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# Feeding Dairy Cattle

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# FEEDING DAIRY CATTLE

BY EARL WEAVER AND BURT ODERKIRK\*

## Liberal Feeding is Profitable

Most farmers realize that good dairy cows will produce more milk when properly fed than when fed scant rations. However, many dairy cows in Iowa receive rations that will not allow them even to approach a profitable level of production.

There are several reasons why cows are underfed. The chief reason is that a majority of men, while they know that increased feed will result in more milk, are not yet convinced that this increased yield will justify the feed cost. They believe that a low feed cost is the ultimate aim in profitable dairying. Economy and thrift in selecting rations are indispensable for profit; extravagance and wasteful expenditures for unnecessary feeds are to be avoided; yet such false economy as allows a cow little better than a starvation ration is deplorable. Successful dairymen had to learn the value of good feeding before they were able to succeed.

## AVOID FALLACIES IN FEEDING

Some men feel that care and judgment in the selection of feeds for cows is justified only with those herds that are producing more abundantly, such as may be true of herds in which official testing or cow testing association work is being done. These men console themselves in the personal assurance that, while their own cows do prove less productive, this production is less costly and consequently the net returns are greater.

Undoubtedly, some herds receive excessive feed and care to a degree that is unprofitable. Some cows have been forced beyond the limits of economical production, but such cases are few as compared to the vast numbers that are neglected and starved.

The greatest agency for improved feeding methods in Iowa is the cow testing association. A member of such an association knows what his cows are doing. Most members benefit by this knowledge and conduct their feeding and breeding operations accordingly. The cows in these associations in Iowa have an average yearly production of 270 pounds of butterfat. Iowa cows, not in such associations, have only about 150 pounds. Of course a part of this increased production of the association cows is due to their individual superiority. Association members make a stronger effort to use better bulls and thereby improve the natural ability of their cows. The members also know and eliminate unproductive cows. All evidence points toward the fact that improved feeding plays a conspicuous part in this situation wherein the association cows produce 120 pounds more butterfat per year.

It is possible to improve the feeding of most Iowa cows. There is ample proof that such procedure would be profitable. Recent studies show that ordinarily good cows when fed better will return \$2.00 in milk profits for each dollar spent in increased feed.

The actual farm records of 7,654 cows in Iowa cow testing associations, which finished their year's records during the 12 months ending June 30, 1926, have been grouped according to the productivity of the

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cows. Table I gives some interesting and valuable information concerning these cows.



Fig. 1. An Iowa cow tester getting some facts for the interested dairymen to use.

Cows in the first group did not eat much. Their feed cost was only \$35.67 a year—less than 10 cents a day. Those of the second group—the average Iowa cows—ate very little more. Those of the highest three groups ate twice as much but their production was about three times as great. Likewise, the value of their product showed the same increase. But the returns over feed cost are the valuable items. It is these returns that must compensate the owner for the time he spends upon the cows. These returns must pay the interest and taxes, take care of depreciation and bull service, and meet every obligation of the dairy herd, except to pay for the feed. With the cows of the second group—the average Iowa

cows—the return is \$36.57 or 10 cents a day. Such operations are unprofitable even tho the feed cost is low. Had feed and milk prices been slightly less favorable for the dairyman, there would have been no returns over feed cost.

The average Iowa cow testing association cow comes about midway between groups 4 and 5, or 270 pounds per year. Her feed cost is 40 percent greater than the average Iowa cow; her production is 80 percent greater and her returns over feed cost two and one-half times as much. The higher three groups of cows, altho they ate only twice as much as the average Iowa cow and produced three times as much milk, returned four to five times as much profit over feed cost.

#### ANY COW POORLY FED IS COSTLY—A GOOD COW WELL FED IS VALUABLE

Returns are greater with the higher producing cows because they are more efficient in converting feed into milk and butterfat. A measure of efficiency in this regard is the feed cost of producing a given

TABLE I. THE INFLUENCE OF THE PRODUCTION OF IOWA COWS UPON THEIR EFFICIENCY AND ECONOMY.

(The figures are for each cow for a year)

Butterfat y <sup>e</sup> ld pounds	Feed cost dollars	Value of product dollars	Returns above feed cost dollars	Feed cost per pound of butterfat dollars
75-125	35.67	52.79	17.12	0.33
126-175	38.96	75.53	36.57	.25
176-225	44.16	99.87	55.11	.22
226-275	50.99	125.44	74.45	.20
276-325	59.51	158.00	98.49	.20
326-375	66.27	179.54	113.27	.19
376-425	73.00	213.17	140.17	.19
426-475	79.89	240.44	160.55	.18
476-525	83.71	275.43	191.72	.17



unit of the product. The right hand column in table I reveals this situation with regard to these cows. The lowest producers required 33 cents worth of feed to produce a pound of butterfat. Feed, however, is only one item in costs. The total cost must be realized in order for any profit to exist. With the lowest producers, butterfat would have had to bring 55 to 60 cents a pound to make them profitable. Butterfat did not bring this price during the year represented by this study. The second group of cows would have been able to break even on total costs had butterfat sold for about 45 cents a pound. It brought about that price. The typical Iowa cow testing association cow, that comes midway between groups 4 and 5, required 20 cents worth of feed for a pound of butterfat. The total cost of butterfat from this cow was 35 to 40 cents a pound. Her owner made a fairly good profit from her at the prices that prevailed. He made money when possibly a neighbor, whose cows fell in the lower groups, was not paying expenses.

#### **ARE YOUR COWS KEPT FOR PROFIT OR PASTIME?**

Every dairyman should desire to have such cows, and should feed them in a manner that will assure good returns for the time he invests. A study of dairy farms by the Minnesota Agricultural Experiment Station revealed that some dairymen were working with their herds for 7 cents an hour. Others were drawing as high a rate as 77 cents. Whether a dairyman is going to be content with 7 cents an hour or whether he will demand 77 cents is a matter that rests pretty largely upon his own personal choice. Referring again to table I, the man with cows that fall in the low group is not drawing more than the 7 cents. Those with the higher producing cows are making their efforts worth while. If the former individual cares to improve the situation he can take any one of the following three steps. First: if his cows are scrubs, he can secure a good purebred dairy sire and by breeding obtain heifers with higher producing ability that will enable them to enter a higher group in table I. This is a reasonably safe procedure, but it takes time. These efforts will prove useless, however, unless the dairyman is determined to feed these resultant heifers properly. Starved grade dairy cows are no more profitable than starved scrubs. Second: he can butcher two of these cows of the lower group and invest the money in one good cow that will fit in at a higher production. This scheme is faster but it entails some chance in buying a cow that is not only capable of higher production but is also free from diseases and is priced reasonably. Third: one of every two cows in the low group may be sold. The remaining cow should then be given all the feed formerly fed to two. This will let her enter a higher producing group with her more liberal milk flow, her greater efficiency, and her larger profits. This scheme gets immediate results and entails no element of chance. It must be noted that none of these schemes contemplates any increase in the total milk production in Iowa. No one of them would have any bearing on prices that might be secured for dairy products. Their sole intent is to get the same amount of milk from fewer cows.

As long as men are content with cows and with feeding methods that yield no profit, there will be little improvement in dairy practices in Iowa. Instructions and suggestions regarding dairy cattle feeding are useless as long as a man's state of mind precludes any possibility of improvement.

#### **"HORSE SENSE" WITH THE COWS WILL HELP**

It is not difficult to feed a herd of dairy cows properly, but it does require some intelligence and common sense. Many men feed their

horses well and keep them in good condition. They know that the horse demands good feed in order to do work and they are willing to meet this requirement, yet the same men neglect their cows until they are starved, emaciated, unthrifty and unprofitable.



Fig. 2. A typical Iowa cow on typical Iowa land. Her feed cost was low—so was her production and profit.

Good producing cows are the hardest worked animals on the farm. Their energy is not expended in the same form as that of the work horse, but they are active for about 300 days each year while the horse works 40 or 50 days.

When a good cow is neglected she may continue for a certain time to produce a creditable quantity of milk, but she does so at the expense of her own body. If scant feeding is continued, she dries up prematurely and then constitutes a liability in the herd.

Certain underlying principles of nutrition must be recognized in order that cows may be intelligently fed. When these essential principles are appreciated, the selection of feeds for greatest economy and efficiency becomes easily possible. These principles will receive first consideration here. After they are presented there will be suggested some effective and economical practices which dairymen may apply in feeding their cows.

## THE USE OF FEED

In animal nutrition many complex body activities are involved. Some of these are not yet understood, but sufficient information is available to allow any dairyman to realize the general uses to which a cow puts her feed. The activities of all animals may be grouped into activities of body maintenance and activities involved in production. Body maintenance is common for all animals. Production may relate to growth, fattening, fetal development, milk production, egg production, wool production, or work. It is apparent that the dairyman must consider some of these body activities.

**MAINTENANCE.** An animal at complete rest requires a certain amount of feed to maintain its body. This feed provides for the vital body processes such as respiration, digestion, or repair of body tissues. A supply of feed sufficient to meet these requirements is of first importance, the amount being largely determined by the size of the animal. This amount is practically the same whether a cow is producing very little milk or is producing near the maximum of her ability. Of the feed supplied, a cow uses first the amount necessary for body maintenance. The balance is used for production and it wholly determines production. It is imperative that this available balance be expanded to the most economical degree. As it is expanded the proportion of the ration used for maintenance is reduced. This portion is the unproductive "overhead" in nutrition. The lower it goes the greater are the possibilities for economy. A low producing cow requires about 65 percent of her ration to maintain her body. The other 35 percent can be utilized for production. The high producing cow gets more

feed and only about 35 percent of it goes for body maintenance. In this case, the other 65 percent is available for production. Liberal feeding is the method of reducing "overhead" from 65 to 35 percent. Of course this reasoning presupposes that the cow receiving the liberal feed allowance is a good dairy cow and one that will respond to the additional feed by increasing her milk flow. There is a limit of feed for each cow beyond which the amount fed must not be carried.

**GROWTH.** Growth exercises a pronounced demand upon the ration. Heifers usually freshen first when they are two years old. They do not attain maturity of growth until nearly four years later. During these four years they must be so fed as to enable them not only to maintain their bodies, but to grow in weight and size, and at the same time perform the other productive functions of dairy cows. A heifer that freshens when too young has too many duties imposed upon her. Growth is often neglected and a stunted cow is the result. A very liberal ration and delayed breeding for the next calf is the method of meeting such a situation.

**FATTENING.** Fattening is of far greater significance with beef cattle than with dairy cattle. Nevertheless, even with the latter, it is not to be ignored. Cows that are approaching freshening should be fattened to a moderate degree. The improved condition at freshening time assures a store of body nutrients that will help tide the cow over the period immediately following freshening. It is also a partial safeguard against a mineral deficiency and helps to preserve the vigor and condition of the cow during the ensuing lactation period. Dairy cows frequently become very much emaciated during the winter or during the hot dry summer season. Their condition may be built up by liberal feeding.

**FETAL DEVELOPMENT.** The amount of food nutrients required for the development of a fetus is probably small, but nevertheless, cannot be ignored. Contrary to the general impression, if a pregnant cow be scantily fed, the fetus is not in particular danger of under-nourishment, but it is the cow that suffers. She sacrifices her own body stores that the fetus may be properly developed.

**MILK PRODUCTION.** The profits on a dairy farm depend upon the abundance and economy of milk production. Other activities are secondary, being of value only as they contribute to this milk production. The entire thought in dairy cattle feeding centers in this objective. The dairy cow possesses remarkable capacity for efficiently converting feed into milk. She uses her feed more efficiently than does any other animal, yet her productivity is completely determined by the kind and amount of feeds she receives.

## Food Nutrients

A feed is a complex substance made up of various chemical elements. The valuable constituents of a feed are called the food nutrients. A food nutrient is defined as a substance or group of substances that support or aid in the support of animal life. An animal eats feed for only one purpose, namely: to secure the food nutrients contained therein. The food nutrients are classed as proteins, carbohydrates, fats, minerals or ash, water and vitamins.

**PROTEINS.** Of all the food nutrients, protein is the most complex. Its distinctive feature is that it contains nitrogen along with many other chemical elements. Proteins have some very important functions to perform. They furnish the essential cellular material for

building muscular and other body tissue. They are consequently necessary for growing animals. Proteins are also required by mature animals for the rebuilding of worn out tissues that are being constantly torn down. Pregnant animals demand protein for the proper development of the fetus. The curd of milk is largely protein. Protein is used for the elaboration of the fat and sugar of milk. A beef cow requires only one-fourth to one-half as much protein as a dairy cow. A lack of sufficient protein in the rations, more than any other factor, explains the low milk production of Iowa cows.

In dairy cattle feeding, the abundant sources of protein are cottonseed meal, gluten feed, gluten meal, linseed meal and soybeans. It should be noted that only one of these can be grown on an Iowa farm. Corn is notably deficient in protein. Corn when fed to dairy cows must be supplemented with a high protein feed, in order to secure creditable production.

Timothy hay, cane, sudan and corn stover are almost useless as dairy cow feeds due to low protein content. The real virtue in alfalfa hay and other legumes is an abundance of this essential food nutrient.

From the foregoing it is evident that the commonly grown Iowa feeds—non-legume roughage and corn—have a marked deficiency in protein. There are two alternatives to this situation. The first is to buy the high protein feeds in sufficient amounts to meet the demands of the cow. If her demands are not met, production will fall. But these feeds are costly. Sometimes they cost so much and milk prices are so low that there is little if any profit in using them. Thus the dairyman is confronted with a serious obstacle. The second alternative, and a nearly complete solution to most feeding difficulties, lies in homegrown legume hays. Alfalfa ranks first, and red clover, soybean hay, and possibly sweet clover may substitute for the alfalfa when necessary. The use of legume hays greatly reduces the need for any other high protein feed. Then, if some soybeans can be grown, threshed and fed as cracked soybeans, the purchase of any feed is unnecessary.

**CARBOHYDRATES.** Carbohydrates are less complex in composition than are the proteins and are more abundant and cheaper in the usual feeds. Carbohydrates are the main source of the heat and energy needed by the animal. If carbohydrates are fed in amounts greater than are required to meet the energy need of an animal, they will be stored up as body fat and if the animal is put to exceedingly hard work, or if the supply of feed is reduced, this body fat is used up to supply the necessary energy. Carbohydrates are also involved in milk secretion in the elaboration of the milk sugar and milk fat. Their functions, while important, are not so inseparably linked with the well-being of the animal as are those of the proteins. If by some chance the amount of carbohydrates in the ration is reduced to a very low level, proteins can furnish the necessary energy. This is an extravagance, however, for the proteins are too costly to be used for this purpose. Under no conditions can carbohydrates serve the especial functions of growth, tissue repair, and milk secretion that are ascribed to the proteins.

Sugar, starch and fiber are examples of carbohydrates. About 4½ percent of milk is sugar. Sugar is not so abundant, relatively, in livestock rations as it is in the human diet. The large part of the corn kernel is starch, which is also true of barley, wheat, oats and rye. These cereal grains also carry the other nutrients, but their starch content is notable and they are called "starchy" feeds.

For reasons that will appear later under the discussion of Feed Laws, it is necessary to understand that carbohydrates are sub-divided into

two groups—nitrogen-free-extract, and fiber. Nitrogen-free-extract is a term used by chemists and feed manufacturers. It includes the starches and sugars. Nitrogen-free-extract is the valuable part of the carbohydrates, while fiber is the coarse woody portions of the plant. Naturally, the fiber content of roughages is very high, corn stalks and oat hulls being good examples. Bran and other seed coats contain more fiber than does corn. Fiber has some use in dairy cow rations in that it provides the desirable bulkiness, but its nutritional value is slight because it is highly indigestible. Generally the more fiber present in a feed, the lower is its value.

**FATS.** Fats are sometimes designated as ether-extract because chemists often use ether in extracting the fat from the feed to determine its amount. Fats consist of the same chemical elements as the carbohydrates. The functions of the two nutrients are the same and they may be interchanged to a considerable extent. A cow does not have to receive fats in her ration but can rely upon carbohydrates as a sole source of energy. It is possible for her to produce the fat in the milk when there is none in the feed supply. The possibility of using large amounts of fat in the ration with a view to increasing the fat percentage in the milk has received much attention. This question is discussed more fully on page 48. Suffice to say here, excessive portions of fat in the ration are likely to effect a temporary rise in the fat test of the milk. This scheme cannot be employed to hold permanently the test of a cow's milk above the limit as determined by her inheritance.

The fats yield relatively more energy than do the carbohydrates, being more concentrated. Experiments have shown that one pound of fat will yield two and one-fourth times as much energy as a pound of carbohydrates.

Roughages contain very little fat. Soybeans, flax, peanuts and sunflower seeds contain fat in enormous amounts. Cottonseed and coconuts are also rich in this nutrient. When oil is removed from these substances in industrial processes the resultant residue is ground and sold in forms such as soybean oilmeal and linseed meal. Even these meals contain considerable fat for it is not all removed in the processes.

Among the farm grains, corn takes first rank as a source of fat. This fact together with the carbohydrate content of corn explains its especial value for fattening livestock. The amount of fat in the ration for cows does not merit much consideration. It takes care of itself.

**MINERALS.** The amount of mineral matter in a feed is determined by burning or ashing a sample of it. The residue is termed the ash or mineral matter and these terms are used interchangeably. The minerals comprise a very small, but indispensable, portion of the feeds. Primarily, minerals constitute the skeleton of the animal and must be available to a pregnant cow for fetal development. They are also necessary for milk production and for the proper functioning of the blood, the heart and the nervous system. Some of the cereal straws contain relatively large quantities of minerals. These minerals are chiefly silicon, however, and have little value in nutrition. The legume hays are notable sources of calcium, the mineral ingredient that deserves most consideration. The concentrates supply phosphorus quite abundantly; this is especially true of wheat bran and linseed meal. Corn and corn products are notably deficient as sources of mineral matter. Milk, including skimmilk and buttermilk, contains a relative abundance of calcium and phosphorus. This in part explains the value of milk for growing animals.

Some of the considerations involved in the question of using mineral supplements for dairy cows are given on page 43.

**WATER.** The importance of water in the ration for cows needs no comment. All feeds contain some water, but an excessive moisture content generally lowers their keeping qualities and feeding value. Dry feeds, such as corn, oats, hay and straw probably contain 8 to 10 percent of water. Soft corn in early fall may contain as much as 30 percent. Pasture grass, silage and roots are largely water, containing from 70 to 95 percent. This water lends especial virtue to these substances in providing the succulence that makes them valuable.

**VITAMINS.** The vitamins are not ordinarily classed as food nutrients, yet they aid in the support of animal life and properly belong in the category of other nutrients. Vitamins are of recent discovery and interest. They cannot be measured in the feed as fat can be measured. Their composition has not yet been determined and they are designated as unidentified substances. It has been quite definitely proved that five vitamins exist. Proof of this existence lies entirely in studies with animals wherein a food substance suspected of containing none or one or more of the vitamins is fed and the behavior of the animal then noted. The vitamins that have been studied have been named A, B, C, D, E. Each one of these five vitamins has definite functions which it performs. These functions manifest themselves chiefly in the prevention of certain diseases. Vitamin A prevents xerophthalmia, a disease of the eyes; B prevents beri-beri, a nervous disorder; C prevents scurvy; D tends to prevent rickets, and E prevents sterility.

While the vitamins are essential in some cases, the dairyman does not need to give them much concern. The Minnesota Experiment Station has found that dairy calves must have vitamin A in their rations, but they also found it nearly impossible to select a dairy calf ration that did not carry a sufficiency of it. Vitamin B is abundant in yeast, yet the use of yeast had no effect upon the growth of calves nor the milk production of cows. Dairy animals get all of this vitamin they need from their rations or they build it up themselves. It is most unwise for a dairyman to spend any money for yeast. The same experiment station found that calves had no use at all for vitamin C for they do not have scurvy. Vitamin D may be needed by calves or cows under certain conditions. However, if these animals get sufficient sunlight and are adequately fed, such needs will be rare. Properly prepared cod liver oil is employed as the commercial source of vitamin D. This vitamin is discussed further on page 46 in connection with mineral assimilation.

Too little is known about vitamin E to permit of any definite recommendation. Some recent studies have been interpreted as proof that sprouted oats would correct sterility in dairy cattle. The value of the sprouted oats is attributed to their content of vitamin E. Until more definite and widespread proof is available, dairymen need not be concerned about this vitamin.

## Feed Laws

Iowa has laws relating to the sale of commercial feeds, mineral mixtures and stock tonics. The laws do not attempt to dictate what feeds shall be offered for sale in Iowa, but they do prescribe that all commercial feeds shall be accurately labeled. The label may be printed on the sack as shown in fig. 3 or it may be on a tag to be attached to the sack as shown in fig. 4.

The labels must list the ingredients used in the feed and must state the minimum percentages of protein, fat and nitrogen-free-extract, and the maximum percentage of fiber. If the amount of protein, fat or nitrogen-free-extract is found, upon analysis, to be below this guaranteed minimum, the seller of the feed is liable to penalty.



Fig. 3. An illustration of compliance with the feed law by printing the analysis on the sack.

Two illustrations of the value of this information will be given. There is a cottonseed meal on the market which is guaranteed to contain 43 percent protein. It may contain more than this minimum, but must not contain less. There is also a 36 percent cottonseed meal available. In addition there is a product known as cottonseed feed which contains the useless hulls. This feed often has little more than half as much protein as choice cottonseed meal and owing to the hulls its fiber content may be twice as high. The excess fiber tends further to lower the value of the feed by making its protein less digestible. Cottonseed feed often has a value less than half that of choice cottonseed meal. It should cost about half as much, yet farmers often buy it when it is within \$4.00 or \$5.00 of the price of choice cottonseed meal. The dairyman's protection in buying these feeds is in the label.

A considerable number of mixed or proprietary feeds are on the market. Some of them are excellent, others are sold largely as a means of disposing of useless byproducts such as cottonseed hulls, oat hulls, screenings, and mill sweepings.

As has been stated, the fiber in a feed is not an especially valuable nutrient. At any rate a farmer cannot profitably spend money for it since he has plenty of it available in coarse farm roughages. The lower the fiber content in a feed, the higher is its value. Feed manufacturers often have coarse fibrous materials to dispose of. These may be oat hulls, cottonseed hulls and other such useless byproducts. The temptation is to include large amounts of these waste materials in the feeds. The laws require that the guaranteed maximum percentage of fiber be given on the label and if the percentage exceeds this guaranteed maximum the seller of the feed is liable.

It is noted that the feed laws merely guarantee to the buyer of feeds that he can have at his disposal information about them. The use to which such information is put is entirely a matter of choice with him.



Fig. 4. A feed label printed on a tag attached to the sack.

TABLE II. THE TOTAL NUTRIENTS IN 100 POUNDS OF SOME FEEDS.

(For use in comparing some feeds that are offered for sale. Not to be used in balancing rations. The digestible nutrients are given in table V. All data except those noted otherwise are from Feeds and Feeding, 18th Edition, by Henry and Morrison.)

	Water pounds	Ash pounds	Protein pounds	Fiber pounds	Nitrogen free- extract pounds	Fat pounds
Some homegrown feeds						
Alfalfa hay	8.6	8.6	14.9	28.3	37.3	2.3
Alfalfa stems	5.6	4.9	6.3	54.4	27.9	.9
Corn stover	19.0	5.5	5.7	27.7	40.9	1.2
Oat straw	11.5	5.4	3.6	36.3	40.8	2.4
Corn, cracked	10.5	1.5	10.1	2.0	70.9	5.0
Corn, soft	30.6	1.0	7.4	1.2	56.0	3.8
Oats, ground	9.2	3.5	12.4	10.9	59.6	4.4
Soybeans, cracked	9.9	5.3	36.5	4.3	26.5	17.5
<sup>1</sup> Mixture I, page 39	9.9	2.8	14.1	6.2	60.9	6.1
<sup>1</sup> Mixture II, page 39	9.9	3.3	18.1	5.9	54.7	8.2
<sup>1</sup> Mixture III, page 39	9.9	3.4	19.7	5.7	52.3	9.0
Some high protein purchased feeds						
Cottonseed meal, choice	7.5	6.2	44.1	8.1	25.0	9.1
Cottonseed feed	8.3	4.9	24.5	21.4	34.6	6.3
Gluten feed	8.7	2.1	25.4	7.1	52.9	3.8
Linseed meal (old process)	9.1	5.4	33.9	8.4	35.7	7.5
Wheat bran	10.1	6.3	16.0	9.5	53.7	4.4
Some commercial feeds sold in Iowa						
<sup>2</sup> Feed A	....	...	23.3	11.7	.....	5.2
<sup>2</sup> Feed B	....	...	14.5	10.1	.....	3.3
Heavy oat feed (Fig. 4)	....	...	9.0	18.0	47.0	3.0
Some low-value byproducts						
Cottonseed hulls	9.7	2.7	4.6	43.8	37.3	1.9
Oat hulls	6.8	6.0	4.0	29.2	52.3	1.7

<sup>1</sup>Percentages calculated from other data in this table.

<sup>2</sup>Data from Bulletin No. 20, Iowa Department of Agriculture.

The feed of which a label is shown in fig. 4 was being purchased by Iowa dairymen in the winter of 1927 at \$38.00 a ton. To comply with the state law the ingredients of this "Heavy Oat Feed" are listed on the label. These are "Fancy Ground Whole Oats" and "Reground Oat Feed." A dairy cow would have difficulty in detecting any difference between "Fancy" ground oats and those ground in some other style. The regrinding involved in the "Reground Oat Feed" conceals the identity of the oat hulls.

The state law is further complied with in that the minimum percentages of protein, fat, and nitrogen-free-extract, and the maximum percentage of fiber are given. The carbohydrate percentage is unnecessary and not required by the law, it being simply the total of the nitrogen-free-extract and the fiber and is in accordance with the explanation of these terms as given on page 9.

The percentages, as given on a label, are often of little meaning to a dairyman unless they can be compared to some feeds with which the prospective buyer is familiar. For such comparisons, table II is presented.

This "Heavy Oat Feed" is included under "Some commercial feeds sold in Iowa." It has less protein than corn, its fiber content is 13 percent, while the fiber in corn is only 2 percent, which is a pronounced advantage for corn. This enormous fiber content will be understood by referring to the fiber content of oat hulls—given as 29.2 percent. The use of oat hulls in the feed is revealed in the high fiber content. This fiber is not only useless, but in this amount is detri-



mental, for it no doubt reduces the digestibility of the other valuable food nutrients. The nitrogen-free-extract is only 47 percent, while that of corn is 70.9 percent, and of oats 59.6 percent. An estimate would place this feed at about three-fourths the value of corn. Corn was worth, during the winter of 1927, about \$20.00 per ton. This would evaluate the "Heavy Oat Feed" at \$15.00. Some Iowa dairymen paid \$38.00 a ton for it.

The value of the feed law is not generally appreciated. Better use of the service it offers would save large sums of money each year. The law is administered by the Iowa Department of Agriculture, Des Moines, and any dairyman who so desires may send feed samples to the Department to be properly analyzed for a fee of one dollar per sample.

### **The Digestibility of Food Nutrients**

Thus far, the figures given showing the percentages of the various nutrients in feeds have been the figures obtained by chemical analysis. The animal does not digest all of the nutrients it consumes. Thus these figures, while they indicate quite accurately the value of the feed, are not so valuable as are the figures which reveal the amounts of the nutrients that will be digested. The figures from a chemical analysis have to be used on the feed labels. In order to determine digestibilities it is necessary to conduct elaborate and expensive digestion trials with animals. These digestion trials measure the amounts of nutrients consumed and the amounts voided in the feces. The difference between these amounts is considered to be the digestible portion that the animal uses.

Many factors affect the digestibility of the nutrients. Roughly speaking, the protein in good commercial feeds will be about 75 to 80 percent digestible. If the feed contains excessive quantities of fiber, the digestibility of all the nutrients is likely to be lowered. When the names of the nutrients are used without being preceded by "digestible," the meaning is that it is the total nutrients as determined by chemical analysis. When reference is made to the portion of the nutrient that is digested, it is so indicated.

## **DAIRY CATTLE FEEDS**

### **Roughages**

The ability of a dairy cow to utilize coarse farm roughage has been so firmly implanted in the thoughts of some men that these men are reluctant to admit any other thought. While a cow's real function is to convert farm feeds into a marketable product, she deserves some consideration in the tasks imposed upon her. She cannot produce milk unless sufficient ingredients for milk are supplied her. These ingredients are not found in timothy hay, straw nor corn stalks. Every possible emphasis herein will be directed to the end that the roughages shall receive major consideration in formulating dairy rations. A poor selection of roughages makes the most profitable dairying impossible; a good selection solves 90 percent or more of the dairy feeding problems. Roughages should be homegrown. The Iowa dairyman does not receive a price for his product that justifies the regular purchase of hay. Furthermore, there is seldom a time when homegrown roughages fed to cows and marketed as dairy products will not bring a larger return than when sold directly as roughage.

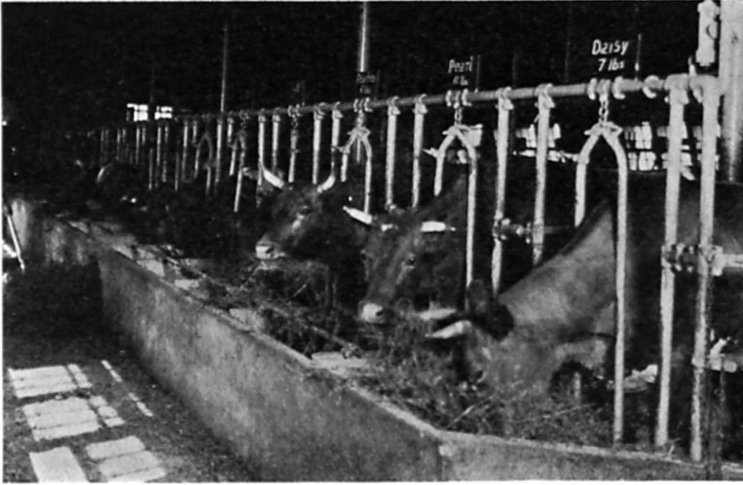


Fig. 5. With the manger full of alfalfa the feeding is nearly done.

#### DRIED LEGUME ROUGHAGES

**ALFALFA HAY.** Alfalfa is not only the best dry roughage for cows, but is more valuable than any other one feed—roughage or concentrate. Its chief value lies in the fact that it supplies protein and calcium in abundance. When alfalfa hay is used, the need for high-priced protein feeds is largely reduced or entirely removed. Likewise, a liberal use of alfalfa more nearly solves the mineral problem with cows than does any other scheme yet devised. It is very palatable and has a beneficial laxative effect upon the system. The hay of the first cutting in a season is generally coarser, more weedy and of a lower feeding value than that of later cuttings, but the difference between the cuttings is not so great as is commonly believed. For various rea-

TABLE III. DIGESTIBLE NUTRIENTS PRODUCED ON AN ACRE OF SOME CROPS.

Crop	Estimated yield of crop per acre	Estimated yield of crop per acre	Digestible protein produced per acre	Digestible carbohydrate equivalent* produced per acre
		pounds	pounds	pounds
Alfalfa hay	2.5 T.	5,000	530	2,050
Soybean hay	2.0 T.	4,000	468	1,676
Red clover hay	1.5 T.	3,000	228	1,302
Mixed clover and timothy hay	1.5 T.	3,000	120	1,266
Timothy hay	1.0 T.	2,000	60	910
Corn—Grain	45 bu.	2,520	189	1,971
Stover	1.25 T.	2,500	53	1,100
Fodder	2.5 T.	5,000	150	2,535
Silage	10.0 T.	20,000	220	3,320
Oats—Grain	40 bu.	1,280	124	777
Straw	1.0 T.	2,000	20	892

\*This term explained on page 52.

sons, alfalfa is not universally grown in Iowa, but as dairymen devote more interest to their cows, the acreages of this valuable crop will be greatly increased.

Table III shows the advantage of alfalfa growing on dairy farms. An important object in the cropping system on a dairy farm is to produce those food nutrients that will result in the largest yield of milk in the cheapest manner. The value of alfalfa hay when compared to other Iowa crops is apparent. An acre of alfalfa supplies more than twice as much digestible protein as an acre of corn, and protein is expensive when it has to be purchased. Alfalfa supplies nine times as much digestible protein per acre as timothy. This shows the uselessness of timothy hay on dairy farms.

**Alfalfa Meal.** Alfalfa meal is used extensively as an ingredient of proprietary feeds. The meal is generally thought of as ground alfalfa hay and as such has a feeding value equal to hay. It is defined by the Association of Feed Control officials of the United States as a product consisting of the entire hay ground without the admixture of alfalfa straw or other foreign materials. It is in no sense a concentrate, even tho it is sold in feed bags. When made from good hay, or even browned hay, it is as valuable as alfalfa hay. Sometimes hay is used in the manufacture of alfalfa meal that has lost a large portion of its leaves, thereby losing some of its nutritive value. The lack of leaves will tend to reduce the protein content below 14 will reduce the fiber above 30 percent.

**Mow-burned Hay.** In this state it is frequently difficult to cure alfalfa and other hays completely before they are put into the mow or stack. The hay is sometimes put in too wet or too green and heating results. This heating is due to fermentation and is accompanied by the liberation of steam and a pronounced aroma.

When this "burned" hay is used it will be found to have a very dark brown or black color. It also has a pronounced aroma. Cattle eat it readily as do other classes of stock. Some dairymen report that the browned hay is not an inferior feed. The fermentative processes, however, do destroy a certain proportion of the nutrients. The black hay has been even further injured and is of less value.

**CLOVER HAY.** Both red and alsike clover have advantages similar to alfalfa hay, but neither is quite so palatable, nor abundant in protein and minerals. Alsike clover is especially adapted for the feeding of calves. Mammoth clover is not recommended for dairy feeding.

**SWEET CLOVER HAY.** Properly cured sweet clover hay of a good quality is practically as valuable as alfalfa. To attain this proper cure and good quality is often difficult. Generally, the biennial white sweet clover is used and, when thickly seeded in the spring and cut the same fall, the quality of hay is usually good. The yield of this fall cutting is not great, nor are the stems so coarse, thus curing is easier. Second year sweet clover grows quite rank and often causes considerable difficulty in curing. For this second year crop, the hay should be cut when about 20 inches high or, when the very first blossoms appear. A delay of two or three days in cutting may make for failure. At the Iowa State College dairy farm, the first crop, second year sweet clover, has been cut by the first of June. The sod is then plowed and used for silage corn with considerable success. The best scheme for cutting the hay is to use a binder and shock the bundles for curing. Sweet clover hay, because of the coumarin it contains, may be unpalatable to some cows. This criticism is not serious, however, for nearly all cows eat it readily and those that do not soon become accustomed to it.

**Sweet Clover Poisoning.** It has been found, within the last few years, that sweet clover hay may cause death in cattle. Some Iowa herds have been depleted in this way. It is commonly believed that moldy sweet clover may cause the trouble. However, some apparently good quality hay has proved dangerous, and on the other hand, some very moldy hay has proved safe. The causative agent has not been determined, but the poisoning manifests itself by the failure of the blood to clot normally. A slight cut may allow the animal to bleed to death. The animal may bleed internally or the blood may appear under the hide. The precautions suggested thus far are to feed the suspected hay to the animals for a period of about two weeks, then change to other roughage for a like period, and continue such alternating thruout the season. This precaution is not a positive guarantee of safety, however, and until more is known about the poisoning and definite preventive measures devised sweet clover hay must not be looked upon as entirely safe.

**SOYBEAN HAY.** Of all the substitutes for alfalfa, soybean hay offers the greatest possibilities in Iowa. Being an annual, it finds its adaptability on rented farms or on farms where alfalfa may have winter-killed. Many trials reveal that soybean hay is nearly as valuable as alfalfa for dairy cow feeding. The hay has been used at the Iowa State College dairy farm with entire success. Most dairymen prefer to use alfalfa, but some insist that soybeans are superior in palatability and value to any other hay. Soybean hay is practically equivalent to alfalfa in its protein and mineral content. The great drawback with soybeans is the difficulty of getting the hay properly cured. Soybeans yield more than 2 tons per acre, which is a large crop to handle and cure at one time. Furthermore, soybeans are generally cut in Iowa in September, when rains may be excessive, and when hay curing weather cannot be depended upon. Difficulty in curing results in moldy hay and the loss of leaves with the result that the stems may not be entirely eaten. The best success at the College Dairy Farm has been obtained when the soybeans were drilled in six-inch rows just as soon after corn planting as possible. Then when they were cut the middle of August they had not become coarse, altho yields of 3 tons per acre have been secured. The soybeans are cut with a binder and cured in shocks. Altho it is often difficult to handle hay in such a manner, the well-cured leafy hay that results offsets these difficulties.

#### **DRIED NON-LEGUME ROUGHAGE**

The dried non-legume roughages are not valuable in dairy cow rations because of their low content of protein and minerals. When they are available on the farm, and have to be fed, it is best to let the horses or beef cattle use them up as largely as possible. When they are used as the only source of dried roughage for dairy cows, the concentrates must contain 25 to 35 percent of high protein feeds. A better plan is to feed this roughage in conjunction with some legume hay.

**CORN FODDER.** Corn fodder is the stalk with the ear attached. Of all the dried non-legume roughages, it is the best. This is because average Iowa corn fodder contains from 50 to 60 percent of ear corn. Cows eat the leaves quite readily, but will refuse the stalks, which comprise 15 to 20 percent of the fodder. The feeding value of the stalks is not great. A good plan on dairy farms is to shred the corn fodder. This procedure husks the corn and yields an exceptionally good bedding at a lower cost than is necessary when bedding would



Fig. 6. An early stalk field that is better than the average, yet there is little value here for milk production. After the snow and ice cover what stalks may be left, this is a very poor place for cows.

have to be purchased otherwise. If the need for roughage is urgent, this shredded material makes fair feed that can be conveniently handled.

**CORN STOVER.** Corn stover is the stalk from which the ears have been removed. Like other dried non-legume roughages, it is a poor source of protein and minerals. Cows will eat corn stover of good quality, but it is not palatable. While the feeding value of shredded stover is little if any greater than the unshredded material, it is more conveniently handled and the cows will eat larger quantities of it without waste. The best use for the stover on dairy farms is for bedding.

**CORN STALK PASTURE.** The plan of turning dairy cows into stalk fields is nearly universal in Iowa. No doubt in early fall, before snow and cold weather come, the cows do save considerable corn that is left in the field. Cows also eat large amounts of the leaves and stalks, but ear corn and corn stover can be utilized by other kinds of stock with less hardship. It is questionable if dependence upon stalk fields is profitable to a dairyman, for after a few days, the field will have been pretty thoroughly covered and the cold weather will have arrived. Dairy cows would then do better in the barn or in a protected lot, even with no feed during the day, but with an adequate ration night and morning.

**SWEET CORN STALKS, STOVER AND FODDER.** Sweet corn stalk pasture is no better than corn stalks for dairy cows. The stalks and leaves are finer and slightly more nutritious, altho there is not so much corn for the cows to find. Sweet corn stover is more easily handled, more palatable, and more valuable than an equal weight of corn stover. In certain seasons, sweet corn fodder with the ears attached is available. This feed is heartily endorsed by some dairymen. It can be used with very good results when supplemented with concentrates carrying a large proportion of high protein feeds.

**TIMOTHY HAY.** Timothy hay is widely grown and fed in Iowa. As shown in table III, it is too poor a source of protein to be used in dairy rations. It is also very deficient in minerals. It is generally more

palatable than corn stover with about the same feeding value, but has a constipating effect. The man who wants to feed his cows properly should grow no timothy. If it is available it will generally be a profitable practice to sell it and buy alfalfa hay. On the hay markets timothy sells for about the same price as alfalfa.

**PRAIRIE HAY.** Prairie hay or wild hay is slightly superior to timothy as a dairy cow feed. It is, however, quite variable in quality, palatability and feeding value and is not recommended for dairy cattle.

**CANE HAY.** Cane is the common term for sweet sorghums, or sorghos. The early varieties such as Amber cane make a fairly good hay, but are more valuable for other kinds of stock than for dairy cattle. Many dairymen in Iowa seeded cane for hay in the season of 1926 because of the imminent hay shortage and some disappointment was experienced in the results secured with this feed. Soybeans, or a mixture of soybeans and sudan grass, would likely have been a better choice.

**Cane Poisoning.** A great many plants have been found to contain, at certain times, prussic acid, which is a deadly poison. Cane and sudan grass are among these plants. Normally there is no danger in pasturing cane and sudan grass, but following a frost or a drouth, the poison may appear. Second growth cane is especially dangerous. In the fall of 1926 considerable cane was frosted before being cut. Many dairymen were hesitant about using it for hay, altho they were unduly alarmed. The prussic acid largely disappears during the curing process so that cane or sudan grass hay are seldom dangerous. Ensiling these crops also destroys the poisonous principle.

**SUDAN GRASS HAY.** Sudan grass hay is a little more nutrititious than timothy hay, and, if not too coarse, is just as palatable. Sudan grass grows rapidly and yields well, but the hay is not satisfactory for cows.

**MILLET HAY.** Millet should not be grown with a view to its use in dairy cattle feeding. Its value is no greater than that of timothy and it is generally less palatable.

**OAT HAY.** Sometimes oats are cut for hay when in the milk stage. This feed is better than timothy because it has more protein. It is one of the best non-legume hays, being quite palatable, but its low feed value for dairy cattle makes its use questionable.

**STRAWS.** The straws of the cereals are chiefly valuable as bedding on dairy farms. Cattle, even when well fed, will eat large quantities of either oat or wheat straw but all the straws take very low rank among the dairy feeds. Rye straw is decidedly unpalatable and barley straw, because of the beards, may be actually harmful.

## MIXED HAYS

The mixed hays generally consist of a legume and a non-legume grown together.

**CLOVER AND TIMOTHY.** The chief mixed hay is red clover and timothy. It is valuable in proportion to the amount of clover present. Unfortunately, red clover, being a biennial, does not last so long in the field as timothy, with the result that a great deal of the mixed hay has very little clover. The tendency of the clover to winter-kill also tends toward the same situation. This mixed hay ranks only fair among the roughages.

**OATS AND PEAS.** In the past, oats and peas were more commonly grown for hay than they are now. The present price for seed peas discourages their wider use. They are annual plants and make a very good catch crop if other crops fail. The hay is superior to clover and timothy.

**SOYBEANS AND SUDAN GRASS.** Soybeans and sudan grass, as a hay mixture, have been quite widely used during the past few years. They make a very excellent hay and are palatable. The yields secured have been enormous and the use of the sudan grass suppresses the growth of weeds that might occur with soybeans alone. Also the presence of the sudan grass aids in the curing of the hay.

### SUCCULENT ROUGHAGES

Next to legume hays, the most important consideration in economical milk production is that regarding succulent roughages. Succulent feeds are more laxative and healthful than dried materials and are generally more palatable. With succulence in the ration, udder troubles and other difficulties are less frequent. Succulence should be provided the dairy herd for each day of the year. Careful attention to pasture and silage or soiling crops and roots when necessary will attain this end.

### PASTURE

Pasture possesses all the characteristics desired in a dairy ration. It contains the essential nutrients for milk production and these are in the proper proportion. Pasture is the utmost in palatability, it is bulky, it generally provides variety, and it is succulent. These conditions contribute toward abundant milk flow and this satisfactory condition continues as long as the pastures remain good. The pasturing season in the central part of Iowa generally lasts from early May till late October, nearly six months. Any effort to prolong this season by turning the cows to pasture late in March or early in April usually avails nothing. The temptation to let the cows onto pasture is great for the feed supply may be nearly exhausted and the use of the pasture makes for less barn labor. The cows are generally restless, somewhat run down, shaggy, and in need of pasture. But, if they go out too early, they find little grass and what they find is very watery. The soil is usually soft and will be badly trampled and the grass destroyed if pasture is used too early in the spring. The grass cannot get a start and it suffers for the rest of the season.

**BLUEGRASS PASTURE.** When pastures comprise waste land their use is generally economical. Iowa, however, has very little waste areas and a large acreage of her pastures are on valuable land on which the taxes, interest, and the upkeep of fences are considerable. Under these conditions, pastures are expensive for they often yield feed for only a few weeks of the year and during the rest of the time are unproductive. Two acres of bluegrass pasture per cow are often necessary. Pastures are nearly indispensable on dairy farms. Every effort should be directed toward enhancing their value by protecting them against over-use, by regular applications of manure, by replenishing the stand of grass thru re-seeding and by judicious cultural methods such as disking and mowing.

The chief pasture crop in Iowa is bluegrass. It makes excellent feed but unfortunately its period of usefulness is usually short. It suffers severely in dry weather, such as is likely to occur in July and August. Bluegrass pastures can invariably be improved by seeding a suitable mixture of grasses and legumes.

**SWEET CLOVER PASTURE.** Enormous interest has recently been centered in the use of sweet clover pasture, because of its carrying capacity, one acre taking care of two or three cows in a better way than would two or three acres of bluegrass. The biennial white sweet clover is generally used, but a few men prefer the yellow variety for pasture.

One of the objections advanced against sweet clover pasture is that it causes bloat. However, men who use it have been able to inaugurate preventative methods that have largely removed the dangers. Sweet clover pasture has been criticised by dairymen in that it causes off flavors in the milk. Any luxuriant crop will tend to do this, but the flavor is not really objectionable, altho it is unusual. Care in slowly getting the cows changed to the pasture will minimize or remove the danger of bloat. When cows use sweet clover pasture, the butterfat test may be lowered, a frequent experience, explained by two conditions. First, sweet clover induces higher milk production and high milk production is almost always accompanied by a lower fat test. Furthermore, cows produce lower testing milk in hot weather, the season during which they are fed sweet clover pasture. Formerly, sweet clover was severely criticised for its lack of palatability. It appears, however, that all classes of stock eat it with considerable relish.

**OTHER PASTURE CROPS.** Crops other than bluegrass or sweet clover are sometimes used for dairy cattle pasture. Red clover, both medium and mammoth, and alfalfa furnish valuable pasture, but neither crop is especially adapted for such use. Alfalfa stands are easily ruined by pasturing. The crop is too valuable for hay to take such a risk. Cane, or sorghum, is sometimes used for pasture, giving good satisfaction. Of course, there is some danger of prussic acid poisoning as explained on page 18 and care must be exercised. Sudan grass makes a satisfactory pasture and no cases of poisoning on sudan have ever been reported in this state.

#### **CORN SILAGE**

Corn silage is the winter time pasture on good dairy farms, silage and grass being nearly identical in composition and characteristics. Most dairymen consider silage essential. Some may have fed quite satisfactorily without it, but they have labored under a handicap. There is no plan, which makes for more effective use of the corn crop, than the silo. The nutrients in silage do not explain its greatest value. It is palatable and bulky. It supplies the succulence for winter feeding and thereby nearly duplicates pasture. It helps to keep the cows laxative and in good health. They take their feed better and they maintain their production. In trials at various experiment stations where efforts were made to measure all the beneficial effects of silage, it was found that an acre of corn put into the silo and fed to dairy cows was invariably worth more for milk production than an acre of corn fed as fodder. When corn is fed as silage the entire crop is consumed without waste. In Indiana it has been found that the use of silage decreases the cost of milk production by 10 percent. From many sources data show that silage is worth one-third as much per ton as alfalfa hay for dairy cows.

The yield and composition of silage varies widely with the season, the variety of corn used and the stage of cutting. Generally little choice exists between growing an early variety or a later variety of corn for silage purposes. It is largely a matter of preference. The former yields less per acre but the silage is of a higher feeding value so that the total amounts of nutrients from an acre are about the same



in both cases. Yields of from 8 to 12 tons per acre are easily possible.

Some dairymen allow their corn to become fairly well dented before ensiling it. This gives a greater yield than would earlier cutting, but the resultant silage is generally less desirable. At this late stage the corn has begun to dry, and so needs water at filling time, but the supplying of water is often neglected. The silage goes in too dry, fails to settle well and spoiled silage often results. If the corn is not quite green at filling time, water must be added. Of course corn that is too green does not yield enough feed and may result in excessive fermentation and rotting. The best time for ensiling is when the corn is in the late milk or early dent stage.

Whether or not silage should be tramped is a question upon which there is great disagreement. There is a growing conviction in the minds of dairymen that the expense of hiring men to tramp silage is not necessary. This is particularly true when the corn is at the right stage or when sufficient water is added. Considerable evidence indicates that moldy silage is due not so much to improper tramping as to insufficient water. But with every precaution, moldy silage may occur. The use of moldy or frozen silage is not so dangerous with dairy cattle as with some other kinds of livestock. At the Minnesota Station various forms of moldy silage were fed dairy cows with no unfavorable results; yet it is known that such silage may cause cows to scour and go off feed. The development of moldy silage should be prevented as largely as possible. Then at feeding time the molded and spoiled portions should be thrown out.

**REMOVING THE EARS BEFORE ENSILING CORN.** Many men are tempted to remove the ears before putting corn into the silo. Thirty or thirty-five pounds of corn silage contain four or five pounds of corn. If this amount of corn is taken away from the cow at one time it will have to be returned later or must be replaced with some other feed equally good. It seems that removing the ears has no advantages.

**SILAGE FROM FIELD CURED CORN STOVER.** Some dairymen have only one silo and it may not be large enough to meet the demands of the herd for an entire season. To these men is presented the alternative of constructing another silo or of refilling the one during the winter. The latter scheme has disadvantages, but on the whole, it is often desirable.

If the corn stover has been well preserved in the shock it makes a fair quality of silage. The Wisconsin Station found that corn stover silage was worth 61 percent as much as corn silage for dairy cows. It must be realized that the corn silage contained the ears while the stover silage did not. The relative values of these kinds of silage depend upon many factors, chief among which are the kinds and amounts of other feeds used.

A very essential point in winter refilling is to have an abundance of water to add to the stover. A quantity of water at least as great as the weight of stover is required. Even a greater quantity is desirable. It is doubtful if too much water can reasonably be added. To handle the water without freezing in the winter-filling is difficult, but it is possible to select the warmer days and so avoid especial trouble.

The same plan of refilling with corn fodder may be employed even more satisfactorily than with corn stover.

Many believe that silage should not be fed immediately upon filling in the fall. There is no harm in using the corn immediately upon its entering the silo. Of course it is not silage for it has not undergone the normal changes which produce silage, but it is entirely safe and there is no reason for not using it.

**OTHER SILAGE CROPS.** In addition to corn, other crops are sometimes used for silage. Sunflowers have attained considerable favor in some sections in this regard. Alfalfa, cane, sudan grass and various mixtures have been used. While any of these may be satisfactory, there is little reason to use them in Iowa where corn is plentiful and unequalled as a silage crop.

#### **SOILING CROPS**

Bulletin No. 231 of the Iowa Agricultural Experiment Station gives in detail the results of eight years' experience in feeding soiling crops to a dairy herd. Soiling crops are those feeds which are cut green and fed in place of or in addition to pasture. While their use is not widely adapted to Iowa conditions, at times they may be satisfactorily employed. Most dairy herds depend upon bluegrass pastures for their succulence during the summer, but as pointed out, the bluegrass usually dries up so that the cows suffer. While men with silos can use summer silage, on some farms the use of soiling crops will be found desirable. This is true on farms where limited areas do not permit of the extensive use of pastures nor of silage. It also applies to the smaller herds that cannot justify the erection of a silo and to those herds on rented farms where no silo is provided. The chief advantage of soiling crops over other methods of providing summer succulence is in the enormous yields of feed that may be secured from a small acreage. Too much labor in growing and feeding the soiling crops is one of the main disadvantages. Also considerable care and judgment are required in selecting crops that will furnish a constant supply of feed. When a soiling system is in operation, the regular farm crops such as alfalfa and corn should be utilized at the proper times. Other crops that have given satisfaction are Amber cane, soybeans and oat and field pea mixture.

#### **OTHER SUCCULENT CROPS**

**ROOTS.** With an abundant production of silage so easily possible in Iowa, the growing of roots for dairy cows is not common. Root crop production entails much labor and some difficulties, few Iowa farmers are familiar with the production methods required, and not many farms are equipped with facilities for storing roots. It appears that those dairymen who have no silos may find roots valuable and practical. Roots contain less dry matter than silage, but the digestibility of the nutrients of roots is greater. Pound for pound the two feeds are about equal; some men, especially test cow feeders, prefer the roots. Among the root crops, mangels give the greatest yield and are the most generally grown. Rutabagas are sometimes used. Sugar beets are higher in feeding value than either the mangels or rutabagas. They are more difficult to grow and harvest, however, and are not produced generally for dairy cattle feeding. All roots should be chopped or sliced before feeding.

**BEET TOPS.** In the vicinity of sugar factories many tops from sugar beets are available. They may be pastured or ensiled. Their value is a fourth or third less than corn silage. Because of their high ash content they are quite laxative and it is better to limit the amounts fed.

**BEET PULP.** Beet pulp is a byproduct from the sugar factories. In the vicinity of the factories it is fed as wet pulp and gives excellent results. Owing to its high moisture content it cannot be transported far. The dried beet pulp is used quite extensively and is very satisfactory either when mixed as an ingredient of the concentrates or when soaked and fed for its succulence. It is no more nutritious than corn, but owing to its laxative effect, palatability and bulkiness it is highly

esteemed by dairymen as one of their concentrates. For feeding test cows, beet pulp is especially favored. It has the property of reabsorbing large quantities of water. When mixed with three or four times its weight of water it makes an excellent succulence. Larger or smaller quantities of water may be used, but in the above amounts the resultant wet beet pulp is closely comparable to silage. Many dairymen prefer the wet beet pulp to silage. The price of the beet pulp is usually too high to permit of its economical use. If it can be bought for about \$25.00 per ton it usually will be profitable.

**POTATOES.** Potatoes are sometimes used in rations for dairy cows. They have about the same feeding value as silage. If too large amounts are fed they will cause a poor flavor in the milk that will manifest itself in the butter. Care should be exercised in feeding potatoes as there is some danger of choking the cows. Also any sprouts should be removed to avoid the danger from a poison they carry.

**PUMPKINS.** Pumpkins may be very satisfactorily used in the ration for dairy cows. Their feeding value is not high but they are relished by the cows. They are worth only 40 percent as much as corn silage. There is a general belief that pumpkin seeds will cause cows to dry up. This belief is incorrect. The seeds should not be removed before feeding for they have considerable nutritive value and will do no harm.

### Concentrates

In practical herd feeding the concentrates must be looked upon as supplements to the roughages used. The proper selection of the concentrates requires some skill, but largely depends upon the roughages. For greatest economy in dairying, roughages should be entirely home-grown. Likewise a man who can grow all, or nearly all, of the concentrates needed by his herd has a pronounced advantage. A few dairymen in Iowa have cows of such merit or have a sufficiently choice market to enable them to buy all of their concentrates with profit. Such cases are rare, however. Most Iowa dairymen must grow their corn and oats and depend upon their cows as agencies for the efficient marketing of these crops. They can even produce enough soybeans to furnish the protein needed in the ration. However, nothing said here must be construed as an argument that the purchase of some high protein feeds is not profitable when these feeds are needed.

A discussion of concentrates largely resolves itself into a consideration of groups of feeds dependent upon their plant source.

**CORN.** Corn should comprise a large proportion of the concentrates used in dairy rations in Iowa because it is cheap, nutritious and palatable. It is generally unwise to allow corn to exceed one-half of the concentrates. It is said to possess a "heating" influence. For this reason, excessive amounts often cause udder congestion. This is likely to occur when corn also comprises a large share of the roughages. A week or 10 days before a cow freshens the corn should be taken out of her ration. It should also be kept away from her after freshening till the udder becomes normal. Corn is chiefly valuable because of its content of starch (carbohydrates) and fat. For fattening purposes it is unexcelled, but for milk production and for growth in young animals, it must be supplemented with better sources of protein and ash.

**CRACKED CORN.** The terms, cracked corn and corn meal, mean about the same, the only difference being that cracked corn is not so finely ground as corn meal. The coarser product has everything to

recommend it. So far as can be learned its digestibility is as great or possibly greater than the corn meal. The latter, if too fine, may resolve itself into a pasty mass that does not yield readily to the digestive processes. Also it is much cheaper and faster to merely crack the corn than to grind it to a meal. A dairyman who has no grinder and who hauls his corn to a mill should specify that the corn be coarsely cracked, which should cost only one-half to two-thirds as much as for fine grinding.

**SHELLED CORN.** Little definite experimental proof is at hand as to the superiority of cracked corn over shelled corn for dairy cows. Cracking corn will not effect the saving in feed cost that some are inclined to believe. Nevertheless, good dairymen do not usually feed shelled corn.

Cracking the corn presumably increases its utilization by the cows. It tends to reduce the amount of corn that passes thru the cow undigested and permits a more desirable concentrate mixture. Dairy cows demand care in the preparation of their feeds—more than beef cows and fattening steers.

It may be estimated that cracked corn is about 10 percent more valuable than shelled corn. Hence, the advisability of cracking depends upon the cost of cracking and the price of corn. Any dairyman with his own mill undoubtedly finds it to his advantage to crack the corn. However, as an example, if corn is worth only 56 cents a bushel or \$1.00 a hundred pounds, cracking will save only 10 cents. Naturally a man cannot spend the labor necessary in hauling the corn to town and back and also 15 cents for cracking if it saves only 10 cents.

**Corn-and-Cob Meal.** Bulletin No. 195 of the Iowa Agricultural Experiment Station gives results that were secured when corn-and-cob meal was compared with cracked corn. It was found that the corn-and-cob meal was valuable in just the proportion of the corn grain it contained. It contains about 80 percent of corn. One hundred pounds of cracked corn was equal to 125 pounds of corn-and-cob meal. These values were secured when the other feeds in the ration were sufficiently bulky in nature. When these other feeds lack bulk, the cob in the corn-and-cob meal exercises a desirable physical effect that increases the value of all the feeds. It is unusual for Iowa dairy rations to lack in bulk, however.

The choice between cracked corn and corn-and-cob meal depends upon the facilities available for shelling and grinding. Grinding ear corn is often difficult but is generally cheaper than shelling the corn and then cracking it. When the roughage of the ration consists of stover, timothy hay or straw, cracked corn is preferred to corn-and-cob meal. If roughages of higher nutritive value, and containing relatively less coarse fibrous material are used, the corn-and-cob meal will give satisfaction.

**Ear Corn.** Bulletin No. 195 of this station reports that it takes 140 pounds of ear corn to equal 100 pounds of cracked corn. Feeding ear corn to dairy cows is the utmost in carelessness. Any cow that is being used for dairy purposes is entitled to more consideration than is evidenced by the use of ear corn.

**Soft Corn.** Soft corn may contain two or three times as much water as well dried corn. Consequently, it is not so valuable. However, the dry matter in the soft corn is as nutritious, pound for pound, as that in well dried corn. The man with plenty of silo capacity is extremely fortunate in a soft corn year. The silo will utilize it to better advantage than will any other scheme.

Soft corn when stored is likely to mold. Moldy corn while not so dangerous with cows as with horses or sheep may cause digestive disturbances and scours. It should be fed with care. Grinding the soft corn is difficult. It should be ground in very small amounts for the ground material is more likely to heat and mold than is the ear corn.

**Gluten Feed.** Gluten feed, or corn gluten feed, is a byproduct obtained in the manufacture of cornstarch. It consists of gluten meal and corn bran. It is a high protein feed containing 25 percent of protein and 60 percent of carbohydrates. This is about three-fourths as much protein as in linseed meal and three-fifths as much as in choice cottonseed meal. Its carbohydrates are twice as abundant as those in choice cottonseed meal and about one-half greater than in linseed meal. All of the corn byproducts are quite deficient in their mineral content except when the materials called corn-solubles are added to them. Gluten feed, while not so palatable as linseed meal, is eaten readily by most cows. It does not have the laxative effect possessed by linseed meal. Also gluten feed at prices which often prevail does not furnish protein so cheaply per pound as does cottonseed meal. However, it does not cause the injurious effects sometimes noted with cottonseed meal. Many dairymen use gluten feed with great success. Very often those men who are giving their cows a little extra care or are forcing them for creditable records find gluten feed a valuable adjunct to the ration. Its bulky nature finds especial favor with these men.

**Gluten Meal.** But very little gluten meal is available on the market because it generally has the corn bran mixed with it to form gluten feed. Gluten meal is one of the most abundant sources of protein, containing about 40 percent. It also carries 50 percent of carbohydrates. It has met some objection by dairymen because it is a rich, heavy feed. The addition of the corn bran to it to form gluten feed removes this criticism.

**Corn Bran.** Corn bran is seldom available because it is mixed with the gluten meal to make gluten feed. Corn bran contains considerably less mineral matter and protein than wheat bran and is not so valuable as a dairy feed.

**Germ Oil Meal.** Terms used synonymously for germ oil meal are corn oil cake meal and corn germ meal. When the corn is used for starch manufacture, the germs are separated and yield corn oil. The residue left after the removal of the oil from the germs is germ oil meal. It contains a considerable quantity of fat and exceeds any of the common high protein feeds in this respect. This fact sometimes causes the feed to become rancid on storage. Its protein content is 22 or 23 percent. This is only about two-thirds that of linseed meal. The desirability of purchasing it depends upon the relative prices of it and other protein feeds.

**Hominy Feed.** Hominy feed is essentially a carbonaceous product and is very similar to corn in composition and feeding value. On most Iowa farms where corn is available in abundance there is little reason for the purchase of hominy feed. Men who feed their cows especially well to make high records are very favorable to the use of some hominy feed as a substitute for a considerable part of the corn. Corn in large quantity does not find favor in the rations used by test cow feeders.

**OATS.** In recent years oats have been very little more expensive, pound for pound, than corn. They are an excellent dairy feed and should be used in dairy rations in about the same amount as corn. They contain twice as much mineral matter and more protein than corn and thus tend to counteract these two deficiencies of corn. They

are quite variable in their feeding value, depending upon their weight. The hulls of the oats comprise about 30 percent of their weight. For best results oats should be ground before feeding, but as in the case of corn, if the cost of grinding exceeds the increased value of the oats it is not profitable. Home grinding largely solves this problem. Men who operate the grinders and farmers commonly want to grind the oats to a very fine state, even nearly to a flour. This is not necessary nor desirable, for coarsely ground oats are generally preferable. Also oats can be coarsely ground two or three times as rapidly as when reduced to a fine state. The grinding charge for oats in different mills in Iowa is known to vary from 8 to 20 cents per hundred pounds. Dairy-men who hire their oats ground should ask for coarse grinding and should demand that the cost be lowered accordingly.

**Oat Feed.** Oat feed properly is a roughage and must be considered as such. It is discussed here because it is a purchased feed, a product of oats, and is generally thought of in connection with oats.

In the manufacture of food products from oats, the small light weight grains are screened out and sold as a constituent of oat feed. Oat hulls are also obtained in the processes. Large quantities of them are used in the oat feed. Oat hulls are very high in their content of fiber and low in protein. These facts are revealed in table II. Their feeding value is less than oat straw. They are often used in reasonable quantities in some of the better mixed feeds. When used in excessive amounts in a feed, their presence will be revealed by the high fiber content. Oat feed generally contains so little protein and so much fiber as to make its purchase unwise. Unfortunately, some unvary buyers purchase it at from \$35.00 a ton up to a higher figure. A discussion on page 12 deals with this question.

**WHEAT.** Wheat is grown primarily for human consumption. Only the spoiled or damaged wheat is available for livestock feeding, but its feeding value is as great as the good quality grain. It is a carbohydrate feed indicated by its high starch content. It has more protein than corn and is slightly superior as a source of minerals. The chief difference between wheat and corn is in the amount of fat contained, wheat having less than half as much. On the whole, wheat and corn may be interchanged in the ration for cows, their feeding values being about equal. Wheat should be fed coarsely ground or rolled where possible. It must be mixed with some bulky feed to prevent the formation of a doughy, indigestible mass.

**Wheat Bran.** Bran is an excellent feed for dairy cows because it is palatable and bulky, has a desirable laxative effect, and is the best source of phosphorus. When a cow's grain ration contains at least one-fifth bran, cottonseed meal or linseed meal, her demands for phosphorus will have been met. Bran is more nearly comparable to oats than to any other common feed. Its protein content varies considerably but the bran available in Iowa usually has somewhat above 14 percent protein. This is slightly higher than oats but bran must not be looked upon as a source of protein to balance homegrown rations. The addition of bran to a ration will not materially change the nutritive ratio, but it will make nearly all rations better.

The limitation of bran is its cost. It is often more expensive in Iowa than oats. If, however, a dairyman finds it necessary to purchase oats or bran, he should watch the market carefully and often may buy bran at the proper season for less than \$25.00. If oats and bran are the same price per ton, bran is preferable. If there is \$4.00 or \$5.00 difference and if plenty of oats are on hand, bran will not be economical except possibly in very small amounts. Some bran should be available

on dairy farms to furnish a bran mash to freshening cows or cows that may be slightly off feed. It is very desirable for cows a few days before they freshen and after their allowance of corn has been reduced. It is unexcelled as a warm mash for cows immediately following freshening.

**Other Wheat Byproducts.** Shorts, middlings and red dog flour are other byproducts from the flour mills. Red dog flour was formerly used quite extensively in dairy rations, but it is not generally available now and is of little consequence any more. Shorts are sometimes spoken of as standard middlings, and middlings as flour wheat middlings. Neither the shorts nor middlings is so desirable as bran in dairy rations. They are decidedly lacking in bulk and thus lack one of the essentials of a good dairy ration. However, many Iowa dairymen have these feeds on their farms for use with hogs. If properly mixed with oats and corn-and-cob meal they may be satisfactorily fed in reasonable amounts.

**BARLEY.** Barley is not of such importance on Iowa farms as it is in other states where corn growing is less general. However, some Iowa dairymen have it and it is nearly as valuable as corn in dairy rations. It should be thought of as a substitute for corn and not for oats in dairy rations. It is higher than corn in its protein and fiber content but lower in carbohydrates and especially in fat. For fattening purposes it is inferior to corn. It should be realized that barley generally brings a much better market price than corn. When such situations exist the barley may be sold as a cash crop and corn purchased. Barley should be crushed or ground before feeding. Rolled barley is especially well liked, but facilities for rolling are rarely available.

**RYE.** Rye is less commonly used in Iowa than is barley. It has about the same composition as wheat but is not so desirable as a dairy cow feed. It is not palatable for dairy cows and in feeding value it takes very low rank among the cereals.

**BUCKWHEAT AND ITS BYPRODUCTS.** Buckwheat and its byproducts are not generally used in feeding. Sometimes buckwheat middlings are offered for sale in Iowa. They may contain up to 30 percent of protein and only 5 percent of fiber. In limited quantity and when used with corn and oats they will make a satisfactory high protein feed. The buckwheat hulls are often mixed with the middlings to make buckwheat bran or feed. This material is worth less than wheat bran.

**SOYBEANS.** The acreage of soybeans grown in Iowa has increased enormously during the past five years. By growing soybeans, Iowa farmers may secure a very satisfactory high protein feed and thus produce on their own farms all feeds needed in dairy rations. The chief commercial use of soybeans is for the extraction of their oil. This industry has not been especially developed in this state. Soybeans grown in Iowa contain about 16 percent of fat, or oil, and 33 percent of protein. The southern grown soybeans have more fat and less protein, thus making them more valuable commercially but less valuable for feeding.

Extensive experience indicates that soybeans are as valuable, pound for pound, as linseed meal. They have been found to be somewhat unpalatable to steers after the steers were on feed for 80 or 90 days. At the College Dairy Farm they were fed for 100 days in amounts up to 4 pounds daily. These amounts were unusually high, but the cows ate their feed as readily at the end of the 100 days as they did at the beginning. They never showed any hesitancy about taking them. Of course it is possible that certain other cows might have found the soy-

beans unpalatable. The high oil content of the beans is said by some to cause undue laxativeness and scouring. No such results could be noted with these cows.

Some creamerymen have discouraged the use of the beans, claiming they caused a poor flavor and texture in the butter. In the trial reported above, experienced butter judges were unable to detect any poor texture or off flavor in the butter either when fresh or after storage for more than 30 days. It must be realized that the other feeds these cows received may have been such as to counteract any undesirable effect of the soybeans. Dairy men will do well to produce cream that meets the approval of the creamerymen, but these results indicate that serious consequences in the butter are unlikely when the soybeans are used. This seems especially true when the concentrate mixture is to consist of about one-tenth soybeans such as would be advisable when legume hay is used.

After the soybeans are threshed they may be put directly into the bins. They are not likely to heat and become rancid unless the moisture in them is very high. A safer procedure would be to store them in sacks. They should be coarsely cracked before feeding and only such quantities should be cracked as will be fed in a short time, or the beans may be mixed with corn and oats before cracking. If too many cracked beans are stored for long periods, they will become rancid.

**Cull Soybeans.** Very often the price of soybean seed is such as to make their use for feeding unwise. Before they are seeded or sold for seed they should be run thru a fanning mill. This separates out the immature, shriveled and lightweight seeds. It also separates the cracked and broken seed. These cull beans have been used at the College Dairy Farm with as good results as were secured with the better beans.

**Soybean Oil Meal.** The residue left after the extraction of oil from soybeans is soybean oilmeal. This product contains about the same amount of protein as does choice cottonseed meal, but somewhat less fiber. It is a better feed for cows than cottonseed meal and is equal to linseed meal. The method used in extracting the oil has some influence upon its palatability but with either method cows eat it readily. Experience at the College Dairy Farm indicates that it is the most palatable feed used there.

**FLAXSEED.** Flaxseed is grown as a cash crop to be used as a source of linseed oil. It is generally too expensive to use in herd rations. Men who feed official test cows often use flaxseed meal. Flaxseed has found favor in calf feeding. It should be ground before being used. There have been instances where flaxseed was poisonous to cattle. The poison is developed thru enzyme action in the feed. It appears that the plan of using boiling water to make a gruel and keeping the material hot for two hours destroys the enzyme.

**Linseed Meal.** Linseed meal is also known by other terms such as oilmeal or linseed oilmeal. After the oil is extracted from the flaxseed, the residue is linseed cake. This is ground to form linseed meal. It is one of the best protein feeds for dairy cattle, palatable, laxative, and when used in proper amounts, causes a good, sleek, pliable hide so much desired in a cow. It is especially valuable for animals that are being fitted for show or sale. Also, tho not looked upon as especially adapted for fattening, it makes an excellent supplement to corn for this purpose.

There are two kinds of linseed meal—old process and new process. These terms are derived from the particular process employed in ex-



tracting the oil. The old process is more common in the United States. The two kinds of linseed meal are of about equal value but the old process is generally preferred. It has about 34 percent protein and over 7 percent fat. The new process has 37 percent protein and less than 3 percent fat. The reason the old process linseed meal is preferred is that while it contains less protein its protein is more digestible. Also it is more palatable and its laxative effect is more pronounced. Figure 3, page 11, gives the guaranteed analysis on a sack of linseed meal. Linseed meal is one of few feeds in which the protein content cannot be employed as a definite criterion of feeding value. This feed possesses advantages not measurable by chemical analysis. Unfortunately, however, it often commands prices that are exorbitant and out of reason.

**COTTONSEED.** In sections of the South cottonseed is sometimes fed to cows. The practice is not so common as it formerly was because of the value of the cottonseed for oil extraction and because cottonseed meal gives better results in feeding.

**Cottonseed Hulls.** In the extraction of oil from cottonseed the hulls are generally separated first. No substance offered for sale as a feed has a lower value than cottonseed hulls. As shown in table II, they contain nearly 44 percent fiber and 4.6 percent protein. Because of the enormous percentage of hulls the protein is almost entirely indigestible. The cottonseed hulls are generally used as fillers for other feeds. They are sometimes mixed with cottonseed meal and marketed as cottonseed feed.

**Cottonseed Feed.** As indicated in the discussion of feed laws, page 10, cottonseed feed has a value less than half that of choice cottonseed meal. It is often sold at a figure only a few dollars cheaper than the cottonseed meal. The unwary buyer may easily make serious mistakes. The composition of the feed will be revealed on the label. In purchasing feeds such as this the label should be studied. Feeds other than cottonseed feed will be most desirable in Iowa.

**Cottonseed Meal.** Cottonseed meal is classed according to its protein content into: choice—containing more than 41 percent; prime—containing from 38.6 to 41 percent, and good—containing from 36 to 38.6 percent. The product containing less than 36 percent protein is cottonseed feed. Instead of using these terms the meal is often described as a 43 percent cottonseed meal or with other figures as the case may be. It should always be bought on a basis of its protein content. Cottonseed meal is one of the richest sources of protein available. Frequently it constitutes the most economical supply of protein for use in balancing homegrown rations. In spite of its abundance of protein and its lower price it is not an entirely safe feed and must be used advisedly. It is often not palatable and it has a constipating effect. At times it will cause congestion in udders.

When injudiciously used, cottonseed meal may be poisonous to cows. This poisoning manifests itself in a failure to eat, a staggering gait or even blindness. Death will frequently ensue. Pregnant cows may abort. The exact cause of the poisoning has not been determined though numerous attempts in this direction have been made. Also various antidotes have been tried with varying success. Within very recent months some effort has been made to detoxicate the cottonseed meal. These efforts have not proved entirely successful. The meal is likely to develop mold in storage. This moldy meal is more dangerous than the fresh.

The best experience indicates that cottonseed meal may be used in

amounts up to 2 pounds a day. If more than this amount of protein feed is needed by a cow, a mixture of equal parts of cottonseed meal and linseed meal or soybeans is preferable. The cottonseed meal is less likely to cause trouble if the cows are on pasture. This seems to explain the more satisfactory use of the feed in the South. There the pasture seasons are longer and large quantities of the meal are used. For feeding while on pasture it has one advantage in that it tends to produce a firmer milk fat that gives the butter a better texture. Cottonseed meal should never be used when there is no silage in the ration. With silage present its laxative effect will tend to offset the constipating effect of the meal. It should also be avoided when the roughage used is not especially palatable nor laxative. It should not be fed to cows that are advanced in pregnancy. Neither should it be used in calf rations because young growing animals are more susceptible to the unfavorable effects of the cottonseed meal.

With many limitations placed upon this feed there appears to be little opportunity for its use. Any dairyman prefers linseed meal when the prices for the two feeds are the same. Most men would still prefer the linseed meal even tho its price is 10 or 15 percent above the cottonseed meal. They are undoubtedly correct in their valuation even tho the cottonseed meal is a more economical source of protein. When the difference in price exceeds 10 or 15 percent the cottonseed meal may be used under the cautions that have been prescribed.

**Cold-Pressed Cottonseed Cake.** Another product closely allied with those just discussed is cottonseed cake. Sometimes when oil is extracted from cottonseed, the hulls are not previously removed. This leaves a product containing the original amount of hulls amounting to nearly 40 percent. The value of this feed is lower than that of the cottonseed meal but higher than that of cottonseed feed.

**COCOANUT MEAL.** Another name for cocoanut meal is copra meal. It is the residue obtained in the extraction of the oil from coconuts. It varies widely in composition and sometimes contains excessive fiber due to the presence of too much of the cocoanut shells. Its protein is less than that of gluten feed averaging 20 to 22 percent. It contains up to 3 percent of oil and its chief disadvantage lies in its likelihood of becoming rancid. It is a very good feed for dairy cows and has found great favor on the Pacific coast where it is more available. It generally sells for little more than bran. If cocoanut meal can be properly stored in sacks and can be used up during the winter season it is satisfactory.

**MOLASSES.** Molasses for livestock feeding is obtained from cane and from beets. Beet molasses is somewhat bitter and difficulty is encountered in trying to get cows to eat it. It also has a purgative action. Cane or blackstrap molasses is a very good carbohydrate feed that will improve most all rations. However, it must not be thought of as a feed to replace corn, oats or high protein feeds. It is not suitable for this purpose because it contains only 60 to 65 percent of the feeding value of corn. Its low content of nutrients makes it uneconomical from this standpoint.

The freight charge on cane molasses makes it very costly. Its use in large quantities is not recommended. In feeding it, the best plan is to add a pint of molasses, which is about  $1\frac{1}{2}$  pounds to 3 or 4 quarts of hot water and then mix this with the grain or pour it over the feed in the manger. This scheme will often induce cows to clean up coarse roughage that would otherwise be wasted. For a cow out of condition, an allowance of 1 or 2 pounds of molasses daily will loosen her bowels and put her hair and hide in good order more

quickly than will any other feed. Many feeders who have used molasses endorse it because it causes the cows to drink more water. Every evidence indicates that great water consumption is beneficial.

**PROPRIETARY FEEDS.** In the United States about 600 companies manufacture a great number of proprietary feeds. Fortunately Iowa is so situated as to be able to produce practically all feeds needed by her dairy herds and the purchase of large quantities of these feeds is not necessary. However, some dairymen must buy feeds. These proprietary feeds can be used when their price is not out of proportion to their value. Some excellent proprietary feeds are on the market. Feed A of table II is one of them and its analysis indicates its value. The determining factor in the purchase of these feeds is their cost. They are necessarily expensive because of the charges for advertising and getting them to the farmers.

Certain other proprietary feeds are manufactured as a means of disposing of waste products with very low value. Iowa dairymen cannot afford to use such feeds.

**Open Formulae Feeds.** Some proprietary feeds are manufactured under secret formulae. The feed laws exempt these feeds from carrying on the labels the amounts of the different ingredients in the mixture. Of course the kinds of ingredients used and the minimum amounts of protein, carbohydrates and fats and the maximum amount of fiber must be stated. But unscrupulous manufacturers may employ various substances to hold up the protein content of their feed. Some of these substances may be of very little or no feeding value.

Recently there has been a growing popularity for so-called open formula feeds. These open formula feeds are not manufactured under any secret process. On each bag of such feed is a list of all the ingredients and their amounts used in the mixture. This is in addition to the guaranteed analysis as required by law. The chief value in the open formula feeds is that the prospective customer is supplied information as to what he is buying. Of course the authenticity of such information depends upon the integrity of the manufacturer.

**Molasses Feeds.** Sharp distinction must be made between molasses sold in barrels and molasses feeds sold in sacks. Molasses feeds are often manufactured with a view to getting rid of low grade products such as alfalfa straw, oat hulls, and peanut hulls. Mixed into the feed are other substances such as cottonseed meal, screenings, mill refuse, or even leather or feathers, to maintain the protein content. The molasses makes the feed palatable. Most Iowa dairymen grow all the carbohydrates they need. They can purchase protein in other forms more cheaply than in molasses feeds.

**Stock Tonics.** A vast number of stock tonics are available on the markets. They are extensively advertised and are said by the manufacturers to possess enormous virtue in curing ailments of dairy cows. They are sold as cures and preventatives for infectious abortion, garget, reduced vitality, retained placenta and hard milkers. They are largely useless except for the purgatives they contain which are seldom harmful. Among their ingredients are aromatic substances such as fenugreek, anise seed or ginger. These cause the cows to eat the tonics readily. Stock tonics should not be purchased. If a cow is healthy she needs no medicaments. If she is sick she needs specific treatment by effective methods.

**Commercial Mineral Mixtures.** Owing to widespread interest in the use of minerals in livestock feeding, many commercial mixtures are available. Most of the companies which manufacture these mix-

tures have exploited and exaggerated the mineral question. These mixtures generally possess a wide assortment of components, some of which are valuable, others largely useless. It is quite definitely proved that in addition to common salt, cows have no need for mineral elements other than calcium and phosphorus. Iodine, which is a frequent constituent of mineral mixtures, may be needed under certain conditions. A dairyman need not expend money for a great many of the ingredients contained in these mixtures such as laxatives, charcoal or sulphur. The single ingredients or the simple mixtures as suggested on page 47 are almost invariably cheaper and are just as effective.

Claims are made for some of the mixtures that they possess curative properties for most of the ailments that affect cows. In the majority of cases such claims are incorrect.

## CHARACTERISTICS OF A GOOD DAIRY RATION

To obtain satisfactory results in feeding dairy cattle some knowledge of the fundamental needs of the cows is the first essential. In addition to this the dairyman must have some familiarity with the different feeds. The next consideration relates to the selection of those feeds that will provide the most satisfactory ration. Certain characteristics must be possessed by a good dairy ration. In the discussion that follows no effort will be made to present these characteristics in order of their relative importance except that economy comes first.

### Economy

Economy is one characteristic of a dairy ration that easily ranks first. Most men feed and milk cows for the profit in these operations. Feed costs represent 50 to 60 percent of the total costs of milk production. Economy in the ration is essential. It must be emphasized again, however, that a scant inefficient ration is not an economical one. The first prerequisite of an economical ration is that it be of such an amount as will enable the cows to produce abundantly. This amount depends upon each particular cow. Furthermore, the ration must be so selected that the demands of the cow for the different food nutrients are adequately met.

An abundance of homegrown feeds of the proper sort makes for the greatest economy. The man who grows these feeds on his farm and who looks upon his cows as an agency to convert these feeds into a highly edible, very valuable food product has the proper viewpoint toward his work. It is sometimes necessary to supplement these homegrown feeds with purchased feeds that the former may be used most efficiently.

The man who does have to buy feeds must be careful to obtain those materials particularly needed. Few Iowa dairymen need to buy carbohydrates. Protein feeds are their chief concern. The need for additional protein is less serious if legume hays are available.

The high protein feeds are the most economical sources of this nutrient. To compare these feeds as sources of protein it is necessary to know their cost per hundred. Table V, page 54, gives the amount of digestible protein contained in 100 pounds of some common feeds. Dividing the cost of one hundred pounds by the amount of protein in one hundred pounds will furnish the desired information.

## Palatability

The more feed a good cow will eat the more steady, abundant and economical will be her milk production. A palatable ration is the longest step in attaining this end.

Cows show some individual variations in their relish for a particular feed, but in general a feed that is eaten readily by one cow will be eaten by another. Dairymen must note these individual likes and dislikes and must cater to them within reasonable limits. Fortunately, the feeds that are valuable for Iowa dairy rations are extremely palatable to most cows. These are pasture grass, corn silage, alfalfa hay, corn and oats. Some complaint has been heard that certain cows will not eat alfalfa hay. If any dairyman owns such a cow and she cannot be taught in a very short time to eat fair quality alfalfa hay she would better be sold as a nuisance. The same may be said for any cow that might steadily refuse a fair or good quality of silage.

The palatability of feeds varies at different times. Moldy silage is often unpalatable and should not be used in such cases. Hay of different cuttings may vary in palatability and moldy corn or oats will be refused. When these situations arise the only solution is to lower the amounts offered and to try to mask their influence by the use of larger quantities of the more tasty feeds.

## Variety

Sufficient variety is generally provided when there are two kinds of roughage and three kinds of concentrates in the ration. This variety is desired for two reasons. First, it makes a ration more palatable.

The dairy cow in Iowa is kept on a winter ration for six months. The good cows when well fed will eat enormous quantities of feed. Some cows are kept on essentially winter rations the year round. Also they may be so fed for several years. A ration that lacks variety may become exceedingly monotonous and fail to give best results.

Another reason why variety is desirable is that it makes for greater nutritive value in the ration. A ration with variety is not likely to be deficient in vitamins. Also the mineral supply is more likely to be adequate. This is especially true if legume hays, bran and cottonseed meal or linseed meal are furnished. Then again, it has been shown that the amount of digestible protein in a feed is not the sole measure of its nutritive value. Proteins from the corn plant differ in composition from those of the oat plant. Corn protein lacks an essential amino acid that is supplied in oats. When different plants are used in a ration, the likelihood of such deficiencies is reduced or entirely removed.

## Bulk

The digestive tract of the cow is large and roomy and especially adapted to use bulky feeds. The contrast between the hog and the cow in this respect is apparent. It is necessary that the cow have bulky feeds. Cows generally secure considerable quantities of roughages which supply most of the necessary bulk. It is essential, however, that the concentrates be not too heavy. Oats, bran, dried beet pulp, corn-and-cob meal and such feeds are valuable because they lighten the ration. Finely ground corn, shorts and the high protein feeds must be mixed with more bulky substances. Successful dairymen like to mix the grain with the silage. This procedure lightens the mixture and it is thought to increase the utilization of the concentrates.

## Succulence

That succulence is desirable in a dairy ration has been emphasized previously. Succulence is secured thru the roughages. In dairy cattle feeding, pasture is the pre-eminent succulence. This is not always available, so that soiling crops or silage should be utilized as a substitute for pasture. For winter feeding the choice will generally fall upon silage. Roots and wet beet pulp may also be used.

## Balance of Nutrients

Not only should the supply of nutrients—protein, carbohydrate, fat, mineral matter—in a ration be abundant, but they must be in proper proportion for best results. The proportions and amounts of the first three of these nutrients are especially considered in balancing rations. On page 52 is given the procedure to employ in the careful balancing of rations for dairy cows. Very few men have the time nor inclination to indulge in this procedure. But they might profitably do so with some of their cows for the lessons to be learned and if members of a cow testing association, they may well expect their tester to perform some such work for them. After all the successful feeder of dairy cows does not have to balance rations in the sense generally implied in the term. He learns how to feed by experience and diligence. A combination of all of these schemes is excellent.

Proteins are essential for certain body activities such as growth, the repair of tissues and milk production. No other nutrient can replace protein in some of its functions; thus it must be supplied in adequate quantity. When proteins are fed to excess they may be used for the production of energy and body fat. But they are too costly to be used for these purposes, carbohydrates and fats being far cheaper and just as effective. A dairy cow requires relatively more protein than does any other farm animal. The greater her production the greater is her need for protein.

**Nutritive Ratio.** The ratio between the digestible protein in a ration and the sum of the digestible carbohydrates plus  $2\frac{1}{4}$  times the digestible fat is the nutritive ratio. The reason the digestible fat is multiplied by  $2\frac{1}{4}$  is explained on page 9.

The nutritive ratio that has been found most satisfactory in dairy cow rations is one in which there is one part of digestible protein to 6 or 7 parts of the digestible carbohydrates plus  $2\frac{1}{4}$  times the digestible fat. These ratios are expressed as 1:6 or 1:7. A more narrow ratio, such as 1:4, will often stimulate a cow to greater production because of the increased proportion of protein. However, such a ratio is often uneconomical. Also it may lead to breeding troubles or other disorders in cows that could be avoided with wider nutritive ratios. Beef cattle rations do not contain so much protein as do those for dairy cows. A ration with a nutritive ratio as wide as 1:3, or wider, is generally too wide for dairy cows. It generally means that too little protein is being fed, thereby lowering production. Or a 1:3 ratio may mean sufficient protein and an excess of carbohydrates and fat. These carbohydrates and fats are then used for fleshing-up the cow. Undue fleshing is generally undesirable in dairy cow feeding.

## Desirable Effect Upon the Digestive System

Feeds that might have a beneficial effect upon the cow have been mentioned previously. Succulent feeds are notably beneficial. They

whet the appetite and are laxative. They improve the hide and hair and the general health and vigor. Other feeds that are valuable in this direction are linseed meal, bran and molasses.

Among those feeds that must be used with caution is cottonseed meal. It is astringent in nature and may be poisonous. Any feeds that are moldy or spoiled are likely to be somewhat injurious. The possible danger of sweet clover poisoning has been mentioned. Frosted or otherwise stunted cane pasture may be fatal. Pasturing sweet clover, alfalfa or rape may cause bloat. This tendency to bloat varies in different herds and in different localities. When the use of questionable feeds is imperative, they must be reduced in amounts or mixed with other feeds that will counteract their undesirable influence.

### Desirable Effect Upon the Milk

Certain feeds influence the flavor and odor of milk and the texture of the butter made from it. Undesirable effects must be avoided. For a few days after cows are turned onto luxuriant pastures the milk probably will have a changed flavor from that while on winter rations. Soiling crops exert a similar effect. Rape is especially questionable in this regard. Many dairymen make this criticism of sweet clover pasture. The changed flavor of the milk can be described as a "cowey" flavor. It is disagreeable to milk patrons and often provokes complaint. The precaution here is to change slowly to these feeds so that patrons gradually become accustomed to the changed flavor. Onions, wild garlic and ragweed in a pasture may make it impossible to use the milk. These weeds have to be controlled by discing, re-seeding and mowing the pastures. Rutabagas, turnips and silage may flavor the milk. It is often recommended that these feeds be given after the milking is done. Then their effects are generally removed before the next milking.

Soybeans have been criticised for the tendency they may have to produce a soft salvy butter. Linseed meal and gluten products may have the same effect. Cottonseed meal has the opposite influence. It is seldom that any of these undesirable effects are so pronounced as to make the use of the particular feed unwise. Yet the tendencies must be recognized and sufficient precaution used to avoid serious consequences.

### SUMMER FEEDING

Attention has been called at various times to the ease with which abundant and economical milk flow is secured during the early summer when cows are on good pasture. Eckles of the Minnesota Experiment Station has enumerated the reasons for this situation as follows:

- |                          |                              |
|--------------------------|------------------------------|
| 1. An abundance of feed. | 4. A balanced ration.        |
| 2. Palatable feed.       | 5. Moderate temperatures.    |
| 3. A succulent ration.   | 6. Comfortable surroundings. |

In this section of Iowa the usual season of good pastures is from the first of May until the first of July. The time varies greatly with the climatic conditions. Also the pastures on certain farms are far superior to others because of the cultural and management methods employed. The use of sweet clover pasture is popular because it prolongs this season of good pasture thru the hot dry months.

When cows are turned to pasture the grain feeding should be continued for 10 days or two weeks. Thereafter the use of grain will depend upon the condition of the cow and upon her production. Omitting grain feeding where advisable has much in its favor. It reduces feed costs and gives the cows a much deserved rest. However, under no circumstances must the cow be permitted to lose weight so badly as to become emaciated. Her condition will largely determine the amount of grain she should have.

Jerseys and Guernseys in good working condition probably will not justify the use of grain if producing less than 20 pounds daily. If they produce from 20 to 30 pounds daily they should have 1 pound of grain for 5 pounds of milk. Production in excess of 40 pounds necessitates even a higher rate of grain feeding. The point for profitable grain feeding for Holsteins is about 30 pounds of milk per day. Holsteins milking 30 to 40 pounds should have 1 pound of grain for 7 pounds of milk. Those milking from 40 to 50 pounds should have 1 pound for 6 pounds of milk and the higher producers a corresponding rate of grain.

The other breeds are about midway between the Channel Island breeds and the Holsteins in their demands for grain.

It must be remembered that these recommendations apply only for good pasture. If the pasture is short and dry, more grain must be used.

Choosing a satisfactory concentrate mixture is not difficult. The pasture itself is a balanced ration for dairy cows. The grain mixture must likewise be balanced. Oats alone would supply this balanced concentrate and they are satisfactory. Corn alone carries scarcely enough protein. Also corn alone could be criticised for its "heating" influence. This influence is not pronounced, however, and is partly offset by the pasture. A mixture of corn and oats is better than either one used alone. For best results this mixture should be supplemented with a high protein feed. Cottonseed meal and gluten products are especially adapted for this purpose. They are generally cheaper sources of protein and the ill effects of the cottonseed meal are counteracted by the pasture. A mixture consisting of 5 parts by weight of corn, 5 of oats and 1 of the high protein concentrate would be desirable. Modifications of this mixture are entirely possible. Barley may replace the corn, and bran may replace a part or all of the oats. However, the bran if available may be used in the winter ration with greater effectiveness.

Generally during July the hot dry weather comes and continues until late August or early September. To maintain the desirable condition of June is difficult. The bluegrass pastures are of little value, the weather is hot and the flies annoying. Sweet clover pasture has proved helpful at this time. Soiling crops, while they entail much labor, are very effective. They are especially applicable, even for the entire summer season, when the acreage of the farm is limited. Summer silage is likewise valuable. For summer use a silo of small diameter is desirable to prevent excessive spoiling from one feeding to the next.

Unless the short pastures are properly supplemented with other forms of succulence, grain feeding is necessary for all the cows. In this case the feeds to be used and their amounts will be about the same as are employed in winter feeding. The short dried pasture is largely useless. It is unfortunate if the use of these succulent feeds or of grain is not started in ample time. Many dairymen fail to note the drying pastures when the hot dry weather comes. Then the cows suffer. It is nearly impossible to build up their condition and production later if they have been neglected for even a week. The value of



proper care in feeding dairy cows during the summer cannot be measured entirely in the milk production at that time. The better care has a beneficial, lasting effect that continues over into the winter following.

## WINTER FEEDING

The object in winter feeding is to duplicate the advantages of early summer as closely as possible.

The individual cow in the herd is the unit in profitable production and she must be fed and handled as an individual. A very common error is to feed all the cows alike irrespective of their varying abilities. This almost invariably results in underfeeding the good producers and, what is just as unwise, overfeeding the low producers. The individual cow must be studied; her demands noted and these demands met. The greatest agency yet devised for furnishing information about individuals is the cow testing association. Its value lies in the fact that it gives the owner of a dairy herd this information that is necessary for success. The man who is not a member of an association must employ some other plan for the facts upon which he may base his practices.

## KEEP RECORDS TO FEED PROFITABLY

A great deal of discussion and argument centers in the question of the daily weighing of the milk from each cow. Some men insist that the time used in weighing the milk is not profitably spent. Most successful dairymen are convinced that time spent in this way is just as logical, necessary and profitable as a record of transactions in any business. The man who weighs the milk of each cow knows what his individuals are doing. It is impossible to feed economically unless he does know this. Intelligent grain feeding depends upon a cow's production and her condition. The amount of roughages she should have depends upon her capacity. Certain rules in feeding may be helpful, but no rule can take the place of good common sense. Any feeding rule is subject to change when cases demand it.

Some of these rules are:

1. *Feed all the legume hay a cow will eat.* This amount will depend largely upon the individual cow and upon the other feeds she receives. If legume hay is the only roughage fed, the cow will eat nearly 2 pounds of it daily for each 100 pounds of liveweight. If used along with silage she will eat about 1 pound per 100 pounds of liveweight.

2. *Feed all the silage a cow will eat along with the hay.* This will generally amount to about 3 pounds of silage for each 100 pounds of liveweight.

3. *Feed grain in proportion to milk production and the condition of the cow.* For cows in good working order and receiving silage the rule is:

Ayrshires, Brown Swiss, Holsteins—1 pound of grain for each 2½ to 3½ pounds of milk.

Guernseys, Jerseys—1 pound of grain for each 2 to 3 pounds of milk.

The higher rates of grain feeding that are indicated are for use when non-legume hays are being fed. The lower rates apply when legume hay is available.

The concentrate part of a cow's ration must be employed to control her weight. If she goes down below the best working order the concentrates must be increased. If she gets too fat they must be reduced.

It is unnecessary to weigh the concentrates out for each cow at each feeding. The extra time and labor required in doing this are not justified. The practical and sufficiently reliable plan is to know by previous checking on the scales the weight of the grain mixture that the feeding pail will hold. Painted marks on the inside of the pail, which indicate the height of mixture necessary for 4, 6, 8 or 10 pounds are helpful. This scheme is shown on the first page of this circular. With reasonable care and checking, dairymen have been able to attain remarkable accuracy and speed in this scheme for measuring out the proper portions of concentrate.

### SOME SUITABLE MIXTURES

It may be realized that the feeding of dairy cows is not a complicated procedure in which only experts can hope to be successful. Most all farmers can feed cows successfully if they do certain things. First and foremost is the prerequisite that in his own mind each man shall establish a desire to feed properly. Then he must appreciate the necessity of meeting the cow's demands. These demands have been explained. They are entirely reasonable. The next question involves the actual supplying of such feeds as will meet these demands. Specifically, the first step is to furnish legume hays in abundance. Next is the provision of corn silage. If these roughages are provided the choice of concentrates is easily made. If either one of them is lacking the concentrate problem is more serious. If they are both lacking, efficient feeding becomes a task.

The roughages determine the concentrate mixtures that are suitable. Considerable flexibility is possible in devising these mixtures and it is unnecessary here to suggest more than one mixture for each kind of hay. Within quite wide limits modifications may be made to suit the particular conditions that prevail. Some of the chief possibilities and precautions for such modifications are given.

A. A part or all of the cracked corn may be replaced with an equal weight of corn-and-cob meal or of ground barley with nearly equal satisfaction.

B. A part or all of the oats may be replaced with an equal weight of bran.

C. One-third of the corn and one-third of the oats may be replaced with an equal weight of bran or of ground barley.

D. The use of bran will improve the mixture. This is particularly true for those mixtures suggested for non-legume hay. In most cases it will make the ration more costly.

E. A part or all of the cracked soybeans may be replaced with some other high protein feed.

F. In no case should cottonseed meal be used when silage is not available.

G. Even with silage in the ration, care must be exercised if more than two pounds of cottonseed meal are to be fed daily.

H. With the exception as noted in F the same mixture will be used with silage or without silage. In the absence of silage, from 10 to 20 percent more concentrates should be fed.

The concentrate mixtures suggested here are to be fed in amounts as just explained. For an illustration of the lower cost of feeding when legume hay is used, the costs of the concentrate mixtures are given. These costs were established on a basis of the approximate current farm prices which prevailed during the winter of 1927. The prices used were: cracked corn \$1.00 per hundred pounds or 56 cents per

bushel; ground oats \$1.25 per hundred or 40 cents per bushel, and cracked soybeans \$2.50 per hundred or \$1.50 per bushel. The total nutrients in these mixtures as would appear on a feed tag if they were offered for sale are given in table II. The digestible nutrients as required in balancing rations are given in table V.

#### FOR LEGUME HAY AND SILAGE

##### Mixture I

Cracked corn-----	400 pounds
Ground oats -----	400 pounds
Cracked soybeans -----	100 pounds
Cost of mixture, \$25.56 per ton.	

A possible modification of this mixture is to omit the high protein feed entirely and use equal parts of corn and oats. A corn and oats mixture is satisfactory for a daily milk production of less than 25 pounds when legume hay is fed. Then those cows producing more than this should receive in addition  $\frac{1}{2}$  pound of high protein feed for each 5 pounds of milk above 25 pounds.

#### FOR MIXED HAY (CLOVER AND TIMOTHY) AND SILAGE

##### Mixture II

Cracked corn -----	400 pounds
Ground oats -----	400 pounds
Cracked soybeans -----	300 pounds
Cost of mixture, \$30.00 per ton.	

This proportion of high protein feed is three times as great as that needed for the legume hay. Naturally the cost is greater. This is for mixed hay containing about one-third red clover and two-thirds timothy. If the hay consists of two-thirds or more of clover, the proportion of high protein feed in the concentrate mixture may be somewhat reduced, even to 200 pounds, with a consequent saving in cost. If an effort is made to cheapen the ration further by using less of the high protein feed, the ration will become unbalanced because of a deficiency of protein.

#### FOR NON-LEGUME HAY AND SILAGE

##### Mixture III

Cracked corn -----	400 pounds
Ground oats -----	400 pounds
Cracked soybeans -----	400 pounds
Cost of mixture, \$31.66 per ton.	

This proportion of high protein feed is four times as great as that suggested for the mixture with legume hay. The cost is over \$6.00 or nearly 25 percent greater. The temptation is to reduce the proportion of the expensive high protein feed. If this is done the ration fails to meet the demands of the cow and production decreases. The only satisfactory solution to the problem is to use legume hay and thus remove the need for so much of the high protein feed.

This same mixture is for use also when corn fodder or corn stover or straw is being fed instead of or along with the non-legume hay.

### DRY COWS

Every good dairy cow deserves a rest between lactations. Good cows should have a dry period of from 6 to 8 weeks previous to freshening. This dry period permits the cow to restore herself to good

condition and to build up her reserve of body nutrients in preparation for the next freshening and milking period. From all the evidence at hand one of the most effective ways of meeting the problem of mineral nutrition in dairy cows is to give them this rest. The only period during which a cow seems able to recoup the mineral losses from her body that have occurred during previous heavy milking is while she is dry. It is also the only time when her mineral reserve can be built up to meet the demands of the ensuing lactation. It is a quite frequent experience on dairy farms that good three-year-old heifers actually milk less than they did as two-year-olds. A very apparent explanation of this situation is that when the heifers freshened with first calf, as two-year-olds, they were in good condition. Then they milked persistently, the following dry period was short, they freshened with second calf in poor condition and the milk flow suffered.

For from 3 to 8 weeks after calving all good cows lose weight. This is because their milk flow is exceptionally high at this time. Also for the first 3 or 4 weeks, they are not on full feed and are not receiving enough to supply the nutrients for the milk. If they are poor at freshening they become unthrifty and emaciated. They seldom can be built up until more than 6 months have elapsed and the milk flow has decreased.

Two common reasons explain why cows are not given a long enough dry period. The first is that the cow may be milking quite heavily at the time she should be dried off. Drying the cow at this time appears to some dairymen as a waste of milk and income. However, it is proved that the sacrifice of milk at this time will eventually mean a saving. The cow milks far better the next year. Another reason cows are not dried off soon enough is that they may cause difficulty in so doing. It must be remembered that such cows are the ones that need a rest the most. The statement that some certain cow has had four or five calves and has never been dry a day is commendation for the cow, but is little justification for a boast by the owner.

### **To Stop Milking, Stop Feeding**

About 8 or 10 weeks before a good cow is due to freshen, the drying-off should be started. Cows milking 30 pounds or more a day can be dried off in two weeks if properly handled. The grain and even the silage should be withheld. It is well even to stop feeding legume hay and use timothy or straw. This procedure starves the cow. She will do considerable fretting, but the dairyman must not yield. She should be milked irregularly. At first one milking should be skipped. When the decrease in milk becomes evident, more milkings should be skipped. After she gets down to 10 or 12 pounds, milking may be stopped entirely. The udder must be watched at this time, however, for spoiled quarters may develop. More udders are ruined in drying cows up than at any other time. Injury to an udder at this time is inexcusable. After the last milking the udder may fill too much in two or three days and should be relieved, but unless it appears too full or feels hard, the milk will be reabsorbed. A precaution in this connection is to be careful, but not unduly alarmed. Also the udder should not be handled any more than necessary because handling it, especially at a regular feeding and milking time, induces further secretion.

When the udder is dry and in good condition, feeding can be resumed. The plan suggested is a drastic one but drastic action is required with many cows. The cow will probably show the effects of her limited feeding and this treatment must be ended just as early as possible so that it may be overcome in good time.

The feeding of the cow in preparation for freshening is important. If she be on pasture the problem is greatly simplified for the pasture is palatable, nutritious and has a desirable laxative effect.

When the cows are not on pasture, any succulent feed is nearly indispensable in providing the laxativeness so much needed. Roots or wet beet pulp are preferred to silage for the last week before freshening. The succulent feed should be supplemented with a legume hay if possible. The legume hay contains great amounts of protein and minerals, especially calcium. The protein is demanded for the tissues of the fetus and for rebuilding the tissues of the cow. The need for minerals in building up the bony structures of the fetus is apparent. An ample supply of minerals for a dry cow also greatly prolongs and increases her subsequent production.

Except in a few cases, when dry cows are in good flesh, grain must be furnished them in liberal amounts. A good grain mixture for the early part of the fitting period is 2 parts cracked corn, 2 parts ground oats, 2 parts bran and 1 part cracked soybeans. This mixture is satisfactory for cows either on pasture or on winter feed and it may be varied to suit individual conditions. The amount of grain to feed must be left entirely to the judgment of the feeder. Plenty of grain is desirable but overfeeding must be avoided.

While corn is a desirable dairy feed in that it builds up a cow's flesh readily, is palatable and available on nearly all farms, it tends to heat an animal and should be omitted for a week before the calf is due. Oats are very desirable for the dry cow. Bran is looked upon with great favor. Its content of protein is high; it is a good source of minerals, especially phosphorus, and its laxative effect aids in keeping the digestive tract in good physical condition. Cracked soybeans are high in their protein content and are quite laxative. Cottonseed meal should never be used for the cows that are about to freshen, for it tends to constipate them and may affect the calves unfavorably.

About a week before the cow is due her grain allowance should be reduced for she is likely to go off feed easily. For a few feeds immediately before freshening, a wet mash consisting of equal parts of bran, oats and oilmeal is very good. If the weather be cold the use of quite hot water for this mash is recommended. Molasses is especially desirable at this time.

Every effort must be made to keep the cow's bowels loose for this tends to avoid the danger of retained afterbirth and results in a better start on feed after freshening. The slightest tendency to constipation must be avoided. If the feces be at all dry and firm, a dose of one quart of raw linseed oil or of castor oil, or a pound of epsom salts is a desirable safeguard.

Exercise for the dry cow is essential. If the cow is on pasture this exercise is provided. If she is in the barn she should be turned out frequently. The plan of removing the cow from the stanchion to a box stall as early as possible has everything to recommend it because of greater comfort and ease.

## THE FRESH COW

As soon as the calf is born the cow should be given all the warm water she cares to drink. During the first day bran mashes, in addition to plenty of legume hay, make a suitable ration. Thereafter a mixture of bran, ground oats and cracked soybeans is excellent. As long as the cow's udder is congested, corn should be omitted.

Two or three weeks should elapse before the cow is put on full feed. During this time she should not be fed so much that she will refuse any.

On the fourth or fifth day after freshening, the cow will usually be in condition to take 4 or 5 pounds of the regular concentrate mixture used for the herd. The allowance may be increased 1 pound every two or three days until maximum milk production is reached. This is when the milk yield ceases to increase as the concentrates are increased. It will occur in three or four weeks. At the time the cow appears to be getting all the feed she will eat, it is well to reduce the allowance and keep her slightly hungry. She must not be starved, however, for she probably will be losing weight anyhow. The grain must be used to prevent a serious loss in weight. During all this time milk production should be watched carefully. Daily milk weights and care in allotting the concentrates will prevent a great many difficulties that might otherwise occur.

### **The Calf and Growing Heifer**

Circular 91 of the Iowa Agricultural Experiment Station describes in detail the methods to be used in feeding dairy calves and heifers. Raising the calves successfully constitutes a problem on a great many farms. The dairyman who sells whole milk is especially confronted with difficulties. The first essential is to keep the calves healthy. This may be accomplished thru sanitary conditions in the barn and thru proper feeding. The calf that has the correct amount of warm sweet whole milk for three or four weeks and this replaced by skim milk for three or four months should thrive. Overfeeding calves is the most common cause of difficulty.

When the calves are 2 to 3 weeks old they will eat some grain. A mixture consisting of 3 parts by weight of cracked corn, 3 parts ground oats, 3 parts bran and 1 part cracked soybeans has proved successful. In fact some extreme modifications of this are just as desirable. Even shelled corn alone or mixed with whole oats is endorsed by many dairymen. Cottonseed meal should be avoided.

Whether or not young calves should receive alfalfa hay is a disputed question. Some say alfalfa hay will cause scouring. It has been known to do so. It may be used, however, unless the calves show some ill effects. Alsike and red clover have given good results as have timothy and oat hay.

Practical feeders differ as to the use of silage for calves. Most of them feed silage even to the very young calves. At times calves have been found to develop scours when silage was supplied. The fact remains, however, that it is widely used and generally gives satisfaction. At the Iowa station, calves which received silage at six weeks of age were found to do better than those without silage; they grew faster and the cost of gains was lower. In using silage care must be exercised to exclude any frozen or spoiled chunks and to clean the mangers of any refused portions.

After calves are weaned, their care depends somewhat upon whether they were born in the fall or in the spring. In any event they should not be neglected. Between weaning time and first freshening, heifers are often forced to rustle pretty largely for themselves. They are unproductive at this period and the temptation is to give them too little consideration. They must not be pampered; neither must they be stunted. Plenty of roughage is the first essential for these growing heifers. If legume hay is supplied very little concentrates is needed. The use of abundant amounts of roughage of the right kind is known to develop large, vigorous, strong heifers. At times some concentrates are desirable to keep the heifers in good order. Corn and oats are excellent for this purpose. If the roughage is non-leguminous, a high protein concentrate will be necessary.

## THE BULL

Until bulls are 5 or 6 months old they may be kept with the helper calves. Thereafter they should be separated to avoid annoyance to the helpers and to prevent accidental breeding. The feeding of yearling bulls should be about the same as for yearling helpers except that they may receive more grain, but not enough to fatten them excessively. The bulls must be kept in healthy growing condition. For bulls in service, legume hay should comprise most of the ration. Bulls will eat enormous quantities of hay. Silage must be used with care. Most dairymen feel from their own experiences that more than 12 to 15 pounds of silage daily may lead to sluggishness in breeding and may tend to induce sterility. It is entirely permissible to use the same concentrate mixture for the bull as is used for the herd. The amount to use is not subject to any rule. It should be determined by the condition of the bull.

## MINERALS FOR DAIRY COWS

The dairy cow has enormous demands for minerals in her ration. She not only requires them for her own skeleton and other body activities, but she must properly nourish the fetus she carries. Milk production is an enormous drain upon the minerals supplied in the ration or stored in the cow's skeleton.

Many mineral substances are indispensable for animals, but most of these are supplied in the ordinary rations that cows will receive, and they need no further consideration. Five, however, need attention. They are sodium, chlorine, iodine, phosphorus, calcium.

**SODIUM AND CHLORINE.** The reason all animals consume common salt is to get the sodium and chlorine of which salt consists. The need for salt is readily appreciated. A cow will eat from  $\frac{1}{2}$  to 2 ounces daily depending upon her individuality, production and the other feeds she receives. The rule for salt feeding is to give all they will eat. It generally requires about  $\frac{3}{4}$  of an ounce daily per 1,000 pounds live weight to maintain the body. Then the requirement is about  $\frac{1}{2}$  an ounce additional for each 20 pounds of milk. Salt consumption varies quite closely with the amount of milk produced. Dairymen, and especially those who are attempting to get higher records from their cows, believe that greater amounts of salt induce greater feed and water consumption and this leads to higher production.

There are three common methods of salting cows, viz.: to have it before them all the time, to give them access to it at stated intervals and to mix it with the feed. For most herds the first method is desirable. Even a better plan is to combine this method with the third one and mix 1 pound of salt with 100 pounds of concentrates, then let the cows have access to extra salt at will. The second plan is not satisfactory.

The choice between common barrel flake salt, block salt and rock salt is of little significance. For mixing with the grain, flake salt or ground rock salt will be used. For use in a box in the pasture or lot the flake salt is often wasted. Most farmers feel that cattle do not secure enough salt from the block or rock. Experience shows that cows with block salt before them all the time will eat large quantities of flake salt if given an opportunity. This seems to indicate a craving for the additional flake salt.

**FLY SALT.** Fly salt has been widely advertised. The component of the mixture that is said to repel the flies is sulfur. This fly salt with

the sulfur it contains is not very palatable but cows can be induced to eat it by mixing it with the feed. Experience at the College Dairy Farm shows that it does not protect cows against the flies. Some men have complained that the use of the fly salt caused a bad flavor in the milk.

**Iodized Salt.** Iodized salt is discussed in the next section under Iodine.

**IODINE.** In certain areas of the United States, goiter or "big neck" in calves is common. The cause of this is a lack of iodine in the water or feed of the pregnant mother. This lack then gives rise to the enlarged thyroid gland which is the goitrous condition. Lack of iodine also causes goiter in other animals, especially in lambs, and results in hairlessness in pigs and foals. Iowa is not in the severe goiter region of the United States but is classed as semi-goitrous. Very few cases of goiter have been observed in calves in this state. If an iodine deficiency is suspected it can be readily corrected by the administration of iodine to the pregnant dam. This may be easily accomplished thru the use of potassium, sodium or calcium iodide. The first one is more commonly used. Only very minute quantities of the iodide are needed.

To supply the iodide the dairyman has his choice of three methods. One method is to add the iodide to the feed each day. It takes only 1 or 2 grains to be effective. If 1 ounce of potassium iodide is dissolved in 1 gallon of water, 1 tablespoon of the solution contains 2 grains of the iodide. This can be added daily or to save time, 10 to 14 grains may be added once a week.

Another scheme for supplying the iodide is to mix it with a mineral mixture. The use of .04 of a pound, or 15 or 20 grams, of potassium iodide in 100 pounds of the mineral mixture will give the desired results with very little trouble.

Or the iodide may be mixed with the salt in the same way as just suggested for the mineral mixture.

When the iodide is purchased it is possible to have the druggist weigh out a standard amount that would be mixed with each batch of salt or mineral mixture and this can be used as a guide for the later mixings.

**Commercial Iodized Salt.** It is possible to purchase iodized salt that contains the proper amount of iodide. This salt is very expensive, however, and is no better than that which the dairyman can mix himself.

**PHOSPHORUS.** Phosphorus is an indispensable mineral element. It is not so likely to be deficient in dairy rations as is calcium. Fig. 7 gives the amount of calcium and phosphorus found in one ton of some common feeds. Wheat bran is the most abundant source of this element, followed by cottonseed meal, linseed meal and cracked soybeans. It is believed that rations which consist of these feeds to the extent of 20 percent will supply the phosphorus demands of all except the highest producing cows. Legume hays and corn and oats are fair sources of phosphorus, while the non-legume hays are deficient.

Some recent work at the Minnesota station has directed attention to a phosphorus deficiency that exists in certain areas of that state. Upon these areas the cattle were found to be very unthrifty and emaciated. Their breeding ability was greatly impaired, milk production was low and the cows showed decidedly depraved appetites. This depraved appetite was the first abnormality noted in the cattle. They would chew bones, wood, leather, manure and dirt. The ill effects were found chiefly in the better milking cows.

Investigation revealed that the soil of these areas in Minnesota was



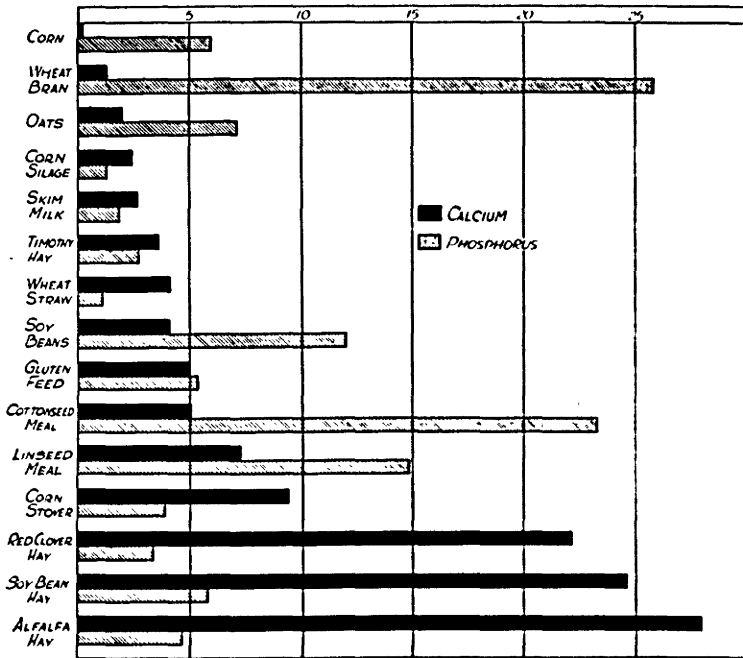


Fig. 7. The calcium and phosphorus contained in one ton of different feeds. The feeds are listed in order of their calcium content.

notably deficient in phosphorus. The crops grown there were likewise deficient. The abnormalities in the cattle were corrected by the use of raw bone meal, a good source of phosphorus.

Conditions similar to these in Minnesota have been noted in Wisconsin and other parts of the world. Similar areas of such pronounced mineral deficiencies in the soil in Iowa have not been observed. Undoubtedly most of the difficulties with dairy cattle encountered in Iowa are not to be attributed to mineral deficiencies but to a lack of sufficient feed or to the existence of infectious abortion. Neither of these shortcomings can be corrected by mineral feeding.

**CALCIUM.** Calcium is more likely to be deficient in dairy rations than is any other mineral element. The chart, fig. 7, lists some common feeds on a basis of the calcium contained in one ton. The apparent fact from this chart is the abundance of calcium in legume hays, its lack in non-legumes and in corn and oats.

Dairy cows have been bred and selected for enormous milk production. Apparently their ability to utilize minerals from the feeds has not kept pace with their improvement in production. It is not unusual for the better producing cows, even when well fed, to show symptoms that are attributed to a lack of calcium. Poor rations often result in identical symptoms with very low producers.

It has been observed that cows often show depraved appetites. This may be due either to phosphorus or calcium deficiencies. Also the better producers, as lactation advances, become poor in condition and

cannot be built up. They often show a tendency to weak, crooked rear legs that cause difficulty in rising and standing. In some cases the cows become irregular in breeding and sterile.

The Wisconsin station found that cows which received timothy hay grown on acid soils and a grain mixture of corn, bran and oil meal were abnormal in breeding and reduced in their milk flow. Such cows often aborted their calves or dropped weak calves that soon died or were raised with difficulty. This nutritional abortion was avoided by the use of 3 percent marl—a high grade calcium carrier—in the grain. Limestone has been found to have the same property of correcting a calcium deficiency.

These abortions were caused by a lack of sufficient calcium to develop a fetus properly. When infectious abortion exists in a herd, mineral supplements will not cure it.

### Meeting the Mineral Problem

The experience of many dairymen is that cows may suffer from a lack of phosphorus or calcium in their rations. While the use of mineral supplements has proved very beneficial with poultry, hogs and steers, the same degree of favorable results has not been secured with dairy cows. Extreme deficiencies have been corrected with phosphorus or calcium compounds, but some investigators believe that cows of moderate production that are being fairly well fed will show no improvement in health nor production thru the use of these elements. Nevertheless, their use will not prove harmful and may be beneficial. Every evidence points toward the fact that legume hays reduce the likelihood of a calcium deficiency. Probably their use with cows producing less than 30 pounds of milk daily will meet the calcium demands. Corn and oats, and especially bran, cottonseed meal and linseed meal will supply the phosphorus needs of such cows. Supplemental mixtures may be required for higher producers and they will do no harm with the lower producers.

It is admitted that it is impossible to prevent some mineral losses with liberal milking cows. The only method of meeting this problem is to give these cows a rest before freshening to recoup their depleted stores and to build up for the next lactation. If the dry period occurs in summer, the ability of the cow to assimilate the minerals of the ration is greater. Pasture grass carries vitamin D. This vitamin enables cows to assimilate the mineral elements. The value of codliver oil lies largely in its content of vitamin D. Also the rays of the sun have the same influence. If a dry cow on pasture also receives supplemental minerals, she is presented every opportunity of a plentiful supply as well as ideal conditions for assimilation.

If under good management and when receiving abundant feeds of the right sort, the cows still fail to do as well as expected, or become unthrifty or show depraved appetites, the dairyman is justified in expecting mineral supplements to be of some value.

### MINERAL SUPPLEMENTS

It is not necessary to purchase a high price complex commercial mineral mixture. More simple mixtures are generally available and if their price is not too great, they are recommended. Also, a dairyman can secure his own ingredients and feed them alone or in mixtures as the case may demand.

**RAW BONE MEAL.** This product is available from the packing houses as raw bone meal for feeding purposes. It is an entirely safe

substance and supplies both calcium and phosphorus. At this station cows showed a preference for the raw bone meal when they were given an opportunity of choosing from six different mineral supplements. They consumed .42 of an ounce daily.

**STEAMED BONE MEAL.** Steamed bone meal is also a packing house byproduct that supplies calcium and phosphorus. Some of this steamed bone meal is a low grade product designed chiefly for fertilizer. It has a very obnoxious odor. While some men say that the odor makes it unpalatable for cows, at this station cows showed especial favor for the odoriferous product and consumed 0.34 of an ounce per head daily.

**SPECIAL STEAMED BONE MEAL.** Special steamed bone meal is especially refined for livestock feeding. It possesses no odor but in the trials just referred to the cows ate only 0.04 of an ounce per day, or one-eighth as much as of the steamed bone meal.

**BONE BLACK.** Bone black is secured from sugar and oil refineries. These establishments use the bone black for decolorizing purposes but after its value for these purposes is exhausted, it is offered for cheap sale.

The bone black is a source of calcium and phosphorus. Cattle will not eat it unless it is mixed with other materials.

**WOOD ASHES.** Wood ashes have been used with success as a source of calcium. They contain various other elements including small amounts of phosphorus. It appears that they would better be used along with other mineral supplements.

**LIMESTONE.** Limestone is a source of calcium. The high grade limestone is preferred. Sometimes limestone which may be satisfactory for use on the soil contains too much magnesium carbonate for livestock feeding. Limestone is not palatable to cows and it must be mixed in the feed or preferably with the salt.

All of these mineral supplements which the cows will eat may be fed alone in a box in the pasture or lot. Or they, as well as those which cows would refuse, may be mixed with salt or with the feed. For mixing with the feed, 2 or 3 pounds of the bone meal or 4 or 5 pounds of the bone black, wood ashes or limestone may be added to 100 pounds of the concentrates. Mixing the supplements with salt generally works out best in practice. If they are mixed with the grain some cows may not receive grain at certain seasons and these cows have to depend upon some other scheme for getting the supplements.

#### **Some Homemade Mixtures**

The use of the bone meals usually will prove most satisfactory. To secure ample consumption a mixture with salt is desirable. Such a mixture may consist of 2 parts bone meal and 1 part salt.

The bone meals are fairly expensive and bone black can take their place. A mixture of 1 part bone meal, 1 part bone black and 1 part salt, or of 2 parts bone black and 1 part salt will give satisfaction. Under certain conditions where cows are receiving relatively more grain than they are legume hay, very little additional phosphorus will be needed. Here, the bone meals, carrying both phosphorus and calcium, can be replaced in whole or in part with calcium carriers such as limestone or wood ashes.

A mixture which will supply some phosphorus and considerable calcium may be made of 1 part bone meal or bone black, 1 part limestone or wood ashes and 1 part salt. When limestone is readily available and the bone meals are not so convenient, a mixture of 3 parts limestone and 1 part salt may be used.

To all of these mixtures some iodide may be added as previously suggested.

### **Some Things Minerals Will Not Do**

The entire mineral problem has been greatly exploited by some commercial salesmen until dairymen have been led to expect miraculous results from the use of some of the products.

Minerals will not cure infectious abortion. It must be recognized that a cow may be so starved for calcium and phosphorus as to abort her calf. Mineral supplements would correct this but such cases are very rare in Iowa. At least they have not been noted and attributed to this cause.

The use of minerals will not help improve the vigor and production of a cow that is not getting enough feed. Plenty of corn and oats, even with their limitations, is a greater need in Iowa than any mineral substance yet discovered.

### **FEEDING FOR A HIGHER BUTTERFAT TEST**

For many years dairymen and investigators have considered seriously the possibility of increasing the butterfat test in cow's milk by the use of certain feeds. Various feeds have been suggested as possessed of the property to induce this increase.

It must be understood that a cow has an inherent characteristic for a certain percentage of butterfat in her milk. No feeds have yet been discovered that can permanently affect this percentage without inducing other physiological changes that may be undesirable.

It is possible to exert a temporary influence upon the test of cow's milk. One scheme that is entirely proper and is employed by all good dairymen, at least indirectly, is the one brought about by physiological underfeeding. Before a cow freshens she should be put in quite high body condition. The reasons for this have been given previously. During the time for a few weeks after freshening when a good cow is undergoing the usual loss of body weight, she is receiving less feed than is required for the milk she is producing. This condition is known as "physiological underfeeding." In this situation a cow's milk tests unusually high. It is not unusual for the butterfat tests to be twice as high for some milkings during this time as it normally is. Men who feed cows for seven-day records take advantage of this period for securing a high test.

This is the only time known when liberal feeding affects the test and in this case it is an indirect effect. The liberal feeding is practiced at one time and the effect manifests itself from one week to two months later.

Another scheme for increasing the fat test is to use certain feeds. However, no feed has been found that will invariably exert this effect nor induce an increase for more than two or three days. Flax meal, or ground flax, is thought of first in this connection. It contains a large percentage of fat, or oil—about 30 percent. Its use generally results in an increased test which will continue for two or three days. The milk yield may not be effected. Sometimes the test will be decreased. Peanuts, sunflower seed and soybeans have a similar effect. The oil from these seeds when fed to cows may also bring about a change for a short time.

Several high protein feeds such as cottonseed meal have been studied with a view to determining their possible influence in this direction. Experience shows that they cannot be relied upon. Their use in exces-

sive amounts will result, especially with cottonseed meal, in physiological disturbances that are abnormal. Most all abnormal, diseased or feverish conditions cause a higher testing milk, but the milk flow usually decreases. Then the total yield of fat may remain unchanged and there remains no object in attempting such a scheme.

## **WATER**

Studies at the Iowa Agricultural Experiment Station show that cows require about 4 pounds of drinking water for every pound of milk they produce. This is in addition to the water contained in the pasture, silage and other feeds. Most good dairymen make every effort to induce a large water consumption. The essentials in supplying water are that it shall be abundant, fresh and pure.

The use of individual drinking cups attains this end more effectively than any other method. A continuous cement manger is used in some herds. This scheme entails a great deal of labor and some risk of communicating disease. Turning cows out to a tank twice a day gives them exercise. The unfortunate feature about this is the crowding at the tank and the failure of some cows to get enough water. Also the water may not be sufficiently heated and the tank may be so exposed to the weather as to keep the cows from drinking enough. Again when cows are turned out of a fairly warm, poorly ventilated barn, they are particularly susceptible to chill. However, the method of watering is of little significance provided the method that is used is effective in meeting the needs of the cow.

## **GENERAL CONSIDERATIONS IN DAIRY FEEDING**

### **Order of Feeding**

The order of feeding is not so important as regularity. If a certain procedure at feeding and milking time is usually employed, this same procedure should always be used. Cows become accustomed to a routine. Disturbances in this routine react unfavorably upon them. Generally the grain is fed at milking time. This is thought to stimulate a larger flow of milk. Also most dairymen prefer to feed the grain on the silage or mixed with it. From a nutritional standpoint this is excellent practice. It does usually mean that the silage is given the cows before the milking starts. Some men insist that the feeding of the silage fills the barn with odors that taint the milk but in most cases this objection is not valid. A few succulent feeds such as rutabagas and rape will taint the milk. They should be fed after milking. Rape pasture or pasture with wild onions, garlic or ragweed also give the milk an offensive flavor. In these latter cases cows must be taken off the pasture two or three hours before milking time.

It is preferable for hay to be fed last and after the milking is done. This prevents contamination of the milk with dust. It also gives the cows time to eat their hay deliberately. They will then consume more of it. There is no particular objection in feeding all the hay at one feed and all the silage at another, but to divide these feeds and feed one-half at each milking is preferable.

### **Method of Feeding**

The concentrates should be mixed in bulk and stored in a bin convenient for feeding. A cart or overhead carrier can then be used down in front of the mangers as shown on the cover page. If the herd is



Fig. 8. The dairyman should have his own mill. This shows an Iowa dairyman grinding his corn and oats. To these he is ready to add the other concentrates that may be necessary.

small and one man feeds all the time, this man will know how much grain to give each cow. In other cases, cards over the stanchions should show in pounds how much grain each cow needs according to her production. A marked feed pail with lines for 2, 4, 6 or 8 pounds makes for care and accuracy.

For silage feeding a cart or carrier should be provided. The plan of carrying silage in a basket is burdensome, tho sometimes necessary. While the cows should have all the silage they will eat, it is well to weigh it occasionally to determine about how much is being fed.

Hay chutes should be convenient. If the barn is arranged so that the hay may be pushed instead of carried the feeding is easier. There is little choice between baled hay and loose hay in ease of handling. Baled hay has some advantages. However, the flakes of baled hay must be shaken out before being put into the manger. This requires some time and is often neglected. Then the cows grab the bunches and often throw them out of the manger.

As with silage, the cows should have all the hay they want. However, occasionally weighing hay to determine how much is being fed each cow is desirable. An accurate check on hay weights is difficult but if a certain sized fork full is put into a sack and weighed, a good guide is established.

### Preparation of Feeds

To justify the preparation or treatment of feed by any process, the feed must be improved sufficiently to compensate for the cost of the

treatment. The different processes are designed to increase the digestibility of the feed, or to increase its palatability, or to reduce it so such a condition as will allow the mixing of a less palatable feed with a more palatable one so that the former will be eaten by the animals.

**GRINDING GRAIN.** The grinding of grain is practiced in the belief that ground grains are more effectively digested by animals. This is especially true when grains are so small and hard that they are not completely masticated. While advantages of grinding corn and oats for dairy cows are not so great as is often supposed, these ground grains are probably 10 percent more valuable than the shelled corn or whole oats. Best practice demands that grains should be ground for dairy cows. Yet there is no object in grinding if the cost of the process is greater than the increased value that accrues. The dairyman who is equipped to do his own grinding is fortunate. Those who haul corn and oats to a mill and back and then pay 15 to 20 cents a hundred for grinding, may not find the practice profitable.

One reason for grinding grains is to allow of a more complete and uniform mixture. Shelled corn, whole oats and any high protein feed after mixing will separate out on handling and the mixture will not be so satisfactory.

A common mistake is that too fine grinding is often demanded. Reducing corn or oats almost to flour does insure that more weed seeds will be destroyed and makes a nice appearing feed. However, this fine grinding does not increase the value of the feed; it may even decrease it and the cost is much greater.

Crushing or rolling is preferred to grinding for some grains, such as barley. However, facilities for crushing or rolling are often not available.

**GRINDING ROUGHAGES.** A consideration of the question of grinding roughages for dairy cattle resolves itself into two phases. The first involves the grinding of good quality hay; the second involves the grinding of poor hay and of coarse materials such as corn stover. The first of these may be disposed of briefly. Good quality hay is palatable; it needs no treatment to induce cows to eat it. Furthermore, the grinding of hay does not increase its digestibility. In a trial at this station it was found that ground alfalfa hay was less readily eaten by cows than was whole hay. Also the ground hay proved detrimental to the health of the cows and to their milk production. Grinding a good quality of hay is unwise.

Evidence about the grinding of poor quality hay and other coarse roughage is not so definite. Some hays may have lost considerable portions of their leaves and consist largely of stems. Cows will refuse these stems. Grinding the hay will result in its entire consumption. The same may be said of the stalks in corn stover and corn fodder. A question arises, however, as to how serious it is to lose these stems and stalks. Obviously they are coarse fibrous materials with little food value. Unless their increased value is great enough to compensate for the cost of grinding them there is no merit in the process. The frequent intimation that the grinding of corn fodder will supplant the need for silage in the dairy ration is not substantiated by facts.

**CUTTING OR CHAFFING ROUGHAGE.** A great deal of the argument advanced for grinding roughage is that cows are induced to eat it all. The proper cutting or chaffing into short lengths will attain this end at far less cost. This plan has met with favor with some dairymen. They do the cutting with such feeds as soybean hay that is likely to be coarse. As in the case of grinding, it is not proved that the utilization of the coarse stems is sufficiently advantageous to

justify the cost. Any of these processes has an advantage in that it makes for greater ease and convenience in handling.

**THE PREDIGESTION OF FEEDS.** Much interest has centered recently in schemes for treating feeds, especially roughages, with certain substances that are said to increase the utilization of the nutrients. Some enthusiasts claim that with the use of suitable enzyme preparations, the fiber in roughages may be predigested so that it will be of enormous value to cows. The processes consist of applying to the feeds some of these enzymes or "starters." Then a high temperature is maintained for the enzymes to act and the feed comes out as a wet succulent mass. Some work at this station showed that the process was largely a nuisance with considerable expense. The resultant feed was not especially palatable and was of no more value than untreated feeds.

### Balancing Rations

The importance of a proper balance between the nutrients of a ration has been emphasized previously. The nutrients involved in balancing a ration are the proteins, or especial tissue building nutrients, and the carbohydrates and fats, or energy forming nutrients. The last two terms are grouped together because they serve identical functions. The grouping gives rise to the term carbohydrate equivalent.

**CARBOHYDRATE EQUIVALENT** is the sum of the digestible carbohydrates plus  $2\frac{1}{4}$  times the digestible fats. When the digestible carbohydrate equivalent supplied in a ration or in one feed is divided by the digestible protein, the nutritive ratio, as defined on page 34, is obtained. The nutritive ratio is the measure of the balance which exists between the nutrients.

Naturally, dairymen do not spend the time that would be required in balancing a ration for each cow in their herds. They do not need to for the rules for feeding, such as are given on page 37, provide rations that are sufficiently well balanced. However, it is of value for a dairyman to select a typical cow from his herd and balance a ration for her, or have someone who is familiar with the procedure do it for him. Then from what he learns of this cow's requirements and his ability in supplying them he can feed the other cows their proportional amounts.

The calculation of a balanced ration is a somewhat laborious process. The steps involved in doing this are explained here in their order. A

TABLE IV. DIGESTIBLE NUTRIENTS REQUIRED FOR BODY MAINTENANCE AND MILK PRODUCTION

(Adapted from the Morrison Feeding Standard)

For body maintenance of 1000-lb. cow.	Digestible Protein pounds .700	Digestible Carbohydrate Equivalent pounds 7.225
To maintenance requirement add:		
For each lb. of 2.5 percent milk		
" " 3.0 " "	.049	.207
" " 3.5 " "	.052	.234
" " 4.0 " "	.055	.261
" " 4.5 " "	.060	.286
" " 5.0 " "	.063	.313
" " 5.5 " "	.067	.335
" " 6.0 " "	.071	.357
" " 6.5 " "	.074	.380
" " 7.0 " "	.079	.403
	.082	.423



1,200-pound cow giving 30 pounds of 3.5 percent milk is selected as an example.

1. Determine the weight of the cow, her daily milk production and her butterfat test. We have assumed a set of conditions in the preceding sentence. In a herd, stock scales or an estimate will be used for the live weight. Milk scales and a Babcock tester are the only sources which will yield the remaining necessary information.

2. Determine the nutrients required to maintain her body. This information is furnished in table IV. This table is called a feeding standard. It is made up from the Morrison Feeding Standard as proposed in Feeds and Feeding, 18th edition, by Henry and Morrison.

Some changes from the Morrison Feeding Standard are incorporated in the table. For instance, in the Morrison Feeding Standard figures are given for the minimum amount of digestible protein a cow should have daily, together with figures for the maximum amount. An average of these extremes is the figure used in table IV for expressing the needed digestible protein a cow should have daily. Also in the Morrison Feeding Standard minimum and maximum figures are given for the amounts of total digestible nutrients needed. In table IV a figure representing the maximum is used. Instead of using the term, "total digestible nutrients," the term "digestible carbohydrate equivalent" is used. Total digestible nutrients include the digestible carbohydrate equivalent and the digestible protein. Either term may be calculated from the other by adding or subtracting, as the case may be, the amount of digestible protein.

Table IV shows that a 1,000-pound cow requires 0.7 pound of digestible protein and 7.225 pounds of digestible carbohydrate equivalent daily to maintain her body. But in this case we have assumed the cow weighs 1,200 pounds. For a 1,200-pound cow, more than 0.7 pound digestible protein and 7.225 pounds of digestible carbohydrate equivalent are required. The proportional figures are twelve-tenths of 0.7 pounds and of 7.225 pounds. This gives a maintenance requirement for a 1,200-pound cow of 0.84 pounds of digestible protein and 8.67 pounds of digestible carbohydrate equivalent. These figures for maintenance will be set down.

3. Determine the nutrients she requires daily for production. This information is also found in table IV. In the first column of the table read down until you come to the figure 3.5, representing the test of this cow's milk. Then reading across, it is found that for 1 pound of 3.5 percent milk there are required 0.055 pounds of digestible protein and 0.261 pound of digestible carbohydrate equivalent. By multiplying, 30 pounds of 3.5 percent milk are found to require 1.65 pound of digestible protein and 7.83 pounds of digestible carbohydrate equivalent. These figures are then set down under those for the maintenance requirements as follows.

	Digestible Protein pounds	Digestible Carbohydrate Equivalent pounds
For maintenance -----	.84	8.67
For production -----	1.65	7.83
	<hr/>	<hr/>
Total daily requirements	2.49	16.50

4. Determine the amounts of the roughages the cow should have daily. This is done by applying the rules given on page 37. They indicate that she will eat 12 pounds of alfalfa hay and 36 pounds of corn silage.

TABLE V. DIGESTIBLE NUTRIENTS IN 100 POUNDS OF SOME COMMON FEEDS.

(From the extensive tables in "Feeds and Feeding," 18th Edition, by Henry and Morrison.)

Feeds	Dry Matter pounds	Crude Protein pounds	Carbohydrate Equivalent pounds	Carbo- hydrate pounds	Fat pounds	Ash pounds
<b>Dry Roughages</b>						
Alfalfa hay	91.4	10.6	41.0	39.0	0.9	8.6
Clover and timothy hay	87.8	4.0	42.2	39.7	1.1	6.1
Corn fodder	81.7	3.0	50.7	47.3	1.5	5.0
Corn stover	81.0	2.1	44.0	42.4	0.7	5.5
Millet hay	85.7	5.0	50.1	46.0	1.8	6.3
Oat hay	88.0	4.5	41.9	38.1	1.7	6.8
Oat straw	88.5	1.0	44.6	42.6	0.9	5.4
Prairie hay	93.5	4.0	43.9	41.4	1.1	7.7
Red clover hay	87.1	7.6	43.4	39.3	1.8	7.1
Soybean hay	91.4	11.7	41.9	39.2	1.2	8.6
Sudan grass hay	88.4	3.7	47.7	45.7	0.9	7.0
Sweet clover hay	91.4	10.9	39.8	38.2	0.7	7.2
Sweet corn fodder	87.7	5.9	50.5	47.6	1.3	9.0
Timothy hay	88.4	3.0	45.5	42.8	1.2	4.9
Wheat straw	91.6	0.7	36.2	35.1	0.5	5.2
<b>Succulent Roughages</b>						
Alfalfa	25.3	3.3	11.3	10.4	0.4	2.4
Beets, sugar	16.4	1.2	12.8	12.6	0.1	1.1
Beet pulp, wet	9.3	0.5	7.0	6.5	0.2	0.4
Bluegrass	45.3	2.0	22.1	20.7	0.6	2.5
Corn	23.1	1.0	14.6	13.7	0.4	1.2
Corn, cannery refuse	5.3	0.1	5.1	4.9	0.1	0.9
Corn, sweet	10.0	0.8	6.6	6.1	0.2	1.0
Corn, silage	26.3	1.1	16.6	15.0	0.7	1.7
Mangels	9.4	0.8	6.6	6.4	0.1	1.0
Pumpkins	8.3	1.1	5.6	4.5	0.5	0.9
Rutabagas	10.9	1.0	8.4	7.7	0.3	1.0
Soybeans	23.6	3.2	11.3	10.2	0.5	2.4
Stover silage (field cured)	20.6	0.6	11.6	10.7	0.4	1.3
Sudan grass	22.5	0.8	12.7	11.8	0.4	1.6
Sugar beet tops	11.4	1.7	5.6	5.4	0.1	2.0
Sweet clover	24.4	3.3	11.0	10.3	0.3	2.1
Turnips	9.5	1.0	6.5	6.0	0.2	0.9
<b>Concentrates</b>						
Barley, ground	90.7	9.0	70.4	66.8	1.6	2.7
Beet pulp, dried	91.8	4.6	67.0	65.2	0.8	3.5
Buckwheat middlings	88.0	24.6	52.0	38.3	6.1	4.8
Cane molasses (black-strap)	74.3	1.0	58.5	58.5	...	6.1
Corn-and-cob meal	89.6	6.1	72.0	63.7	3.7	1.5
Corn, cracked	89.5	7.5	78.2	67.8	4.6	1.5
Corn, soft	69.4	5.5	61.2	53.3	3.5	1.0
Cocoonut meal (N. P.)	90.0	19.9	51.0	44.2	3.0	6.0
Cottonseed feed	91.7	14.2	43.5	30.7	5.7	4.9
Cottonseed meal, choice	92.5	37.0	41.2	21.8	8.6	6.2
Cottonseed meal, prime	92.2	33.4	42.1	24.3	7.9	6.6
Cottonseed meal, good	92.1	31.6	43.2	25.6	7.8	6.4
Germ oil meal	91.1	16.5	66.0	42.6	10.4	2.7
Gluten feed	91.3	21.6	59.1	51.9	3.2	2.1
Gluten meal	90.9	30.2	53.8	43.9	4.4	1.1
Linseed meal, O. P.	90.9	30.2	47.7	32.6	6.7	5.4
Linseed meal, N. P.	90.4	31.7	44.2	37.9	2.8	5.6
Oat feed	93.5	4.1	39.2	35.6	1.6	6.2
Oats, ground	90.8	9.7	60.7	52.1	3.8	3.5
Soybeans, cracked	90.1	33.2	60.9	24.7	16.1	5.3
Soybean oilmeal	89.5	39.7	44.8	34.7	4.5	4.9
Wheat	89.8	9.2	70.9	67.5	1.5	1.9
Wheat, bran	89.9	12.5	48.4	41.6	3.0	6.3
Wheat, shorts	89.5	13.4	55.9	46.2	4.3	4.4
Mixture I, page 39	90.1	11.3	68.4	56.0	5.5	2.8
Mixture II, page 39	90.1	15.3	67.0	50.3	7.4	3.3
Mixture III, page 39	90.1	16.8	66.7	48.2	8.2	3.4

5. Determine the amounts of nutrients furnished by the alfalfa hay and corn silage. Table V shows that in 100 pounds of alfalfa hay there are 10.6 pounds of digestible protein and 41.0 pounds of digestible carbohydrate equivalent. By calculation, it is found that 12 pounds contain 1.27 pounds of digestible protein and 4.92 pounds of digestible carbohydrate equivalent. Similarly, 36 pounds of corn silage is found to contain 0.40 pound of digestible protein and 5.98 pounds of digestible carbohydrate equivalent. These figures are then set down to indicate the nutrients furnished by the roughages.

	Digestible Protein pounds	Digestible Carbohydrate Equivalent pounds
12 pounds alfalfa hay-----	1.27	4.92
36 pounds corn silage-----	.40	5.98
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Nutrients in roughages--	1.67	10.90

6. Determine the amounts of nutrients that must be supplied by the concentrates.

This is accomplished, as follows, by subtracting from the total daily requirements the nutrients in the roughages.

	Digestible Protein pounds	Digestible Carbohydrate Equivalent pounds
Total daily requirements---	2.49	16.50
Nutrients in roughages-----	1.67	10.90
	<hr/>	<hr/>
Needed in concentrates--	.82	5.60

This leaves 0.82 pounds of digestible protein and 5.60 pounds of digestible carbohydrate equivalent that must be supplied in the concentrates.

7. Determine the amounts of concentrates the cow should have daily. This will be an estimation and may have to be altered. The rules on page 37 state that Holsteins should have about 1 pound of grain for each  $2\frac{1}{2}$  to  $3\frac{1}{2}$  pounds of milk. We may presume that this cow will need about 9 pounds of grain. The grain mixture suggested for legume hay and silage on page 39 indicates that about one-ninth of the concentrates should be a high protein feed. The rest will be equal parts of cracked corn and oats. For a trial we shall select 4 pounds of cracked corn, 4 pounds of ground oats and 1 pound of cracked soybeans as likely to meet the needs.

8. Determine the amounts of nutrients furnished by these amounts of concentrates. The use of table V as in the case of the roughages and then the proper calculations gives the following as the amounts of nutrients furnished by these concentrates.

	Digestible Protein pounds	Digestible Carbohydrate Equivalent pounds
4 pounds cracked corn-----	.30	3.13
4 pounds ground oats-----	.39	2.43
1 pounds cracked soybeans--	.33	.61
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	1.02	6.17

Apparently this amount of concentrates is more than the cow needs. It furnishes 1.02 pounds of digestible protein while she needs only .82 pound from the concentrates; it furnishes 6.17 pounds of digestible carbohydrate equivalent while she needs only 5.60 pounds.

The best way of reducing this oversupply of nutrients would be to use only one-half pound of cracked soybeans instead of one pound. In this case the concentrate mixture becomes

	Digestible Protein pounds	Digestible Carbohydrate Equivalent pounds
4 pounds cracked corn-----	.30	3.13
4 pounds ground oats-----	.39	2.43
½ pounds cracked soybeans--	.17	.30
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	.86	5.86

This mixture supplies 0.04 pound more digestible protein than is called for. This supply is close enough to the requirements to be entirely satisfactory. In fact, if the amount of digestible protein furnished in a ration is within 0.2 of a pound of the requirement for this nutrient, the ration is accepted as satisfactory. The supply of digestible carbohydrate equivalent in this mixture is 0.26 pound in excess. This variation is not serious especially in so far as it is an excess. If the amount of digestible carbohydrate equivalent furnished is within 1.0 pound of that required, the ration will not be considered defective. When an attempt to select feeds does not come within these limits for variation it is necessary to make changes. With a little practice these changes can be readily made by adding, withdrawing or substituting one-half pound or one pound of the feeds that may be used. Above all things a balanced ration must be practical. The entire ration now stands as follows:

	Digestible Protein pounds	Digestible Carbohydrate Equivalent pounds
12 pounds alfalfa hay-----	1.27	4.92
36 pounds corn silage-----	.40	5.98
4 pounds cracked corn-----	.30	3.13
4 pounds ground oats-----	.39	2.43
½ pound cracked soybeans--	.17	.30
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Total nutrients in ration	2.53	16.76
Nutrients required by the cow -----	2.49	16.50

This ration has a nutritive ratio of 1:6.6. It coincides very closely with the rules for feeding is given on page 37. Furthermore, it possesses all the desirable characteristics of a dairy ration. It is economical and palatable; it possesses variety for it contains five feeds and these are from four different plants. Consisting of nearly one-half ground oats in the concentrates, it is sufficiently bulky; the silage adds succulence; it is properly balanced; it would have a desirable laxative effect upon the cow and it contains no feeds that would cause criticism of the milk.

This ration could well serve as a guide in feeding an entire herd, the cows all receiving quantities of the roughages as determined by their individual capacities for roughage consumption. The amount of grain would be changed to suit the production and condition of each cow.