage and headed darso silage for milk production indicate that 70 percent of the grain in darso silage is present as whole kernels. In the first experiment, when darso silage is valued at $3.00 per ton, the headed darso silage is worth $2.47 per ton. On the basis of current feed prices in the spring of 1933 the grain in a ton of darso silage was worth 53 cents when fed to milk cows. Preliminary results of the second trial indicate that there will be very little difference in the feeding value of the two silages. When these crops are used for silage and grains are scarce or high priced, it may often be profitable to head the kafirs and sorghums before they are put into the silo. The ground heads or chops can be used in the concentrate ration or fed to other livestock on the farm.

Grinding Roughages: Several experiment stations have studied the value and economy of grinding roughages for milk cows. The general results of these investigations show that cows may eat a larger amount of ground roughage than of unground, that less feed is wasted when ground roughages are fed and that ground feeds can be handled more easily but the cost of grinding usually more than offsets the benefits obtained from grinding.

Many people do not realize that grinding can not change the nutrients contained in a roughage. The operation of grinding, which reduces a coarse roughage to a fine meal, does not convert a roughage into a concentrate. There is some evidence that cows actually obtain a smaller portion of the nutrients from a finely ground roughage than from a coarse roughage of the same quality. This is due to the fact that

finely ground roughage does not remain in the paunch for a sufficient length of time so that digestion can proceed normally. Another fact which should be considered is that the coarser stems which are often refused by cows contain much fiber and only small amounts of nutrients. Therefore the wasted portions are also the least valuable part of the roughage. To facilitate the handling of coarse roughages, cutting these feeds may often be more desirable than grinding. When compared with grinding, cutting is less costly, because it requires less time. There is also some evidence that cut roughages are digested more readily than finely ground.

Silos: Corn, kafir and other suitable crops may be cut and put into the silo to furnish succulent feed in the winter and during seasons of drouth when summer pastures do not furnish sufficient grazing. Trench, pit and upright silos are all efficient in preserving feed if proper methods of construction and filling are followed. The details concerned with building silos or with filling them are quite extensive and can not be discussed in this publication.

The following table taken from Circular 246, (now out of print), published by the Oklahoma Extension Division contains valuable information about upright silos. Information concerning trench silos, etc., may be obtained from the Oklahoma Extension Division, Stillwater, Oklahoma.

Relation of Diameter and Capacity of Silo to Dairy Herd

Diameter of silo (feet)	Depth of settled silage (feet)	Capacity (settled silage) (tons)	Average weight of one inch layer (pounds)	MINIMUM HERD NEEDED			
				Winter		Summer	
				Jersey	Holstein	Jersey	Holstein
10	26	39.2					
	28	42.5					
	30	45.9	236	14	10	24	16
12	26	56.4					
	28	61.2					
	30	66.0	339	20	14	34	24
14	26	76.8					
	28	83.4					
	30	90.0	462	28	19	46	32
16	26	100.3					
	28	108.9					
	30	117.5	603	36	25	60	42

The calculations made in compiling this table are based on the assumption that a cubic foot of silage weighs 36 pounds, that an average daily allowance of silage is 25 pounds for Jersey cows and 36 pounds for a Holstein cow. To prevent spoilage

of the exposed silage it is necessary to remove an even layer of about two inches of silage each day during the winter months. During the summer when silage spoils more rapidly than during the cooler months it may be necessary to remove as much as three inches of silage daily in order to keep it in good condition.

7. GENERAL FEEDING SUGGESTIONS

Overfeeding: That cases of overfeeding occur even in some of the better herds is shown by the records of cow testing associations, for some cows are fed as much as one pound of grain for each pound of milk produced. Overfeeding may induce some cows to put on surplus fat. If this is not eventually used in producing milk and butterfat the feed used in producing this surplus fat actually represents a loss. In some cases overfeeding will put a cow off feed. This is also undesirable because if the condition continues for a time a decline in milk yield is very likely to follow.

Underfeeding: Underfeeding is perhaps in many cases fully as costly as overfeeding because cows receiving an insufficient amount of feed may use all or a large portion of the feed for body maintenance and consequently very little will remain which may be used for milk production. Herds which are constantly underfed will seldom produce any returns above the cost of feeds. Underfeeding is also undesirable because if it continues for a long time it may cause good dairy cows to draw too heavily on their body tissues. If this condition continues too long even very good dairy cows will soon become unprofitable producers.

Changes: Changes in the feeding program should always be made gradually. This includes changes as to kind, amount, form and condition of the feeds used. If very marked changes are to be made at least a full week should be used for completing the entire change. Turning cows on pasture from winter rations, changing from a legume to a grass hay or vice versa, or from a succulent to a dry are some of the changes which are often made in a single day. In these cases it would be better to use several days so that cows may gradually become accustomed to the new conditions.

Irregular feeding is also a bad practice. A dairyman has said that it is as harmful to profitable milk production to vary the time or method of feeding as it is to practice irregular milking. It is therefore important that as far as possible feeding should be done at the same hour and in the same manner from day to day.

Special Care: The use of alfalfa and sweet clover pastures is often accompanied by bloating of some of the cows. When such pastures are used cattle should be watched quite carefully because loss often occurs within a few hours after the animal is turned out on pasture. Access to dry roughages such as straw or prairie hay is believed by some farmers to be a help in preventing bloating.

Moldy feeds may also cause bloat as well as digestive disturbances. All feed which has spoiled or is otherwise unfit for use should be discarded. It can seldom be used profitably in feeding milk cows.

The feeding of sick cows involves several conditions. It is good practice to reduce the feed allowance one-half as soon as any cow shows indication of illness. It is also desirable to change the ration so that it will consist largely of bulky and highly digestible feeds. A small amount of bright grass hay or alfalfa hay with a small amount of bran is usually sufficient feed for most sick cows. If a veterinarian has diagnosed the case, his suggestions for feeding and handling the cow should be followed closely.

Summer Feeding: Although milk production should be more economical during the pasture season than during the winter season it is a fact that the summer feeding program is badly neglected on many farms. Many good producing cows are not fed grain while they are on pasture. Although good grass is one of the most ideal feeds for a dairy cow, a maximum milk flow can not be maintained on pasture alone because grass is so bulky and high in water that she is unable to consume sufficient amounts of the nutrients which are required for a large flow of milk. The use of grain and hay during those portions of the summer when pastures become short will help to maintain the condition of the cows. Proper summer feeding affects not only the milk yield during the summer months but if cows are allowed to become too thin their subsequent production during the winter may also be greatly reduced.

When on good pasture it is usually advisable to feed some grain if a Jersey cow produces 21.5 pounds (two and one-half gallons) or more, milk daily or if a Holstein cow exceeds 25 pounds (about three gallons) of milk daily. Three pounds of concentrates should be fed daily when cows reach these levels of production. For each additional five pounds of milk produced daily, the concentrate allowance should be increased by one to one and one-half pounds. On this basis cows yielding 40 pounds of milk daily should receive five to seven pounds of concentrates daily.

In the spring when pastures are at their best, almost any mixture of several farm grains will be satisfactory for milk cows. Concentrate mixtures Nos. 1 to 4 illustrate the kind of concentrates which may be used. As the season advances a mixture similar to those recommended to be used with average legume hay should be used. During the summer as pastures become dry the grasses become more stemmy and contain less protein. At this time the concentrate mixture should be changed accordingly and for this part of the season, the mixtures Nos. 9 to 12 are desirable. In late summer and fall when pastures have lost all signs of green color and tenderness the feeding value of pasture grasses resembles that of prairie hay and a concentrate mixture suitable for such conditions should be used. Mixtures Nos. 13 to 16 are examples of adequate mixtures for this season.

Some feeds such as wheat and rye pastures, green alfalfa, alfalfa hay, corn silage and many weeds impart a very undesirable flavor to milk when they are consumed before milking. If it is known that the pasture contains weeds which produce off flavors cows should be removed from it at least several hours before milking time. The common dairy feeds which may affect flavors should be fed after milking rather than before milking.

Roughage-alone Rations: For many years, some dairy farmers in the best alfalfa sections of the west have maintained their herds on a ration consisting entirely of very choice alfalfa hay. The Bureau of Dairy Industry of the United States Department of Agriculture has conducted feeding experiments for a number of years which furnish information about the economy of such a system of feeding. In order to compare the value of this practice with other systems which have been used, three methods of feeding were followed.

Cows of more than average productive ability were fed a full grain ration for a year. These cows were fed roughages according to the rules which have already been discussed and one pound of good grain mixture daily for each three pounds of milk produced. The following year the same cows were fed all the choice alfalfa hay they would consume, without any concentrates. The third ration consisted of roughages and one pound of concentrates daily for each six pounds of milk produced. On the roughage-alone ration cows consumed about 60 percent more hay and the cows on the limited ration about 40 percent more hay than the cows on the full grain ration.

The all-roughage ration produced about 70 percent as much milk or butterfat as the full-grain ration, while the limited grain ration produced about 93 percent as much as the full-grain ration. When economy of production is considered the results show that the all-roughage ration is the most profitable when butterfat prices are lowest, while the full grain ration is the most profitable only when butterfat prices are highest. When the returns per acre of feed crops used are considered the results again show that alfalfa-alone ration is the most profitable at all price levels for butterfat, the limited-grain ration second and the full-grain ration the least profitable.

The results of this study are of especial interest during periods of low prices of dairy products but they also point out several facts which should receive consideration at all times in feeding cows. The results obtained are possible only when large quantities of roughages of the highest quality are used. This calls for a carefully planned program of growing legumes to provide sufficient feed, timely harvesting and proper curing of the hay crops and careful storage of the cured hay until it is used. On account of climatic and soil conditions many sections of Oklahoma are better adapted to the growing of grain crops and non-legume roughages than to the production of the highest type of legume roughage. Under such conditions an all-roughage system of feeding dairy cows is not desirable. Economy of production, however, is influenced greatly by the amount and quality of the roughages used and dairy farmers in this state should plan to provide roughages of high quality for their cows.

Feeding the Dry Cow: Every dairy cow should have a rest between lactation periods. Most cows need a rest of six to eight weeks after completing one lactation and before starting another. If cows are thin and in a run-down condition a longer dry period is advisable. During this time the cow should be given an opportunity to gain in weight so that she will be in good condition at the time of freshening. The dry period also enables the cow to restore mineral reserves which have been depleted in the cow's body during her flush production. Since larger amounts of nutrients are also required by the rapidly growing calf during the last few weeks of the gestation period, this is another reason for a dry period during which the good producer should be fed properly. Under farm conditions, from five to ten pounds of a good concentrate mixture will be sufficient for most cows. The larger amounts are needed only for cows in very thin condition.

Feeding the Fresh Cow: For a few days after freshening the cow may be fed a small amount of the same concentrate mixture which she received during the dry period. If this mixture is not used for the milk cows, a change should be made gradually to the regular herd mixture. The daily allowance of concentrates should be increased gradually. Ordinarily a half pound increase daily will give better results than more rapid increases. If these changes are made in this manner a period of three to six weeks is usually required to get a cow on a full concentrate mixture.