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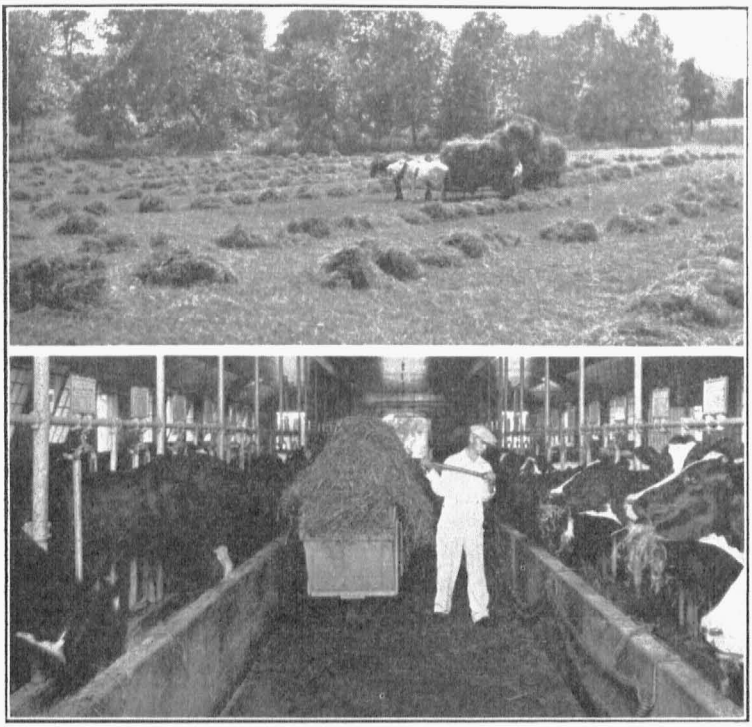
Feeding Dairy Cattle



The growing and feeding of an abundance of good quality legume hay is ordinarily one of the most important single factors in profitable dairy farm and herd management.

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Milk production and profits from the dairy herd are always in close relationship to the kinds and amounts of feed consumed. The profitable cow consumes large quantities of feed, and converts it into milk. This ability to convert feeds into milk is inherited and cannot be changed by any method of feeding or management. The problem of the dairy farmer is to so feed the cow that this inherited ability is utilized to its maximum efficency and a high yearly average production maintained. It is well known however, that certain feeds or combinations of feeding stuffs are more efficient than others for producing milk, chiefly because while all feeding stuffs have essentially the same nutrients to a greater or lesser extent, they do not contain these nutrients in the same amounts nor are they digested or assimilated as completely in some feeds as in others.

The good dairy cow provides an excellent market for many farm crops and these home grown feeds should ordinarily play a large part in the feeding of dairy cows.. The growing and feeding of an abundance of legume hays, such as alfalfa, clover, and soybean will invaribly save the individual farmer hundreds of dollars every year, which must otherwise be spent for high protein feeding stuffs. The more general use of silage will usually lessen the cost of milk production. The wise selection of grain feeds is another factor that often means the difference between profit and loss.

This publication is prepared for the purpose of providing those interested in the feeding of dairy cattle with useful information, especially regarding the problems which confront the farmer who milks cows, in selecting, purchasing and preparing rations which will aid in the most economical production of milk. Rations already formulated to meet a wide variety of conditions and general feeding rules are suggested; also a method for calculating rations, and a table giving the composition of the most commonly used dairy feeds are included.

THE CLASSES OF FEEDS

Feeding stuffs may be divided into two general classes or groups: roughages and concentrates.

Roughages.—Roughages are the coarser, bulky feeds such as the hays, corn stover or fodder, silage and straws. Soiling crops,

pasture grasses, root crops, and beet pulp may also be grouped as roughages, although in a sense some of them, at least, are really watery, or diluted concentrates. Some of the low grade milling by-products, such as oat hulls, cottonseed hulls, peanut hulls, should also be classed as roughages. Roughages as a rule are high in fiber less digestible and supply a lower percentage of digestible matter than do concentrates.

Concentrates.—Concentrates are the grain feeds; either the whole grains or by-products from the milling of the different grains. They are feeds of a condensed nature, usually low in fiber and relatively high in digestible nutrients. They include the various grains such as corn, barley, wheat, oats, soybean seeds, and milling by-products such as wheat bran, wheat middlings, gluten feed, gluten meal, soybean oil meal, linseed oil meal, cottonseed meal, etc.

THE CONSTITUENTS OF FEEDS

The constituents of feeds of value for growth and milk production are commonly classed as protein, carbohydrates, fat, mineral matter, vitamins and water.

Protein.—The crude protein of feeding stuffs is a complex nitrogenous substance. It is essential for growth and milk production. In the animal body it is used for the development of the internal organs, nerves, ligaments, tendons, muscles, skin, organic portion of the bones, lean meat, etc., and is found in milk in the form of casein, albumin and minor proteins. The individual proteins have widely varying values, and may supplement each other so that the combined effect of proteins from two or more plant sources is often better than the protein from a single source. The proteins of the legume hays such as alfalfa, clover and soybeans, supplement the proteins from other sources especially well, so that where legume hays form a considerable portion of the roughage ration, there is usually little difference in the feeding value per pound of digestible crude protein in the common protein-rich concentrates.

Carbohydrates.—The carbohydrates of feeding stuffs are compounds of carbon, hydrogen and oxygen, and include the fiber and nitrogen-free extract. They include the starch and sugar together with related products, are easily digested and are of great importance in the formation of fat and as a source of heat, butterfat, and energy. They are also sources for the making of milk sugar. They serve three important purposes in nutrition. They are unstable, being (1) easily broken down or changed into

sugar; (2) easily oxidized, giving off heat and thus serving as fuel for the body, and (3) easily reduced, forming products which can be turned into fat.

The carbohydrates are usually relatively cheap nutrients, being found in liberal amounts in all common farm roughages and grains.

Fat.—The fat or ether extract contains the same elements as carbohydrates, but the proportion of oxygen is less and that of carbon and hydrogen greater. The fats, like the carbohydrates, are used as a source of fuel, but are more concentrated, containing much more energy per unit and are thus well adapted for the storage of reserve energy in the body. One pound of fat produces two and one-quarter times as much heat or energy as a pound of carbohydrates. In feeding tables the carbohydrates and fats are sometimes combined by adding together the carbohydrates plus two and one-quarter times the fat.

Minerals Including Salt.—The mineral matter or ash constituents of the body consist of combinations of calcium, magnesium, sodium, potassium, and iron, with phosphorus, chlorine, iodine, and flourine, and others less important in the animal body. Mineral matter is found in all the vital parts of the body and its functions are numerous. It furnishes materials for the formation of new tissues, especially the skeleton. The muscles of all cells are rich in phophorus. Blood serum is rich in common salt and other salts of sodium and the red corpuscles are rich in potassium compounds. An iron-protein, hemogloblin, in the red corpuscles gives the blood its power to carry oxygen. The minerals help in maintaining the osmotic pressure, the neutrality of the body, and aid in respiration and digestion. They are an important constituent of milk.

Minerals are of especial importance for young, growing animals and for the cow giving large quantities of milk. Liberal feeding of grain does not insure an edequate supply of all the minerals needed, especially calcium. The legume hays such as alfalfa, clover, etc., however, do furnish calcium in liberal amounts. If legumes are fed in liberal amounts, an adequate supply of minerals except common salt is usually provided, but in the case of very heavy producing milk cows, or where liberal amounts of legumes are not included in the roughage ration, an additional supply of calcium may be needed. Practically all of our common grain feeds supply an abundance of phosphorus. There is no shortage of iodine and no other known mineral deficiencies under Missouri conditions.

Calcium (*lime*) is then the only mineral constituent, except common salt, that may be deficient under Missouri conditions with the feeding stuffs commonly used. This can usually be supplied most satisfactorily and economically by means of *special feeding steamed bone meal.* This also supplies phosphorus but is recommended because calcium phosphate is believed to be more palatable and is eaten readily without disturbance in digestion. Calcium carbonate in the form of a *finely ground limestone,* if high in calcium and free from magneisum and fluorine, may also be used but is less palatable and there is often difficulty, in this State, in getting such a high grade limestone. The steamed bone meal is best fed when mixed with the grain feed in the proportions of 1 to 2 per cent, the amount to be used depending upon the character of the roughages fed. If ground limestone is used 2 to 4 per cent is recommended.

There are many commercial mineral mixtures to be found on the market but it is important to keep in mind that they usually contain many useless and sometimes even harmful ingredients and no better results may ever be expected from their use than will be obtained by using simple calcium compounds and common salt. Since they are ordinarily relatively expensive, the farmer usually wastes money when he buys such complicated mineral mixtures. They are therefore never to be recommended.

Salt is essential and cows should have access to it daily. The average requirement is about ¾ of an ounce daily per 1000 pounds of live weight with an additional ¾ of an ounce required for each 20 pounds of milk produced. Cows may be allowed free access to salt or it may be mixed with the grain feed. One of the most practical and satisfactory plans is to mix it with the grain in the proportion of 1 pound for each 100 pounds of the grain mxture. The method of feeding salt is not important but it is essential that the cows get it daily in amounts sufficient for their needs. A plan used by some feeders is to mix the steamed bone meal and salt in the proportion of one or two parts of the bone meal and one part of the salt and allow the cows free access to the mixture.

Vitamins.—Vitamins is the terminology commonly used to designate a group of as yet unidentified substances essential to a complete ration, but which cannot as yet be classified with the well known nutrients—protein, carbohydrates, fat and mineral matter. The exact number of vitamins of importance in nutrition is not known, but our present knowledge indicates that there are at least six. These are commonly known as vitamins A, B_1 or F, B_2 or G, C, D and E.

Vitamin A, the antixerophthalmic vitamin, is essential for adequate growth, well being at all ages, and reproduction. In the feeding of dairy cattle there is no lack of this vitamin in their usual rations. The Vitamin B complex, including Vitamin B_1 or F, the antineuritic vitamin and Vitamin B_2 or G, the antipellagric vitamin is essential for growth, reproducton, lactation, proper functioning of the digestive tract, and resistance to bacterial infection. It is widely distributed in common feeding stuffs and no deficiency of it need ever be feared. Vitamin C, the antiscorbutic vitamin, is of no significance so far as is known in the feeding of dairy cattle. Vitamin D, the antirachitic vitamin, also has distinct growth promoting effects. Vitamin E is the antisterility vitamin. An abundance of pasture and other green feeds and plenty of well cured legume hay are believed to be sufficient safeguards against any possible shortage of Vitamins D and E. No prepared vitamin mixtures need ever be purchased.

Water.—Of all farm animals, dairy cows require the largest amounts of water, due to the fact that it forms about 87 per cent of milk. Recommendations concerning supplying water are discussed fully later in this bulletin under the heading "Feeding Rules—Amount to Feed."

Total Digestible Nutrients.—The term *nutrient* is applied to any food constituent or group of food constituents, of the same general composition, that aids in the support of animal life. Crude protein, carbohydrates, and fat are generally recognized as the primary classes of nutrients, although mineral matter, vitamins and water may likewise be so termed. The term *digestible nutrient* covers that portion of each nutrient that is digested or assimilated and used as contrasted with the indigestible portion which is excreted in the feces.

The *total digestible nutrients* of any feeding stuff is obtained by adding the digestible crude protein, the digestible carbohydrates and two and one-quarter times the digestible fat. The total digestible nutrients are in reality the nutrients of the feeding stuff converted into carbohydrate equivalents. The digestibility of the proteins, carbohydrates and fats of all common feeding stuffs have been determined by digestion experiments. These results form the foundation for working out the nutritive values of rations.

Nutritive Ratio.—The term nutritive ratio is sometimes used to express the ratio or proportion between the digestible crude protein and the combined digestible carbohydrates and fat. When the total digestible nutrients in a feed or ration are given, as in

table 3 the nutritive ratio may be computed by simply subtracting the digestible crude protein from the total digestible nutrients, and dividing the remainder by the digestible crude protein. For example, the nutritive ratio of alfalfa hay may be found thus: (51.6 - 10.6) ÷ 10.6 = 3.9. The nutritive ratio is then expressed with the colon, thus 1:3.9, and means that for each pound of digestible crude protein in alfalfa hay, there are 3.9 pounds of digestible carbohydrates and fat equivalent. A feed or ration having a large amount of digestible crude protein in proportion to the carbohydrates and fat combined is said to have a *narrow nutritive ratio,* and if the reverse, *a wide nutritive ratio.* The nutritive ratio of rations commonly fed dairy cows usually varies between 1:4 to 1:7, the rations having the narrower nutritive ratios usually being best suited to the feeding of the higher producing cows.

DESIRABLE CHARACTERISTICS OF A DAIRY RATION

Balance of Nutrients.—Balance of nutrients is the first essential of a good ration. If the dairyman is to grow his young stock most profitably, and is to get the largest and most economical production from his cows, it is evident from the foregoing discussion that he must supply in the feed all the essential nutrients in such quantities and proportions as will assure an abundance of each nutrient and yet not a surplus of any one, i. e., *a balanced ration.* Feeding an unbalanced ration forces cattle to eat considerable proportions of feed which they cannot use for maintenance, growth or milk production, and is therefore wasteful and extravagant. Cattle fed a balanced ration will make better and more economical growth and will produce more milk for the feed consumed, and remain healthier, breed more regularly, and live a longer productive life. The method of computing balanced rations, which are most economical for local conditions and feed prices, is fully discussed later in this bulletin.

Palatability.—Palatability is important, for it is essential that a cow's feed appeal to her appetite. Palatability means increased feed consumption with a resulting larger and more economical milk yield. When a cow eats feed, the first part of goes for maintenance and only the feed consumed over and above this amount is available for milk production. The good feeder recognizes this fact, and feeds the cow up to her full capacity or inherited ability for milk production and thus reduces proportionately the amount of feed used for maintenance and so increases the proportion of the feed used for milk production. It must be un-

derstood, however, that it is possible to overfeed. Govern the amount you feed by the increase in milk production, and the live weight of the cow.

Feeds of low palatability and poor quality are not eaten readily and the result is less feed nutrients are taken into the body and lowered milk production follows. Early cut, fine stemmed, leafy hays are more palatable than over ripe, coarse, stemmy hays. In making up the grain mixture it is well to keep in mind that some feeds, although of high quality and digestibility, are less palatable than others. Cottonseed meal and gluten meal are illustrations of high quality feeds lacking in palatability. Corn, oats, wheat bran and linseed oil meal and molasses are illustrations of especially palatable feeds. Some feeds are also heavy and constipating, and others light and laxative. The skilled feeder will combine his grain mixture so as to have these qualities offset each other. Thus heavy, constipating feeds such as corn, light feeds such as oats and wheat bran, laxative feeds such as wheat bran and linseed meal, all highly palatable should be used in the proper proportions, with less palatable, heavy feeds such as cottonseed meal and gluten meal, so as to give a resulting grain mixture that will be palatable, reasonably light and laxative. Clean mangers are also conducive to palatability.

Succulence.—Succulence in the ration is especially desirable. Feeds of a succulent nature tend to keep the digestive system in good working order, and make the entire ration more palatable. Pasture grass, sometimes termed Nature's best feed for the dairy cow, and other green crops, furnish this desirable quality in the ration during the spring and summer months. Silage is one of the best and usually our most economical succulent feed during the winter months, and to supplement short pastures during the summer. Root crops such as mangels, sugar beets and rutabagas are also excellent succulent feeds. They may be preserved during the winter months in a cellar or pit. They are, however, not ordinarily as economical or practical where corn thrives and may be used for silage, chiefly on account of the labor involved in their production. They are recommended chiefly for cows on official test, where greater variety is desirable and costs are not so important or for small herds where a silo is not practical. Beet pulp may also serve as a succulent feed where silage is not available, or as a supplement to silage where cows are on test and maximum production is desired, but is not ordinarily as economical as silage. It may be fed dry, mixed with the grain or soaked from one feeding to the next in sufficient water to thoroughly moisten it. Cane

or blackstrap molasses may also be used to add palatability to concentrates or dried roughages. The molasses may be mixed with warm water and then sprinkled over the feed. Feeders handling test cows frequently use both beet pulp and molasses. In this case the molasses is usually first mixed with warm water—a good proportion is to use about 20 pounds of molasses and 200 pounds of water, and then use this to soak about 100 pounds of the dried beet pulp. This beet pulp-molasses mixture is then frequently fed by placing it on top of the grain mixture in the feed box or manger. There are also a number of good molasses beet pulps and alfalfa molasses feeds on the market which are very satisfactory, if care is used in avoiding cheap molasses mixtures containing low grade substances. In the absence of any succulent feed, the liberal use of linseed oil meal in the grain mixture will do much to make up for the lack of succulent feeds.

Variety.—Variety tends to make the ration palatable and gives greater assurance of an adequate supply of protein and mineral matter. The heavier producing the cow or the herd, the greater the importance of this factor. A general rule is that at least two different plants should be represented in the roughage, and a minimum of three in the grain mixture or at least four different plants in the entire ration including roughages and grain feeds. Thus a ration containing alfalfa hay and corn silage for roughage and ground corn, wheat bran and cottonseed meal, would supply feed from two different plant sources in the roughage, three in the grain mixture, but only four different plant sources are represented in the entire ration, since the corn plant is represented in both the roughage and grain feed.

Bulkiness.—Bulkiness is necessary because the cow's stomach is especially adapted to the handling of bulky feeds. Nature has made special provision so that the cow may consume large amounts of bulky feeds, store them temporarily in the rumen, or first stomach, and then later rechew this food. Thus the common expression of "chewing the cud". A ration deficient in roughage, or bulky feeds, does not seem to satisfy the cow no matter how adequate the supply of feed nutrients. Bulkiness is closely associated with palatability. Therefore in choosing the dairy ration, some bulky feeds such as hays, silage, etc., seem necessary to the most satisfactory results.

FIGURING RELATIVE FEED COSTS

Economy.—As a general rule the dairyman should grow all the feed possible, especially roughages. Home grown feeds usually

furnish nutrients at lower cost than where feeding stuffs supplying an equivalent amount of nutrients are purchased on the open market.

When necessary to purchase feeds the question of first importance is—which feeds to buy? Low cost of digestible nutrients rather than low cost per hundredweight or per ton, the quality and individual characteristics of the feeds under consideration being otherwise approximately equal, offers the best measure of the relative economy of feeding stuffs.

Calculating the Costs.—A simple method of figuring the relative cost of digestible nutrients in feeding stuffs is as follows: Assume that the choice of a protein feed lies between linseed oil meal, cottonseed meal and corn gluten meal. Referring to Table 3 in the back of this bulletin, the analyses of the three feeds are found to be as follows:

	Digestible Crude Protein	Total Digestible Nutrients
Linseed oil meal	30.2%	77.9%
Cottonseed meal	37.0%	78.2%
Corn gluten meal	30.2%	84.0%

Assume that the cost of these feeds is $56 per ton for the linseed oil meal, $50 per ton for the cottonseed meal, and $54 per ton for the corn gluten meal. To find which feed is the cheapest source of protein, figure the cost per hundred pounds of each feed by dividing by 20. The result is $2.80, $2.50, and $2.70 respectively for the three feeds in the order named. The cost of one pound of digestible protein supplied by the linseed oil meal is then determined by dividing the cost per hundred pounds ($2.80) by the pounds of digestible protein (30.2) in 100 pounds of the feed. The result is 9.24 cents. In a similar manner the cost per pound of digestible protein in cottonseed meal is found to be 6.76 cents, and in the corn gluten meal is found to be 8.92 cents. Therefore, *at the prices given, protein would be purchased cheapest* in the cottonseed meal followed by corn gluten meal, while linseed oil meal would be the most expensive source of protein. In like manner *the cost per pound of total digestible nutrients* supplied by these three feeds is found to be 3.60 cents for the linseed oil meal, 3.20 cents for the cottonseed meal, and 3.21 cents for the corn gluten feed. The cost figures thus obtained are worthy of the consideration of every feeder as they give the *relative* cost of these growth-promoting, milk producing, food nutrients as supplied by the several feeds named.

It must also be remembered, however, that the best rations cannot be computed on the basis of costs alone, but that proper

consideration must be given to balance of nutrients, quality and to the individual characteristics of the feeding stuffs such as succulence and palatability, also to variety and bulkiness. It is always well, however, to first determine the relative cost per pound of the digestible nutrients in available feeding stuffs. The feeder with a knowledge of feeding stuffs is then in position to select those feeds which when mixed together will furnish most economically all the requirements of a good and complete ration. It must also be borne in mind that this method of studying the *relative* costs of feeding stuffs, while reasonably accurate when feeds of approximately similar composition and characteristics are compared, is not a satisfactory measure of the relative costs of feeds of widely varying composition and characteristics. Thus linseed oil meal, cottonseed meal, corn gluten meal, corn gluten fed, crushed soybean seed, etc., may be compared, also wheat bran, and ground oats, or ground corn, ground barley, hominy feed, etc., but such a comparison for ground corn and cottonseed meal, one a carbohydrate and the other a protein feed, would not be a fair one. Also in comparing feeds of similar composition, such as linseed oil meal and cottonseed meal, the special characteristics of the individual feeds should be kept in mind. Thus, linseed oil meal is palatable and laxative whereas cottonseed meal is less palatable. If these characteristics are balanced by other concentrate feeds in the ration, or if the roughage ration takes care of these charactertistics, then these special qualities of the individual feeds are not of quite so much importance. Thus in a ration containing wheat bran or silage, the less palatable, heavy, characteristics of the cottonseed meal would be offset but in a ration containing no such palatable, light, laxative or succulent feeds, linseed oil meal would have a distinct advantage.

Similarly this method may be used in comparing the cost of commercial mixed feeds and home mixed rations, provided the commercial and the home mixed rations are reasonably similar in the quality and characteristics of the individual ingredients, variety and other characteristics.

SELECTING RATIONS FOR MILKING COWS

The first thing to consider in formulating a ration is the feeds available.

The Roughage Ration.—The first step is to consider the roughages available since they determine, to a large extent, the character of the entire ration. There are considerable differences between the milk-making qualities of legume hays, such as alfalfa,

clover and soybean and non-legume roughages, such as timothy hay, corn stover, etc. These differences are due chiefly to the higher protein content, better quality of the proteins, mineral constituents, vitamin content, physiological effect and palatability of the legume hays. The availability of silage and other succulent feeds also influences the character of the ration. Legume hays and silage are usually economical roughages and both tend to reduce the amount of grain required to produce milk and their use, therefore, ordinarily reduces feeding costs and increases profits.

During the spring, summer and early fall months, pasture grass furnishes the choicest feed for dairy cattle because of its succulent nature and abundant supply of nutrients. It provides a goodly amount of protein and a liberal supply of mineral matter and vitamins. Every dairy farmer welcomes the time when he can turn his cows on pasture, for experience has taught him that it is the late spring and early summer months when the cows are on luxuriant pasture that the dairy herd normally reaches the maximum production of the year. The superior quality of pasture grass is often a danger, however, unless the feeder realizes its limitations, the varying amount of nutrients it supplies depending on its maturity and the amount of it available and properly supplements it with a suitable grain mixture. In periods of drouth, silage, soiling crops, other succulent feeds or good quality legume hay is also indicated.

The Grain Ration.—The second step in formulating the ration is to consider all the grain (concentrate) feeds available, their relative costs based upon their quality and the digestible nutrients they supply, and then to select a grain mixture that, with the roughages available, is best suited for use. This grain mixture should then be fed to the whole milking herd according to the requirements or production of the individual cows. The experienced feeder will know, and the novice must learn by experience, how to vary the ration to secure the maximum production from individual cows and the herd as a whole. Seasonal changes affect the feed supply and necessarily call for changes in the ration. Other factors, such as variations in the production of individual cows, advanced lactation, drying off cows, feeding while dry and just before and just after freshening, also require changes in the feed and feeding methods. The better the feeder understands his cows, the characteristics of feeds and the general principles involved, the better he will be able to make the changes as the need arises.

Typical grain mixtures recommended for feeding with the

various classes of roughages are given on the following pages. Each one has been formulated after a careful consideration of all factors concerned in the making of a good ration and is balanced to be fed with the various roughages under which it is listed.

Substituting Feeds.—Several of the feeds used are interchangeable and may be substituted for each other without materially disturbing the balance of nutrients. Although such changes may somewhat affect the physical character of the ration, the results are usually satisfactory when good judgment is used in making substitutions. Thus, ground corn, corn and cob meal, hominy feed, and ground barley are all of about the same feeding value and any one, or any combination, of two or more of them may be substituted for any other, pound for pound. Ground oats and especially wheat bran and alfalfa meal are of similar feeding value and all add bulk to the ration, however, wheat bran has a more beneficial laxative effect whereas alfalfa meal supplies more minerals. Wheat middlings is also of approximately equal feeding value with bran, alfalfa meal and oats but is a heavier feed and should not be used in as large quantities unless there are plenty of light feeds in the grain mixture. Cottonseed meal, gluten meal, gluten feed, linseed oil meal, soybean oil meal, crushed soybean seed, and corn distiller's grains should normally be the chief sources of protein in the grain mixture. All are more or less interchangeable but because of their individual characteristics, care should be used in making substitutions. The following substitutions will usually give the most satisfactory results; cottonseed meal for gluten meal; gluten feed for corn distiller's grains; linseed oil meal for soybean oil meal, crushed soybean seed or peanut meal, or vice-versa. There are also many other concentrates on the market which may be used in the grain mixture with good results. A list of the most common grains and concentrates and their composition is given in Table 3 at the end of this publcation.

The best results may usually be expecetd where a good variety of feeding stuffs is used in the grain mixture. Variety usually improves the physical character of the ration, insures a variety of proteins which will usually supplement each other to better advantage and the feed is better relished by the cows. Where pasture, silage, other succulent roughages or dried beet pulp are not available, it it usually advisable to use larger proportions of the more palatable and laxative feeds such as wheat bran and linseed oil meal and to decrease proportionately the amounts of such less palatable feeds as cottonseed meal and gluten meal.

The variation in the kind of feeding stuffs and the different

proportions in which they are used in the various grain mixtures also suggests that it is often economical to make changes to meet varying market conditions. While exactly equal results are not to be expected from all grain mixtures of the same percentage protein content, approximately the same milk production will ordinarily be obtained where the feeds are of similar quality and palatability, have similar individual characteristics, supply approximately the same amounts of digestible nutrients and where a similar variety of feeding stuffs is used.

Grain Mixture Influenced by Type of Roughage Used.—A grain mixture must be provided that will give a balance of nutrients with the roughages used. Protein is usually the limiting nutrient in the average ration fed to milk cows on Missouri farms. Where legume hays make up approximately one-half of the roughage fed, the grain mixture should usually contain a minimum of 16 to 18 per cent of crude protein or 12.5 to 15.0 per cent of digestible protein in order to maintain the most economical milk production. Grain mixtures containing 20 to 22 per cent crude protein or about 16 to 18 per cent digestible protein are recommended for use with mixed hays and silage or other non-legume roughages. If no legumes are fed, the minimum crude protein content of the grain mixture should approximate 24 per cent or about 20.0 per cent of digestible protein. Should legume hays be the sole roughage used, grain mixtures with a crude protein content of 12 to 14 per cent or approximately 9.0 to 11.0 per cent of digestible protein are indicated.

Since most of our home grown grains such as corn and oats contain only about 9 to 12 per cent of crude protein, and most of the legume hays about 12 to 16 per cent, it is evident that home grown grains alone will seldom provide sufficient protein unless soy beans or other high protein seeds are grown and fed or unless a good quality of legume hay is the sole roughage feed.

Combinations of good legume hay with silage or other succulent feeds, or good pasture, and a suitable grain mixture usually make the most desirable and profitable rations for milk cows.

GRAIN MIXTURES SUGGESTED FOR VARIOUS ROUGHAGES

In general the simpler grain mixtures, i.e., those with fewer ingredients are recommended for dairy herds of average to good producing ability and those mixtures containing a larger variety of feeding stuffs are recommended for high producing herds, for cows under official test conditions and are also suggested as de-

sirable mixtures to be used by milling companies desiring to mix a high quality ready mixed dairy feed.

Group 1.—The following grain mixtures contain approximately 24 per cent crude protein, or about 20 per cent digestible crude protein, and are recommended for feeding with either timothy hay, corn stover or corn silage, any combination of these or any other non-legume roughages.

1		2		3	
Corn and cob meal	220	Ground corn	320	Ground corn	220
Wheat bran	200	Wheat bran	200	Ground oats	150
Wheat middlings	200	Linseed meal	200	Wheat bran	150
Cottonseed meal	350	Cottonseed meal	250	Linseed meal	200
Steamed bone meal	20	Steamed bone meal	20	Cottonseed meal	250
Salt	10	Salt	10	Steamed bone meal	20
				Salt	10

4		5		6	
Corn and cob meal	220	Ground corn	270	Ground corn	245
Ground oats	150	Wheat bran	100	Ground oats	100
Wheat middlings	150	Wheat middlings	100	Alfalfa meal	150
Linseed meal	200	Corn gluten feed	100	Corn gluten meal	150
Cottonseed meal	250	Linseed meal	200	Linseed meal	125
Steamed bone meal	20	Cottonseed meal	200	Cottonseed meal	200
Salt	10	Steamed bone meal	20	Steamed bone meal	20
		Salt	10	Salt	10

7		8		9	
Corn and cob meal	170	Ground corn	95	Ground corn	145
Ground oats	100	Ground oats	100	Molasses beet pulp	150
Wheat bran	200	Wheat bran	125	Wheat bran	125
Wheat middlings	100	Wheat middlings	150	Wheat middlings	100
Crushed soybean seed	150	Linseed meal	250	Corn gluten meal	150
Cottonseed meal	250	Corn gluten meal	250	Linseed meal	100
Steamed bone meal	20	Steamed bone meal	20	Cottonseed meal	200
Salt	10	Salt	10	Steamed bone meal	20
				Salt	10

10		11		12	
Ground corn	100	Ground corn	120	Hominy feed	95
Molasses (cane or blackstrap	120	Ground oats	100	Dried beet pulp	100
Alfalfa meal	100	Wheat bran	125	Molasses (cane or blackstrap)	100
Wheat middlings	125	Corn gluten feed	100	Wheat middlings	50
Corn gluten feed	125	Wheat middlings	100	Alfalfa meal	100
Linseed meal	150	Corn distillers dried grains	125	Corn gluten feed	75
Cottonseed meal	250	Linseed meal	150	Linseed meal	200
Steamed bone meal	20	Cottonseed meal	150	Cottonseed meal	250
Salt	10	Steamed bone meal	20	Steamed bone meal	20
		Salt	10	Salt	10

Any high quality commercial mixed 24 per cent crude protein dairy feed may be substituted for any of the above grain mixtures. Likewise any high grade 34 per cent feed when mixed in the proportion of 3 parts of such feed to 2 parts of home grains, (such as corn, oats, etc.) will result in a concentrate mixture of approximately 24 per cent crude protein content that should give satisfactory results.

Group 2.—The following grain mixtures contain approximately 22 per cent crude protein, or about 18 per cent digestible crude protein, and are recommended for feeding with mixed hay light with clover, and corn silage or any other non-legume roughage.

1		2		3	
Corn and cob meal	270	Ground corn	320	Ground corn	220
Wheat bran	200	Wheat bran	300	Ground oats	200
Wheat middlings	200	Linseed meal	100	Wheat bran	200
Cottonseed meal	300	Cottonseed meal	250	Linseed meal	100
Steamed bone meal	20	Steamed bone meal	20	Cottonseed meal	250
Salt	10	Salt	10	Steamed bone meal	20
				Salt	10

4		5		6	
Corn and cob meal	370	Ground corn	270	Ground corn	270
Ground oats	100	Wheat bran	200	Ground oats	100
Wheat middlings	100	Wheat middlings	100	Alfalfa meal	200
Linseed meal	150	Corn gluten feed	100	Corn gluten meal	150
Cottonseed meal	250	Linseed meal	100	Linseed meal	100
Steamed bone meal	20	Cottonseed meal	200	Cottonseed meal	150
Salt	10	Steamed bone meal	20	Steamed bone meal	20
		Salt	10	Salt	10

7		8		9	
Corn and cob meal	220	Ground corn	120	Ground corn	170
Ground oats	150	Ground oats	100	Molasses beet pulp	150
Wheat bran	150	Wheat bran	200	Wheat bran	150
Wheat middlings	100	Wheat middlings	150	Wheat middlings	150
Crushed soybean seed	150	Linseed meal	200	Corn gluten meal	100
Cottonseed meal	200	Corn gluten meal	200	Linseed meal	50
Steamed bone meal	20	Steamed bone meal	20	Cottonseed meal	200
Salt	10	Salt	10	Steamed bone meal	20
				Salt	10

10		11		12	
Ground corn	175	Ground corn	200	Hominy feed	95
Molasses (cane or blackstrap)	120	Ground oats	120	Dried beet pulp	100
Alfalfa meal	100	Wheat bran	100	Molasses (cane or blackstrap)	125
Cottonseed meal	225	Wheat middlings	100	Alfalfa meal	100
Wheat middlings	125	Corn gluten feed	100	Wheat middlings	100
Corn gluten meal	125	Corn distillers dried grains	100	Corn gluten feed	100
Linseed meal	100	Linseed meal	125	Linseed meal	125
Steamed bone meal	20	Cottonseed meal	125	Cottonseed meal	225
Salt	10	Steamed bone meal	20	Steamed bone meal	20
		Salt	10	Salt	10

Any high quality commercial mixed 24 per cent crude protein dairy feed when mixed with home grains, (such as corn, oats etc.) in the proportion of 4 parts to 1 part of the home grains may be substituted for any of the grain mixtures included in this group. Likewise equal parts by weight of any high grade 34 per cent crude protein feed and home grains will result in a satisfactory concentrate mixture.

Group 3.—The following grain mixtures contain approximately 20 per cent crude protein, or about 16 to 16½ per cent digestible crude protein, and are recommended for feeding with mixed hay heavy with clover, and corn silage or any other non-legume roughages.

1		2		3	
Ground corn	400	Ground corn	425	Ground corn	375
Wheat bran	325	Wheat bran	250	Ground oats	100
Cottonseed meal	250	Linseed meal	100	Wheat bran	200
Steamed bone meal	15	Cottonseed meal	200	Linseed meal	100
Salt	10	Steamed bone meal	15	Cottonseed meal	200
		Salt	10	Steamed bone meal	15
				Salt	10

4		5		6	
Corn and cob meal	400	Ground corn	275	Ground corn	425
Ground oats	150	Wheat bran	200	Ground oats	100
Wheat middlings	100	Wheat middlings	200	Alfalfa meal	100
Linseed meal	100	Corn gluten feed	100	Linseed meal	100
Cottonseed meal	200	Linseed meal	50	Corn gluten meal	100
Steamed bone meal	15	Cotton seed meal	150	Cottonseed meal	150
Salt	10	Steamed bone meal	15	Steamed bone meal	15
		Salt	10	Salt	10

7		8		9	
Corn and cob meal	325	Ground corn	200	Ground corn	275
Ground oats	100	Ground oats	150	Molasses beet pulp	150
Wheat bran	150	Wheat bran	150	Wheat bran	150
Wheat middlings	100	Wheat middlings	150	Wheat middlings	100
Crushed soybean seed	150	Linseed meal	150	Corn gluten meal	100
Cottonseed meal	150	Corn gluten meal	175	Linseed meal	50
Steamed bone meal	15	Steamed bone meal	15	Cottonseed meal	150
Salt	10	Salt	10	Steamed bone meal	15
				Salt	10

10		11		12	
Ground corn	300	Ground corn	300	Hominy feed	175
Molasses (cane or blackstrap)	125	Ground oats	100	Dried beet pulp	100
Alfalfa meal	100	Wheat bran	100	Molasses (cane or blackstrap)	125
Wheat middlings	75	Wheat middlings	100	Alfalfa meal	100
Corn gluten feed	75	Corn gluten feed	100	Wheat middlings	100
Linseed meal	100	Corn distillers dried grains	100	Corn gluten feed	100
Cottonseed meal	200	Linseed meal	75	Linseed meal	75
Steamed bone meal	15	Cottonseed meal	100	Cottonseed meal	200
Salt	10	Steamed bone meal	15	Steamed bone meal	15
		Salt	10	Salt	10

Any high quality commercial mixed 20 per cent crude protein dairy feed may be substituted for any of the grain mixtures in this group. Also a 24 per cent ready mixed feed when mixed in the proportion of 2 parts to 1 part of home grains, (such as corn, oats, etc.) will result in a satisfactory 20 per cent concentrate mixture. Likewise 2 parts of a 34 per cent feed and 3 parts of home grains may be expected to result in a satisfactory 20 per cent concentrate ration.

Group 4.—The following grain mixtures contain approximately 18 per cent crude protein, of about 14½ to 15 per cent digestible crude protein, and are recommended for feeding with clover hay and corn silage or any other non-legume roughages. These grain mixtures are also suggested for feeding with summer and fall pasture.

1		2		3	
Ground corn	475	Ground corn	525	Ground corn	350
Wheat bran	300	Wheat bran	200	Ground oats	150
Cottonseed meal	200	Linseed meal	100	Wheat bran	250
Steamed bone meal	15	Cottonseed meal	150	Linseed meal	100
Salt	10	Steamed bone meal	15	Cottonseed meal	125
		Salt	10	Steamed bone meal	15
				Salt	10

4		5		6	
Corn and cob meal	500	Ground corn	350	Ground corn	425
Ground oats	100	Wheat bran	150	Ground oats	150
Wheat middlings	100	Wheat middlings	200	Alfalfa meal	150
Linseed meal	125	Corn gluten feed	150	Corn gluten meal	50
Cottonseed meal	150	Linseed meal	50	Linseed meal	50
Steamed bone meal	15	Cottonseed meal	75	Cottonseed meal	150
Salt	10	Steamed bone meal	15	Steamed bone meal	15
		Salt	10	Salt	10

7		8		9	
Corn and cob meal	425	Ground corn	275	Ground corn	300
Ground oats	100	Ground oats	150	Molasses beet pulp	150
Wheat bran	100	Wheat bran	150	Wheat bran	150
Wheat middlings	100	Wheat middlings	150	Wheat middlings	150
Crushed soybean seed	125	Linseed meal	125	Corn gluten meal	75
		Corn gluten meal	125	Linseed meal	50
Cottonseed meal	125	Steamed bone meal	15	Cottonseed meal	100
Steamed bone meal	15	Salt	10	Steamed bone meal	15
Salt	10			Salt	10

10		11		12	
Ground corn	350	Ground corn	375	Hominy feed	250
Molasses (cane or blackstrap)	125	Ground oats	100	Dried beet pulp	125
Alfalfa meal	100	Wheat bran	100	Molasses (cane or blackstrap)	100
Wheat middlings	75	Wheat middlings	100	Alfalfa meal	100
Corn gluten feed	100	Corn gluten feed	100	Wheat middlings	100
Linseed meal	75	Corn distillers dried grains	50	Corn gluten feed	100
Cottonseed meal	150	Linseed meal	75	Linseed meal	50
Steamed bone meal	15	Cottonseed meal	75	Cottonseed meal	150
Salt	10	Steamed bone meal	15	Steamed bone meal	15
		Salt	10	Salt	10

Any high quality commercial mixed 24 per cent crude protein grain mixture when mixed with home grains (such as corn, oats, etc.) in the proportion of 3 parts to 2½ parts gives an 18 per cent concentrate mixture which may be substituted for any of the concentrate mixtures in this group. Also 1 part of a 34 per cent feed mixed with 2 parts of home grains may likewise be used.

Group 5.—The following grain mixtures contain approximately 16 per cent crude protein, or about 12½ to 13 per cent digestible crude protein, and are recommended for feeding with alfalfa, soybean or cowpea hay and corn silage or any other non-legume roughages. These grain mixtures are also suggested for feeding with spring pasture.

1		2		3	
Ground corn	580	Ground corn	580	Ground corn	380
Wheat bran	250	Wheat bran	200	Ground oats	200
Cottonseed meal	150	Linseed meal	100	Wheat bran	250
Steamed bone meal	10	Cottonseed meal	100	Linseed meal	50
Salt	10	Steamed bone meal	10	Cottonseed meal	100
		Salt	10	Steamed bone meal	10
				Salt	10

4		5		6	
Corn and cob meal	530	Ground corn	480	Ground corn	530
Ground oats	150	Wheat bran	150	Ground oats	150
Wheat middlings	100	Wheat middlings	150	Alfalfa meal	100
Linseed meal	75	Corn gluten feed	100	Corn gluten meal	50
Cottonseed meal	125	Linseed meal	50	Linseed meal	50
Steamed bone meal	10	Cottonseed meal	50	Cottonseed meal	100
Salt	10	Steamed bone meal	10	Steamed bone meal	10
		Salt	10	Salt	10

7		8		9	
Corn and cob meal	480	Ground corn	480	Ground corn	355
Ground oats	100	Ground oats	100	Molasses beet pulp	150
Wheat bran	100	Wheat bran	100	Wheat bran	150
Wheat middlings	100	Wheat middlings	100	Wheat middlings	150
Crushed soybean seed	150	Linseed meal	100	Corn gluten meal	75
		Corn gluten meal	100	Linseed meal	75
Cottonseed meal	50	Steamed bone meal	10	Cottonseed meal	25
Steamed bone meal	10	Salt	10	Steamed bone meal	10
Salt	10			Salt	10

10		11		12	
Ground corn	460	Ground corn	455	Hominy feed	380
Molasses (cane or blackstrap)	120	Ground oats	100	Dried beet pulp	100
		Wheat bran	100	Molasses (cane or blackstrap)	125
Alfalfa meal	100	Wheat middlings	100		
Wheat middlings	75	Corn gluten feed	100	Alfalfa meal	100
Corn gluten feed	50	Corn distillers dried grains	50	Wheat middlings	50
Linseed meal	50			Corn gluten feed	50
Cottonseed meal	125	Linseed meal	25	Linseed meal	50
Steamed bone meal	10	Cottonseed meal	50	Cottonseed meal	125
Salt	10	Steamed bone meal	10	Steamed bone meal	10
		Salt	10	Salt	10

Any commercial mixed dairy feed of high quality containing 16 per cent of crude protein may be substituted for any of the concentrate mixtures given in this group. Also one part of a 24 per cent ready mixed feed and 2 parts of home grains (such as corn, oats, etc.) gives a satisfactory 16 per cent feed. Likewise 1 part of a 34 per cent feed and 3 parts of home grains will give a satisfactory grain mixture to be fed with the roughages in this group.

Group 6.—The following grain mixtures contain approximately 14 per cent crude protein, or about 11 per cent digestible crude protein, and are recommended for feeding with good quality legume hays, such as alfalfa, soybean, cow pea or clover hay when no silage or any other non-legume roughage is used.

1		2		3	
Ground corn	680	Ground corn	655	Ground corn	480
Wheat bran	200	Wheat bran	225	Ground oats	200
Cottonseed meal	100	Linseed meal	25	Wheat bran	200
Steamed bone meal	10	Cottonseed meal	75	Linseed meal	50
Salt	10	Steamed bone meal	10	Cottonseed meal	50
		Salt	10	Steamed bone meal	10
				Salt	10

4		5		6	
Corn and cob meal	555	Ground corn	605	Ground corn	630
Ground oats	150	Wheat bran	150	Ground oats	100
Wheat middlings	150	Wheat middlings	100	Alfalfa meal	100
Linseed meal	50	Corn gluten feed	50	Corn gluten meal	50
Cottonseed meal	75	Linseed meal	25	Linseed meal	25
Steamed bone meal	10	Cottonseed meal	50	Cottonseed meal	50
Salt	10	Steamed bone meal	10	Steamed bone meal	10
		Salt	10	Salt	10

7		8		9	
Corn and cob meal	480	Ground corn	555	Ground corn	505
Ground oats	100	Ground oats	100	Molasses beet pulp	150
Wheat bran	200	Wheat bran	100	Wheat bran	100
Wheat middlings	100	Wheat middlings	100	Wheat middlings	100
Crushed soybean seed	50	Linseed meal	50	Corn gluten meal	50
Cottonseed meal	50	Corn gluten meal	75	Linseed meal	50
Steamed bone meal	10	Steamed bone meal	10	Cottonseed meal	25
Salt	10	Salt	10	Steamed bone meal	10
				Salt	10

10		11		12	
Ground corn	530	Ground corn	555	Hominy feed	380
Molasses (cane or blackstrap)	125	Ground oats	100	Dried beet pulp	125
Alfalfa meal	100	Wheat bran	100	Molasses (cane or blackstrap)	125
Wheat middlings	50	Wheat middlings	100	Alfalfa meal	100
Corn gluten feed	50	Corn gluten feed	25	Wheat middlings	100
Linseed meal	50	Corn distillers dried grains	25	Corn gluten feed	50
Steamed bone meal	10	Linseed meal	25	Linseed meal	25
Salt	10	Cottonseed meal	50	Cottonseed meal	75
		Steamed bone meal	10	Steamed bone meal	10
		Salt	10	Salt	10

Any commercial mixed dairy feed of high quality containing 24 per cent of crude protein when mixed with home grains, (such as corn, oats, etc.) in the proportion of 1 to 3 will result in a grain mixture containing approximately 14 per cent crude protein that may be substituted for any of the concentrate mixtures shown in this group. Likewise 1 part of a 34 per cent feed mixed with 4 parts of home grains, or 1 part of a 20 per cent feed to 2 parts of home grains, or equal parts by weight of a 16 per cent ready mixed feed and home grains may be used to replace any of the concentrate mixtures suggested in this group.

Group 7.—The following concentrate mixtures contain approximately 34 per cent crude protein, or about 29 per cent digestible crude protein, and are suggested for milling companies desiring to mix a high protein supplemental feed with a good variety of proteins. Such feeds should ordinarily be purchased only by dairymen with an abundance of home grown grains, such as corn and oats, and for mixing with these grains in such proportions as to give a grain mixture of the approximate protein content which the type of roughage they use would justify them feeding.

(1)		(2)	
(Containing molasses)	lbs.	(Without molasses)	lbs
Cottonseed meal (choice)	300	Cottonseed meal (choice)	300
Corn gluten meal	200	Corn gluten feed	200
Linseed meal (o. p.)	100	Linseed meal (o.p.)	160
Soybean meal	100	Soybean meal	100
Peanut meal (from shelled nuts)	100	Peanut meal (from shelled nuts)	100
Alfalfa meal	100	Alfalfa meal	100
Molasses (cane or blackstrap)	60	Steamed bone meal	40
Steamed bone meal	40		

Commercial Mixed Feeds

There are many commercial mixed feeds on the market under special trade names. These feeds are usually mixed in such proportions as to supply a certain minimum percentage of crude protein and other nutrients contained in the feed as a whole, also the separate ingredients used, are commonly stated on the bag, the feed tag, and often in the advertising relating to the feeds. These feeds are commonly known as 12 or 14, 16, 20, 24 and 32 or 34 or other stated percentage crude protein feeds. Most states have laws requiring such feeds to be sold under a guarantee of purity. The Missouri law requires a statement of (1) the net weight of the feed contained in the package, lot or parcel; (2) the name, brand or trade mark under which the feed is sold; (3) the name and principal address of the manufacturer or person responsible for placing the feed on the market; (4) the minimum guaranteed percentage of (a) crude protein, (b) crude fat, (c) the maximum percentage of crude fiber, and (d) the specific name of each ingredient used in the manufacture of the feed.

Many of these commercial mixed feeds contain high grade materials mixed in proportions intended to fit them to be fed with specific combinations of roughages and home grown grains, and have won good reputations among intelligent feeders. The idea behind high grade ready mixed feeds is not to replace the

farmer's grain, but to furnish him with a feed that will give him variety, and the proper protein content to make a balanced ration, considering the roughages and home grown grains he has available. These high grade feeds usually have high palatability, a wide variety of proteins, are well mixed and give good results at the pail. Others of these feeds contain low grade materials, often carrying enough molasses to make them palatable and are manufactured chiefly just to sell. Many of the best feeds on the market, however, contain molasses and should not be confused with the low grade mixtures. A study of the list of ingredients will usually enable the feeder to distinguish between such high and low grade mixed feeds. In general, any feed carrying over 10 per cent of fiber should be studied carefully, the ingredients noted and considered before purchasing. Some manufacturers use alfalfa meal or beet pulp as a base on which to build their rations, and such feeds may run somewhat higher in fiber, but usually should not exceed 12 per cent, if only high grade ingredients are used.

In considering the purchase of any mixed feed, it is distinctly to the advantage of the purchaser if he can know:

1. The specific name of each ingredient used in the manufacture of the feed.
2. The exact amounts and grade of each ingredient used.
3. The percentage of crude protein and fiber.
4. The percentage of digestible nutrients.

Such knowledge of the kind, amount and grade of each ingredient, the composition and digestible nutrients of the mixed feed enables the feeder to more intelligently study and analyze his feed requirements. He will more easily come to understand:

1. That there is no secret magic involved in mixing feeds, and that the kind, quality, and proportions of the various ingredients used and the composition and digestible nutrients in the feed when honestly stated offers one of the best means of making comparisons and of determining the merits of the feed;

2. That he may figure just what it would cost him to buy the individual ingredients in the open market and mix the feed at home;

3. That the individual ingredients may be changed, or the proportions varied and still carry the same general analysis, and that it is often economical to make such changes to meet varying market conditions. This knowledge also serves to teach the fact that there is no one "best" feed for all conditions all the time, although there may be, and in fact usually is, one "best" feed or

combination of feeds for a given set of conditions when proper consideration is given to the kind, quality, individual characteristics, composition and prices of feeding stuffs available;

4. The chacteristics of the different ingredients used, the proportions in which they may be mixed to give best results, and to best supplement his home grown feeds.

Such knowledge has distinct educational value, but is of course dependable only when the full facts are given by reliable manufacturers.

The considerations just named have led some manufacturers to put on the market what is now commonly known as *Open Formula Feeds,* with which practically all this information is made available to the public. When the reliability of the manufacturers is such as to guarantee that the feeds are honestly manufactured and so are exactly what they are represented to be, this is a distinct advantage. The only important disadvantage of the open formula feeds is that it affords unscrupulous manufacturers, faced with keen competition, an opporunity to take advantage of the farmer by using lower quality feeding stuffs, and even not to put into their feed the ingredients in exactly the proportions claimed, since there is now no known method of making an absolute check on these points, once the ingredients are mixed in the feed. This leads to the obvious conclusion that no commercial *mixed feed, closed or open formula, is worth more than the honesty and reliability of the company manufacturing it.*

Finally, it is well to keep in mind that any commercial mixed feed naturally carries the manufacturers' charge for the service he renders in mixing the feed, including a reasonable profit. Whether it is best to buy the individual ingredients and mix the feed at home or buy the feed already mixed is a problem which the individual farmer must settle for himself, and is chiefly dependent upon the availability of the individual feeding stuffs of good quality which he wishes to use, their cost to him which may be somewhat dependent upon the quantities in which the size of his herd may justify him buying, his own knowledge of feeding stuffs and ability to learn or readiness to seek and secure from dependable sources information on how to prepare a balanced ration possessing those characteristics which go to make a desirable feed. The intelligent feeder when buying feeds for his dairy herd will give first consideration to the question of in which feeds and in what manner he can purchase the crude or digestible nutrients which he needs most economically, but with the full knowledge that the results he obtains at the pail and the consequent economy

of production are dependent not only on the cost of the nutrients themselves, but also upon the balance of nutrients, the quality and characteristics of the individual feeding stuffs and the variety of feeds used as well as his own skill as a feeder.

The 14, 16, 18, 20, 22, 24 and 34 per cent crude protein mixtures suggested in the preceding pages of this publication compare favorably with the highest quality of commercial mixed feeds of similar crude protein percentages where the individual feeds available are of good quality and when the home mixed rations contain a similar variety of feeding stuffs. Therefore high quality commercial mixed feeds of like protein percentage or of any protein content when mixed with home grains, (such as corn, oats, etc.) in such proportions as to result in a concentrate mixture of the desired protein content may be substituted for any similar home mixed feed recommended when the dairyman finds it economical to do so at the prices quoted. When all grain is purchased, commercial mixed feeds lend themselves particularly to consideration. When feed is purchased in small quantities the advantage of variety which many commercial mixed feeds offer is of importance. The careful buyer will, however, calculate the cost per pound of protein and total nutrients and after giving proper consideration to the other factors named he is then in position to make an intelligent choice.

Tonic Feeds

Tonic or *stock feeds* are often found on the market. They usually have some of the common feeds such as wheat bran, wheat middlings, linseed oil meal, etc., as a base to which has been added such ingredients as salt, charcoal, bone meal, fenugreek, ginger, gentian, sulphur, etc. It is usually claimed that they are appetizers, regulators and supply mineral balance. Such tonic feeds usually sell at a high price, but when presented by an expert salesman, it is sometimes not difficult to persuade the farmer, not thoroughly conversant with the facts, that he needs something of the kind. They are usually harmless, but if dairy animals are out of condition or sick, a veterinarian should be consulted and specific treatment given. If the animal needs salt or other minerals, then the dairyman should supply the deficiencies in his ration by adding the simple nutrients needed.

The feeder invariably wastes money when he buys these so-called tonic or stock feeds and the safe and sensible thing to do is to avoid them. If in doubt, consult your veterinarian or your state Agricultural Experiment Station.

FEEDING RULES—AMOUNT TO FEED

Winter Feeding.—*First,* feed all the roughage the cow will clean up. This will vary with the size and capacity of the cow but, for each 100 pounds live weight of the cow, it will usually closely approximate 3 pounds of silage and 1 to 1¼ pounds of hay, or 5 to 6 pounds of roots and 1 to 1¼ pounds of hay, or 1 pound of dried beet pulp soaked twelve hours or more before feeding and 1 to 1¼ pounds of hay, or 2 to 2¼ pounds of hay or other dried roughages.

Where possible, it is desirable that both a succulent roughage, such as silage, and a leguminous hay such as alfalfa, soybean or clover, be used in the roughage portion of the ration. Under Missouri conditions the most economical milk production is usually obtained only where both are fed. If silage is abundant it may be fed in somewhat larger amounts than suggested, or if the amount is limited, it should be restricted to less than 3 pounds per 100 pounds live weight and the allowance of hay or other dried roughages decreased or increased proportionately. As a general rule roughages, especially when grown on the farm, are the cheapest source of nutrients.

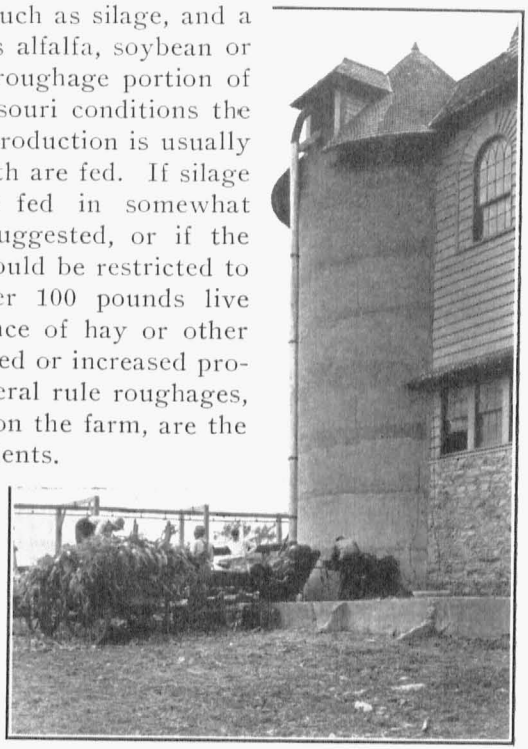

Fig. 2.—The feeding of corn silage is usually a factor of first importance in the economical feeding of milking cows.

Second, feed the grain mixture according to the amount of milk and butterfat produced. The breed, period of lactation and the character of the roughage fed are factors influencing the amount and kind of grain needed. On the average, Jerseys and Guernseys, when in full milk flow, should be fed about 1 pound of grain for each 3 to 3½ pounds of milk produced daily. For Holsteins, Ayrshires, Brown Swiss and Milking Shorthorns, feed 1 pound of grain for each 3½ to 4 pounds of milk produced daily. Another general rule is to feed 1 pound of grain daily for each pound of butterfat produced per week.

When the cow is receiving an abundance of good quality roughage and especially when leguminous roughages such as alfalfa, soybean or clover hay and a succulent roughage such as silage are fed, relatively less grain is required per pound of milk and fat produced than when other inferior or non-succulent roughages are fed.

Grain feeding should follow the milk production of the cow rather than milk production follow grain feeding. That is, as a cow increases in milk production, the grain should be increased accordingly; when increased milk production stops, there should be no further increase in grain feeding, and when production begins to fall off, the amount of grain fed should be decreased.

Third, the live weight of the cow is a good index as to whether she is being fed a proper amount, but good judgment must be exercised in regulating the ration by observing this condition. It is to be expected that a cow, calving in good condition, will lose weight during the first few weeks of her lactation period, while she is being brought to full feed and full milk flow, also that she will gain in weight toward the end of her milking period. Toward the end of of the laction period, therefore, it is often desirable to feed slightly larger amounts of grain than the amounts recommended above, in order that the cow may get in good condition before being dried off preparatory to next calving.

Heifers in milk may also profitably be fed slightly more than mature cows yielding the same amounts of milk and butterfat, because they require some nutrients for growth as well as for maintenance and milk production.

Fourth, feed the cow as many times each day as she is milked. Under usual farm herd conditions, the cow is milked twice daily and half of the roughage and grain allowance for the day should be given morning and evening. If a cow is milked three or more times daily she should be fed a proportionate amount of her daily ration at each milking period.

The particular order of feeding grain and roughages is not of importance for when the grain and roughage are eaten separately, they are thoroughly mixed in the paunch of the cow. It may be said, however, that in most instances the cow seems better satisfied when the grain is given first, and with it out of the way, she fills up on the roughages before her. Where the herd is milked and fed twice daily, many breeders have found it a very satisfactory plan to feed silage in the morning and hay in the evening. This practice seems to be especially satisfactory if the cows are allowed access to corn stover or other dried roughage in a feed

rack in the barn lots. If the grain mixture is rather heavy, it is often fed by placing it on the silage. Hay and other dry roughages may also fill the air with dust, and for this reason it is usually desirable to feed them after milking. Silage, turnips or other feeds which impart a noticeable odor to the milk are likewise best fed after milking, especially where retail milk is sold.

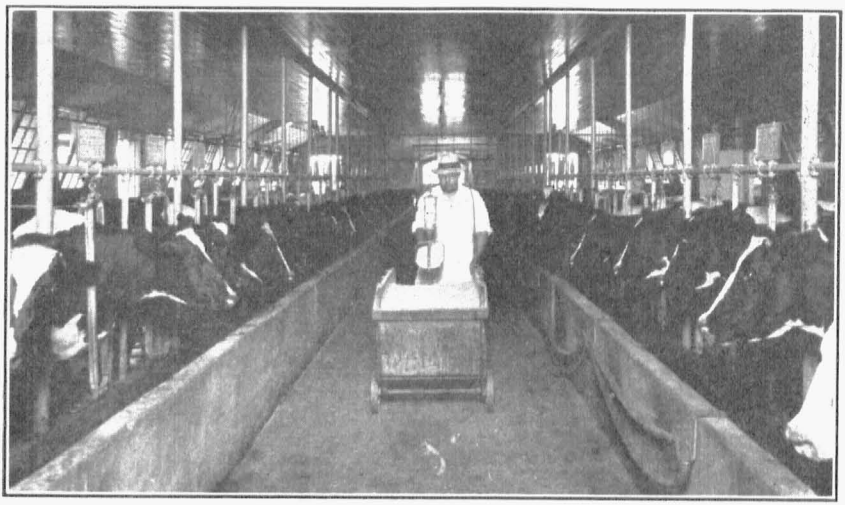

Fig. 3.—A suitable grain mixture fed in proportion to the amount of milk produced offers the dairy farmer one of his best opportunities to maintain a high yearly milk production and secure the maximum return above feed costs. (Feeding time in the Dairy Barn of the Missouri College of Agriculture).

Fifth, it is important that cows in milk have access to water at least two or more times daily, and better at will. Best results may be expected where individual drinking cups are used in the barn and watering troughs or other sources of fresh, pure water are available in lots and pastures, so that water is available at all times. Often milk production is lessened simply because the cows cannot conveniently get plenty of fresh water.

The amount of water cows will drink depends upon the yield of milk, the amount of water in the feed, the air temperature and whether the available water supply is of moderate temperature. During the winter months, if outside watering troughs must be depended upon, the use of tank heaters is recommended so that the cows will not be forced to drink ice cold water. Cows in milk require from 100 pounds (12½ gallons) to 300 pounds (37½ gallons) or more of water daily.

Water is the cheapest feed and more and better use should be made of it. This cannot be emphasized too much, as it is too often neglected in feeding. It pays big dividends in increased production.

Summer Feeding.— Pasture grass is a bulky watery feed, varying in the nutrients it supplies, depending upon its maturity. It is usually rich in mineral matter and vitamins, medium in protein, and slightly low in energy producing nutrients. The succulent nature of pasture grass combined with its abundance of mineral matter and vitamins, and the high quality of its proteins account for its well known superior power as a stimulant to milk secretion.

The pasture season is, however, too often welcomed as a time when grain feeding may be discontinued. Many farmers also make the mistake of turning their cattle on pasture too early in the spring. This reduces the amount of grass for the rest of the season, also this early pasture is so watery and bulky that it is impossible for the cow to consume enough of it to supply sufficient nutrients to maintain a high milk production. In fact, very heavy milk producers always require more nutrients than they can get from grass alone, even when it is well matured. Without additional feed, cows must call upon their body reserve to make up the deficiency. This means a loss of flesh and lowered milk production, often very quickly, in the case of the very heavy producers, and in any event during the later summer months and the following fall and winter. The usual falling off in milk flow in most dairy herds during the late summer months is due chiefly to an insufficient amount of feed and the hot weather. If a marked falling off in milk flow is allowed at this time, it is impossible to fully regain the loss, even with the best of feeding later, and a lowered production results for the balance of the lactation period. It is important, therefore, to maintain a high level of production during the later summer and early fall months, since a high yearly production must be secured, if greatest profits are to be realized.

When cows are turned on pasture in the spring, the feeding of roughages may usually be discontinued, but grain feeding should be continued for the time being at the same rate as they have been receiving on dry feed so long as it is cleaned up readily. As the pasture becomes more abundant and mature, the amount of grain may be reduced until no grain whatever is allowed Jersey or Guernsey cows producing less than about 20 pounds of milk daily, or Holstein, Ayrshire, Brown Swiss or Milking Shorthorns giving less than approximately 25 pounds of milk daily, provided

always there is an abundance of good pasture, otherwise such cows should receive a small grain allowance. Heavier producers should always receive a grain allowance. One point of importance in this connection is that cows receivng grain on pasture invariably produce better after the pasture season is over, and this should be taken into account in considerating the advisability of feeding grain at this time.

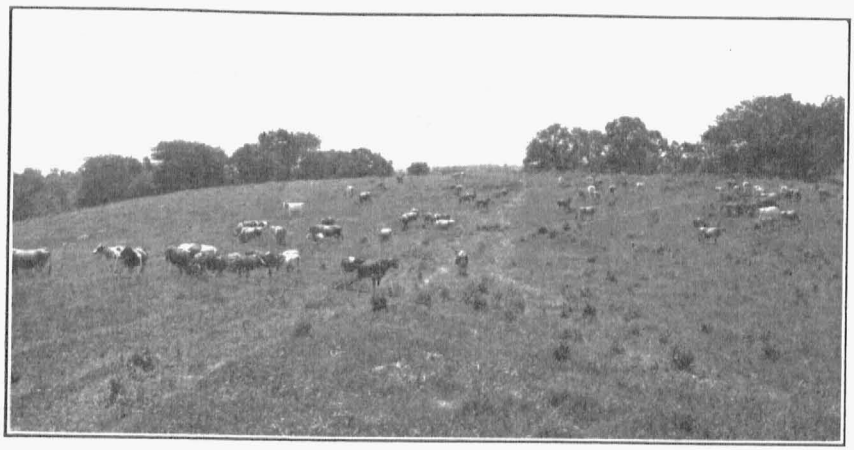

Fig. 4.—Dairy herd on typical bluegrass pasture in Central Missouri. Even on a pasture that has been luxuriant during spring and early summer, the herd needs supplementary feeds, such as silage or soiling crops, during periods of drouth in midsummer, and a suitable grain mixture in proper amounts throughout the year. Herds thus cared for invariably make the highest and most ecenomical year-round milk production.

Jersey or Guernsey cows on good pasture when producing 20 to 30 pounds of milk daily, should ordinarily be fed about one pound of grain for each 5 to 6 pounds of milk produced. Cows producing 30 pounds or more of milk daily should receive one pound of grain for each 4 to 5 pounds of milk and for exceptionally heavy producers it may be necessary to feed grain at a rate heavier than the above recommendations.

Holstein, Ayrshire, Brown Swiss or Milking Shorthorns producing 25 to 30 pounds of milk should usually be fed one pound of grain for each 6 to 7 pounds of milk. With a production of 30 to 40 pounds, allow one pound of grain for each 5 to 6 pounds of milk. When the production exceeds 40 pounds of milk daily, one pound of grain for each 4 to 5 pounds of milk is ordinarily required. For very heavy producers, special care should be given and the amount of grain required may closely approximate the amounts recommended for winter feeding.

During periods when the pastures are short, supplement them with silage or some green feed in addition to the grain allowance. Silage is usually the most economical and convenient succulent feed for use at this time. Any green crops, such as oats and peas, legumes such as alfalfa, clover or soybeans, green corn, etc., may also be used. It usually requires 40 to 50 pounds or more of such soiling crops to supply as much dry matter as 30 pounds of silage or 10 pounds of hay. Silage, however, has many advantages as it saves labor in cutting the green feed each day and hauling it to the barn, also it eliminates the difficulty of providing a suitable succession of crops and always having them ready in the proper amounts. If neither silage or soiling crops are available, legume hay, if of good quality, is ordinarily satisfactory.

Grain mixtures suitable for feeding during the spring and early summer months while the growth of grass is luxuriant, should contain approximately 16 per cent of crude protein (or about 12½ per cent of digestible protein). For later in the summer when the grass becomes more mature and begins to dry up, 18 per cent crude protein (or about 14½ digestible protein) grain mixtures are suggested.

FEEDING BEFORE AND AFTER CALVING

Feeding Dry Cows.—Cows should be dried off six to eight weeks before calving. The best production and largest profits may be expected only from cows that have been gotten into good condition during the dry period. A cow that has no rest and that is in thin condition at calving time never has an opportunity to do her best in the following milking period. She begins production at a lower level, and is not able to give as large a yearly production as if she had been given a rest and brought to a good condition of flesh. There is an old axiom that "one pound of feed fed while the cow is dry is worth two after the cow freshens."

Legume hays and silage or good pasture are the best roughages for the dry cow or heifer approaching calving. The grain mixture should be light, laxative and cooling. Heavy, heating feeds such as corn should be fed in minimum amounts and heavy, more or less unpalatable feeds such as cottonseed meal and gluten feeds should be eliminated. A typical and very satisfactory grain mixture to be fed at this time may be made up as follows:

100 pounds ground corn or hominy
100 pounds ground oats
100 pounds wheat bran
50 to 100 pounds linseed oil meal
8 pounds special feeding steamed bone meal
4 pounds salt

This grain mixture should be fed in sufficient amounts to put the cow in good condition. Under average conditions, this will usually mean anywhere from 5 to 12 pounds daily. A few days to a week before calving time, the amount of grain should be reduced and with cows showing a tendency toward inflammation and caking of the udder, it is a good plan to remove the corn from the ration. Some breeders prefer to substitute a warm bran mash (bran mixed with warm water) for the grain mixture the day before calving and on the day the cow calves. Cows on good pasture will need little extra feed for the few weeks before calving if in good condition of flesh. Avoid cold water the day before and for a day or two after calving or until the cow has cleaned. Plenty of lukewarm water may be allowed at this time.

The cause of the disease known as milk fever, which usually occurs only after calving, and then generally in the case of only high producing cows calving in good condition, is unknown. There is, however, some evidence that it may be due to a lack of minerals or sugar in the blood. The feeding of steamed bone meal and sugar, especially glucose, for a few weeks before calving, to cows with which previous experience has indicated milk fever may be expected, may be helpful in lessening danger, although this is not as yet a definitely established fact.

Feeding the Fresh Cow.—The grain mixture used just before calving should be continued for a few days gradually changing over to the milk producing ration you intend to feed. The feed may then be gradually increased as milk production increases. Experience indicates that this increase should rarely be more than 1 pound of grain per day. If the udder is badly congested or caked, grain should be fed sparingly until this condition has passed. If the cow gets along satisfactorily she should usually be on a full ration in 3 to 6 weeks.

PREPARATION OF FEEDS

Grains.—It is always advisable to grind grain for dairy cattle. The soaking, cooking or fermenting of grain, as a general rule, has no beneficial effect. Wheat bran, however, is often mixed with warm water, in which condition it is known as a bran mash and is a good conditioner for cows just before and after calving or in case of sickness from other causes. Dried beet pulp is frequently soaked for about 12 hours before feeding, because when soaked it has the advantage of acting to some extent as a succulent.

Roughages.—A careful study of experimental and practical feeding trials conducted in recent years indicates very clearly that

the grinding of roughages for dairy cattle has no appreciable effect upon digestibility. However, in the case of the coarser roughages especially, they will be eaten in greater quantities and with less waste when recut or ground. A serious objection to the use of ground roughages, especially hay, has been the dust resulting from grinding although it now appears that specially constructed dust hoods may eliminate this difficulty. Equally objectionable, however, is the dust when feeding. The quality of the milk is not affected and there is no significant effect upon the quantity of milk produced whether the roughages are fed whole or ground.

For first class fine stemmed hays, such as, good quality alfalfa and clover, the waste in feeding the whole hay is negligible usually ranging from less than 1 per cent to not more than 4 per cent. Recutting or grinding usually reduces this loss to less than ½ of 1 per cent. In the case of the coarser stemmed hays, such as soybean, the percentage of waste may run anywhere from 15% to 25% or possibly 30%, especially in the case of late cut, very coarse stemmed hay. Recutting or grinding usually reduces this loss to 5% or less. Under the most favorable conditions this waste may be almost entirely eliminated. With such roughages as oats and vetch hays the percentage refused usually averages somewhere around 10%. This loss can be largely reduced by recutting or grinding. With the coarse roughages such as corn stover and corn fodder the refused portions amount to as much as 30 to 40% when fed whole while cutting or grinding will in most cases bring the refused portions to 5% or less.

In general it appears that the cutting or grinding of roughages will usually largely reduce the percentage of waste which would otherwise occur by refusal of the coarser portions of the feed.

The cost of recutting or grinding roughages varies wth the type and size of the cutter or grinder, the kind and amount of power used, and labor costs, but is usually within the approximate limits of $1.50 to $3.00 per ton. The cost of grinding damp roughages is always more (approximately one-third) than in the case of dry roughages. The type of mill used is of considerable importance in this connection.

It is at once apparent that it is not an economical practice to cut or grind good quality, early cut, fine stemmed leafy hays. The economy of grinding late cut, coarse, stemmed hays or the coarser roughages such as corn stover or corn fodder resolves itself chiefly into a question of whether the saving, of the otherwise refused or waste portions, thus effected is more than enough

to pay for the cutting or grinding. Convenience in feeding and especially the quality and price of the roughage are the important considerations in connection with the desirability of recutting or grinding.

Conversion of Dry Roughages into a Succulent Feed such as is attempted by cutting and soaking with special cultures, converters or ferments such as the so-called "Sugar Jack," "Kultogras" and other special processes for sale by some commercial companies has no economic value. The changes occurring in roughages so treated are similar to those which normally occur in all methods of silage preparation. Investigation has shown that the claims commonly made concerning such specially prepared feeds are misleading and the use of such processes is not recommended.

FEEDING STANDARDS AND CALCULATING RATIONS

Feeding Standards.—Feeding standards are commonly expressed in the form of tables setting forth the amounts of digestible nutrients required by farm animals, such as the dairy cow, for growth, maintenance and milk production. Many years of scientific investigation and experience gained from practical feeding trials have developed present day feeding standards until, as a rule, they are very accurate. It should be understood however that feeding standards are not infallible but rather represent averages which should serve as a guide only. There are times when the requirements of the individual cow may vary from the limits set by the standards, and under special conditions the prices of available feeding stuffs may vary to such an extent that more economical production may be secured by varying from the standards. Intelligent farmers and herdsmen will however familiarize themselves with feeding standards and their use.

The *Morrison Feeding Standards* are almost universally used in this country today. They are believed to be the most satisfactory and practical for use in calculating the rations of dairy cows and are those used in this bulletin. Since this publication does not deal particularly with the requirements of growing animals, only those tables which set forth the requirements for maintenance and milk production are presented. Table 1 shows the daily requirements of digestible crude protein and total digestible nutrients for dairy cows of various weights.

TABLE 1.—DAILY MAINTENANCE REQUIREMENTS FOR DAIRY COWS

Weight Pounds	Digestible Crude Protein (Pounds)	Total Digestible* Nutrients (Pounds)
750	.525	5.943
800	.560	6.340
850	.595	6.736
900	.630	7.132
950	.665	7.528
1000	.700	7.925
1050	.735	8.321
1100	.770	8.717
1150	.805	9.111
1200	.840	9.150
1250	.875	9.906
1300	.910	10.302
1350	.945	10.699
1400	.980	11.095
1450	1.015	11.491
1500	1.050	11.887
1550	1.085	12.283
1600	1.120	12.679

*This includes protein plus carbohydrates plus 2¼ times the fat.

Table 2 shows the requirements in terms of digestible crude protein and total digestible nutrients needed, in addition to the maintenance requirements, for the production of milk of different percentages of butterfat. These requirements are the same regardless of the size of the cow.

TABLE 2.—NUTRIENTS REQUIRED FOR PRODUCING MILK IN ADDITION TO MAINTENANCE (MORRISON STANDARD)

	Digestible Crude Protein (Pounds)		Total Digestible* Nutrients (Pounds)	
	Minimum	Maximum	Minimum	Maximum
For each lb. of 2.5% milk	0.045	0.053	0.230	0.256
For each lb. of 3.0% milk	0.047	0.057	0.257	0.286
For each lb. of 3.5% milk	0.049	0.061	0.284	0.316
For each lb. of 4.0% milk	0.054	0.065	0.311	0.346
For each lb. of 4.5% milk	0.057	0.069	0.338	0.376
For each lb. of 5.0% milk	0.060	0.073	0.362	0.402
For each lb. of 5.5% milk	0.064	0.077	0.385	0.428
For each lb. of 6.0% milk	0.067	0.081	0.409	0.454
For each lb. of 6.5% milk	0.072	0.085	0.434	0.482
For each lb. of 7.0% milk	0.074	0.089	0.454	0.505

*This includes protein plus carbohydrates plus 2¼ times the fat.

Calculating the Ration.—To calculate the ration for a cow producing milk, the first step is to determine the amounts of nutrients required. To do this, three computations are necessary; (1) Determine the amounts of nutrients required for maintaining a cow of the given weight. For example, the nutrients needed for maintenance by a 1000 pound cow are shown in Table 1 to be 0.700 pounds of digestible crude protein and 7.925 pounds of total digestible nutrients. If the cow is of a different weight, the figures for the nearest weight should be taken from Table 1. (2) Determine the amount of nutrients required for the amount of milk the cow is producing of any given percentage of butterfat, as shown in Table 2. For example, if a cow is producing 30 pounds of milk testing 5 per cent fat, the nutrients required for 1 pound of such milk are shown in Table 2 to be between 0.060 and 0.073 pounds of digestible crude protein and 0.362 and 0.402 pounds of total digestible nutrients. Multiplying these amounts by 30 gives from 1.800 to 2.190 pounds of protein and from 10.860 to 12.060 pounds of total nutrients required for this amount of milk. (3) Add together the nutrients required for maintenance and milk production to determine the total amount of nutrients required by the cow. In this case, it would be 0.700 plus 1.800 to 2.190 or a range of 2.500 to 2.890 pounds of digestible crude protein, and 7.925 plus 10.860 to 12.060 or a range of 18.785 to 19.985 pounds of total di-

gestible nutrients. The nutrients required by this cow may be presented somewhat more clearly as follows:

	Digestible Crude Protein (Pounds)	Total Digestible Nutrients (Pounds)
For maintenance 1000 lb. cow	0.700	7.925
For 30 lbs. of 5% milk	1.800 to 2.190	10.860 to 12.060
Total nutrients required	2.500 to 2.890	18.785 to 19.985

The next step in calculating the ration is to determine the kinds and amounts of suitable feeds which will supply approximately the digestible crude protein and total digestible nutrients required. From the previous discussion we know that some combination of roughage, such as legume hay and silage, and a suitable grain mixture should be fed. The general rules given for feeding roughages indicate that a 1000-pound cow will consume about 10 to 12½ pounds of hay and 30 pounds of silage, and since this is known to be one of the most satisfactory types of roughage ration, these feeds will be used in calculating an example ration.

Table 3 gives the composition of our most common dairy feeds. By referring to it we find the amount of nutrients contained in alfalfa hay and corn silage. Assuming we will feed about 12 pounds of alfalfa hay and 30 pounds of silage daily, multiply the nutrients contained in 1 pound of alfalfa hay by 12, and the nutrients in 1 pound of silage by 30, we get the following results:

	Digestible Crude Protein (Pounds)	Total Digestible Nutrients (Pounds)
Alfalfa hay 12 lbs.	1.272	6.192
Corn silage 30 lbs.	0.330	5.310
Total nutrients supplied by roughage	1.602	11.502

Comparing the nutrients supplied by these two roughages with what the cow requires, we find that additional feed is required. Since we have used about all the roughage a cow of this size will ordinarily eat, we will make up the deficiencies by the use of grain feeds. By subtracting from the total nutrients required the amount of nutrients supplied by the roughage we find the amounts of nutrients to be supplied by the grain mixture. Thus:

	Digestible Crude Protein (Pounds)	Total Digestible Nutrients (Pounds)
Total Nutrients required	2.500 to 2.890	18.785 to 19.985
Nutrients supplied by roughage	1.602	11.502
Nutrients to be supplied by grain mixture	0.898 to 1.288	7.283 to 8.483

The kinds of grain feeds and the approximate proportions in which they should be mixed to feed with a roughage ration such as this one, consisting of alfalfa hay and corn silage, can only be learned by study and experience. In this case we will assume that ground corn, wheat bran, linseed oil meal and cottonseed meal are available. Since earlier in this publication we have already suggested a number of grain mixtures, any of which should be suitable for feeding with a roughage such as this one, we will select for a trial, one of the 16 per cent crude protein grain mixtures there suggested in which the available feeds are used. Grain mixture No. 2, containing 580 pounds of ground corn, 225 pounds of wheat bran, 75 pounds of linseed oil meal and 100 pounds of cottonseed meal, 10 pounds of steamed bone meal and 10 pounds of salt is taken as an example.

The general rules previously given for determining the amount of grain to feed call for one pound of grain for each 3 to 3½ pounds of milk for Jersey and Guernsey cows testing around 5 per ment fat. This would mean somewhat between approximately 8½ and 10 pounds of grain. For a trial we will determine the nutrients supplied by 9½ pounds of this grain mixture. By referring to Table 3, which gives the composition of our common feeding stuffs, we are able to calculate the amount of nutrients contained in this grain mixture. This is found to be as follows:

	Digestible Crude Protein (Pounds)	Total Digestible Nutrients (Pounds)
Ground corn 580 lbs.	41.18	473.86
Wheat bran 225 lbs.	28.12	137.03
Linseed oil meal 75 lbs.	22.65	58.43
Cottonseed meal 100 lbs.	37.00	78.20
Steamed bone meal 10 lbs.	------	------
Salt 10 lbs.	------	------
Nutrients supplied by 1000 lbs. this grain mixture	128.95	747.52
Nutrients supplied by 1 lb. (dividing by 1000)	0.129	0.748
Nutrients supplied by 9½ lbs. this grain mixture	1.225	7.106

The last step is now to compare the nutrients required by the cow with that supplied by the entire ration. This comparison may be illustrated as follows:

	Digestible Crude Protein (Pounds)	Total Digestible Nutrients (Pounds)
Nutrients supplied by roughage	1.602	11.502
Nutrients supplied by 9½ lbs. grain	1.225	7.106
Nutrients supplied by total ration	2.827	18.608
Nutrients required by feeding standard	2.500 to 2.890	18.785 to 19.985

It will be observed that the nutrients supplied are within the approximate limits required by the feeding standard. Since protein is usually the chief nutrient limiting milk production, it is most important that the ration supply a sufficient amount of this nutrient. If cows fed this ration show a tendency to become thin, the proportion of corn in the grain mixture may be slightly increased or a little more grain may be allowed. A close study of this ration will also show that it possesses all the essential requirements suggested for a good ration.

TABLE 3.—NUTRIENTS IN 100 LBS. OF COMMON FEEDS

Feeds	Crude Protein lbs.	Digestible Protein lbs.	Total Digestible Nutrients lbs.	Fiber lbs.
Concentrates:				
Ground corn (No. 2)	9.6	7.1	81.7	1.9
Corn and cob meal	8.5	6.1	78.1	7.9
Hominy feed	10.6	7.0	84.6	4.4
Ground barley	11.5	9.0	79.4	4.6
Ground wheat	12.4	9.2	80.1	2.2
Ground oats	12.4	9.7	70.4	10.9
Wheat bran	16.0	12.5	60.9	9.5
Wheat middlings, standard (shorts)	17.4	13.4	69.3	6.0
Corn bran	9.7	5.8	73.1	9.8
Corn germ meal	22.6	16.5	82.5	9.0
Corn gluten feed	25.4	21.6	80.7	7.1
Corn gluten meal	35.5	30.2	84.0	2.1
Distillers' dried grains (corn)	30.7	22.4	88.9	11.6
Brewers' dried grains	26.5	21.5	65.7	14.6
Cotton seed (ground)	19.5	13.3	80.0	22.6
Cottonseed meal (choice)	44.1	37.0	78.2	8.1
Cottonseed meal (good)	37.6	31.6	74.8	11.5
Linseed meal (o. p.)	33.9	30.2	77.9	8.4
Soybean seed (crushed)	36.5	33.2	94.1	4.3
Soybean oil meal	43.2	39.7	84.5	5.3
Peanut Meal (from shelled nuts)	44.8	40.3	83.5	7.6
Peanut meal (from unshelled nuts)	34.1	24.2	55.1	23.1

TABLE 3—(CONTINUED) NUTRIENTS IN 100 LBS. OF COMMON FEEDS

Feeds	Crude Protein lbs.	Digestible Protein lbs.	Total Digestible Nutrients lbs.	Fiber lbs.
Dried Roughages:				
Alfalfa hay or meal	14.9	10.6	51.6	28.3
Red clover hay	12.8	7.6	50.9	25.5
Soybean hay	16.0	11.7	53.6	24.9
Cowpea hay	19.3	13.1	49.0	22.5
Peas and oats	11.4	8.3	48.8	25.6
Clover and timothy	8.6	4.0	46.2	29.9
Timothy hay	6.2	3.0	48.5	29.8
Sudan grass	8.2	3.7	51.4	26.9
Orchard grass	7.9	4.7	49.4	30.3
Oat hay	8.4	4.5	46.4	28.3
Corn stover	5.7	2.1	46.1	27.7
Corn fodder	6.7	3.0	53.7	22.0
Kafir stover	5.1	1.7	47.7	27.4
Kafir fodder	8.9	4.1	52.9	26.8
Sorghum fodder	7.4	2.8	52.1	26.1
Soybean straw	5.6	2.8	43.5	36.8
Oat straw	3.6	1.0	45.6	36.3
Wheat straw	3.1	0.7	36.9	37.4
Cottonseed hulls	4.6	0.3	37.0	43.8
Silage, Roots, Beet Pulp and Molasses				
Corn silage	2.1	1.1	17.7	6.3
Corn stover silage	1.5	0.6	12.2	6.8
Kafir silage	1.8	0.8	17.5	9.9
Corn and soybean silage	2.6	1.6	17.4	6.7
Mangels	1.4	0.8	7.4	0.8
Rutabagas (swedes)	1.2	1.0	9.4	1.4
Dried beet pulp	8.9	4.6	71.6	18.9
Molasses beet pulp	9.5	5.9	75.3	15.9
Molasses, cane or blackstrap	3.2	1.0	59.5	
Fresh Green Roughages				
Blue grass (before heading)	5.3	3.7	15.9	5.2
Blue grass (all analyses)	4.1	2.3	18.5	8.7
Alfalfa	4.5	3.3	14.6	7.0
Red Clover	4.1	2.7	17.1	7.3
Soybeans	4.1	3.2	14.5	6.3
Cowpeas	3.0	2.3	11.0	3.8
Sweet Clover	4.4	3.3	14.3	7.0
Lespedeza	6.7	4.5	23.0	10.7
Peas and oats	3.2	2.4	14.4	6.3
Sudan grass	1.8	0.8	13.5	7.5
Orchard grass	2.9	1.7	16.1	9.8
Corn fodder	1.9	1.0	14.7	5.5
Kafir fodder	2.4	1.1	14.4	6.6
Sorghum fodder	1.5	0.7	17.1	7.0