TEXAS AGRICULTURAL EXPERIMENT STATION

BULLETIN NO. 170 NOVEMBER, 1914

DIVISION OF CHEMISTRY

Texas Feeding Stuffs; Their Composition and Utilization

POSTOFFICE:
COLLEGE STATION, BRAZOS COUNTY, TEXAS

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BY

G. S FRAPS, PH. D., CHEMIST

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†In cooperation with United States Department of Agriculture.
*As of November 30, 1914.

TABLE OF CONTENTS.

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THE COMPOSITION OF TEXAS FEEDING STUFFS AND THEIR UTILIZATION.

BY G. S. FRAPS, PH. D., CHEMIST.

The object of this Bulletin is to give information concerning the chemical composition, and the utilization of Texas feeding stuffs. The information is based partly upon analyses, digestion experiments, and other work done at this Station, and published in special bulletins from time to time, and partly upon general principles of feeding animals, and information secured elsewhere.

CONSTITUENTS OF FEEDING STUFFS.

For the purposes of a chemical analysis, the constituents of feeding stuffs are divided into several groups; namely, protein, ether extract, crude fiber, nitrogen-free extract, water, and ash. With the exception of the water, each of these groups comprises a number of separate and distinct substances which vary in their digestibility and their value to the animals. All vary in the relative quantities in which they occur in different feeding stuffs. Hence the chemical composition alone is *not* a suitable basis for *comparing different kinds* of feeding stuffs, although it furnishes a good basis on which to compare different samples of the same kind of feeding stuff. While, for example, the chemical analysis alone is not a fair basis on which to compare the relative value of corn and cottonseed meal, it is a good basis on which to compare several samples of corn with one another, or several samples of cottonseed meal with one another.

DEFINITION OF TERMS.

Protein is the constituent of food which forms flesh, muscle, hair, ligaments and other portions of the animal body, and is of great importance. It replaces the wear and tear of the animal tissue and furnishes material for additional flesh. Besides furnishing material for tissue, protein may be burned in the body to produce heat, or it may serve as a source of fat in case of a deficiency in carbohydrates and fat in the food, accompanied by excess of protein. It is, however, a costly source of heat and fat as a rule, though, under special conditions, as will be pointed out later, protein may profitably be used for such purposes.

Value of Protein: Protein is the most expensive portion of a feed, and feeds rich in protein usually sell for a higher price than feeds low in protein, though the difference is not as great in Texas as in the Northern States. With a given feed, the more protein it contains the better its quality, compared with other feeds of the same kind. For example, cottonseed meal containing 48 per cent. protein is of better quality than cottonseed meal containing 45 per cent. protein. A low protein content, accompanied by a high content of crude fiber, indicates

that the cottonseed meal contains an excessive amount of hulls. Protein alone, however, is not a suitable basis for comparing feeds of the same kind. We must consider the fat or ether extract, and also the water and ash to a certain extent. Neither can we justly compare the values of feeds of different kinds on a protein basis only. For example, a cottonseed meal containing 45 per cent. protein does not have five times the value of corn chops containing 9 per cent. protein. There are other constituents of both cottonseed meal and corn chops (fat and nitrogen-free extract), which are of value to the animal, and corn chops contains much more nitrogen-free extract than cottonseed meal. The digestibility of the constituents is also of importance. This will be discussed on another page in this bulletin.

Fat (or Ether Extract) is composed mainly of fats and oils in the case of concentrated feeding stuffs, but, with fodder and hays, it is often composed to a considerable extent of waxes, coloring matter, and other substances (see Bulletin No. 150 of this Station). Fat is used in the animal body as a source of body fat, and to furnish heat and energy. The animal requires heat to keep its body warm and energy to run the animal mechanism or to do outside work. The beating of the heat, chewing, movements of the intestines, and the voluntary and involuntary muscular movements, require energy, which is furnished by the oxidation of fats, carbohydrates or protein. One pound of fat is equal to 2.25 pounds of carbohydrates.

Value of Fat: Fat ranks next to protein in its value as a feeding stuff. The more protein and fat a given food contains, the better its quality compared with other feeds of the same kind. Cottonseed meal in which the percentage of protein and fat together make a total of 55 per cent. is of higher value than cottonseed meal containing a total of 50 per cent. protein and fat added together. Cottonseed meal is indeed often sold on the basis of its protein and fat content, as determined by chemical analysis, but this method of comparison does not sufficiently consider the quantity of hulls present, as shown by the crude fiber.

Protein alone is not a suitable standard for comparing feeds, and protein and fat combined is also not sufficient. Two feeds of different kinds should not be compared on the basis of their contents of protein and fat, since other factors enter into consideration, which will be discussed later.

Crude Fiber is that portion of the plant which resists the intense action of certain acids, and alkalies. It consists mostly of the cell walls and woody fiber of the plant, and is the most indigestible part of the feed stuff. By means of fermentation in the intestines, crude fiber is digested to some extent in animals which chew the cud. The operation, however, consumes so much energy that a large proportion of the value of the crude fiber is taken up by the process of digestion. Hogs have little digestive power for crude fiber. Hays and fodders and other roughage generally contain much crude fiber, but concentrated feeding stuffs comparatively small quantities of it.

Value of Crude Fiber: Crude fiber is the woody and less digestible portion of the feeding stuff. The more crude fiber a feed contains, the poorer its quality compared with other feeds of the same kind.

Feeding materials of low commercial value, and of low value to the animal, such as straw, cottonseed hulls, rice hulls, oat hulls, corn cobs, etc., contain large quantities of crude fiber, and their addition to the concentrated feeding stuff increases its content of crude fiber. Thus, if the crude fiber in cottonseed meal exceeds certain limits, it means that the meal is adulterated with cottonseed hulls. In a similar way, crude fiber in excess of a given quantity may indicate corn cob or corn bran in corn chops; rice hulls in rice bran, wheat bran in wheat shorts, etc. The amount of crude fiber is a much more sensitive indication of low quality or of adulteration than is the protein and fat, since the adulterants generally contain large quantities of crude fiber.

To repeat, the more crude fiber a feeding stuff contains, the poorer its quality compared with other feeds of the same kind. This also holds good to some extent in comparing feeds of different kinds, but not entirely. In these cases, we must also consider the protein and fat contents of the two kinds of feed. Thus, wheat bran contains considerably more crude fiber than corn chops, but may have a higher feeding value when protein is worth more than fat and nitrogen-free extract.

Nitrogen-free Extract is composed of starches, sugars, dextrin, and other substances of similar nature. These substances are mostly carbohydrates; that is, they contain carbon, and hydrogen and oxygen in proportions to form water. Crude fiber is also composed largely of carbohydrates. There are, however, other substances than carbohydrates in the nitrogen-free extract.

Value of Nitrogen-free Extract: The nitrogen-free extract of concentrated feeding stuffs, such as corn chops, wheat bran, cottonseed meal, kafir corn, is composed largely of sugars and starches, which are readily digested and have considerable value to the animal.

The nitrogen-free extract of wheat skins, corn bran, corn cobs, rice hulls, hays and straws, and similar feeds, is composed mostly of other substances than the sugars and starches, and has a lower value to the animals. The nitrogen-free extract of these two kinds of feeds, therefore, cannot be compared directly.

In general, we may say that the more protein, fat and nitrogen-free extract, and the less crude fiber, ash and water, a given feed contains, compared with other feed stuffs of the same kind, the better the quality of the feeding stuff.

The same statement also holds in comparing feed stuffs of different kinds, but not altogether; since, in comparing feeds of different kinds, we must consider their digestibility and the productive value of the digested materials.

Ash is the residue left when the plant is burned. It represents mostly the mineral portion of the plant and the portion which comes from the soil, although a part of the ingredients withdrawn from the soil are volatilized during combustion. Nitrogen particularly is driven out completely. Ash is valuable to the animal, inasmuch as it furnishes the material for bones, and some constituents of it, particularly phosphoric acid and sulphur, are essential constituents of the animal cell.

Value of Ash: Ash is necessarily present in feeding stuffs. An excessive amount of ash indicates contamination with dirt, sand, or other

mineral matter. Too little ash in the ration may give rise to disorders, especially in young animals.

Water (*moisture*) is always contained in feeding stuffs, but since it is furnished for the most part in liquid form, it cannot be considered as having any special nutritive value.

Value of Water: The more water a feeding stuff contains, the less of the other nutrients it contains, and the more liable it is to be injured by heating, mold, etc. The water content of feeds varies. In concentrates it runs from 7 to 12 per cent., but may be larger in fresh grain.

Nutritive Ratio: The nutritive ratio is the proportion of digestible protein to digestible non-protein. In calculating the nutritive ratio of a feed or a ration, the percentage of digestible fat (ether extract) is multiplied by 2.25, the product is added to the percentage of digestible nitrogen-free extract, and digestible crude fiber, and the sum is divided by the percentage of digestible protein. The quotient is the nutritive ratio. If we say the nutritive ratio of a feed is 1.8, it means that the feed contains one part digestible protein to eight parts digestible nitrogen-free extract.

The fat is multiplied by 2.25, for the reason that it is a more concentrated form of nourishment than crude fiber or nitrogen-free extract, and has 2.25 times as much value to the animal.

COMPOSITION OF TEXAS FEEDING STUFFS.

The table near the end of this bulletin gives the average composition of Texas feeding stuffs based upon our best present knowledge. The figures for the concentrated feeds are, for the most part, based upon analyses made for the Texas Feed Control for several years past. The figures for the hays and roughages are based partly upon Texas analyses, partly on analyses made at other stations.

DIGESTION OF FEEDS.

Digestion converts food into forms which, dissolved in water, pass through the digestive organs, and can be utilized by the animal body. Digestive organs of different animals have different sizes and capacities and are adapted to varied kinds of food. The digestive organs of cows, sheep, goats, etc., are comparatively large and are suited for the utilization of large quantities of feeds containing comparatively small quantities of nourishment. The digestive organs of the dog, pig, and similar animals, are much smaller and are not suited to work over bulky feeds, such as hays, fodders or straws. The digestive organs of the horse, while of large capacity, do not have the capacity of the ruminants such as the cow; and, for this reason, the horse has a lower digestive power and is less well suited for the utilization of the coarser feeding stuffs. The horse is also unable to chew his food over again. The differences in the digestive power of the horse and ruminants is most marked for crude fiber, for which the horse has only a low digestive power.

A number of losses occur in the process of digestion.

In the first place, that part of the food that is not digested passes through the body and is eliminated in the solid excreta.

In the second place, a portion of the food is converted into gases, such as marsh gas, and carbon dioxide. Since the food converted into gases disappears during the process of digestion, it obviously has no value to the animal organism.

In the third place, there is a loss due to the work required for the digestion. The chewing of the food, movement of the body, secretion of the digestive juices, and the various operations involved in digestion, consume a portion of the value of the food.

After all these losses have been deducted, what remains is the net value of the food to the animals. As stated above, animals vary somewhat in their ability to digest food. There are also differences in individuals, due to bad teeth, the condition of the digestive organs, etc. The composition of the ration also has some effect on the digestion.

If the proportion of non-protein to protein is excessive, the digestibility of the ration is decreased. With pigs, the nutritive ratio may be 1:12 with no decrease in digestibility, but, with other animals, an increase in the non-proteids which increases the nutritive ratio beyond 1:10, results in decreased digestibility of the ration. The addition of feed rich in digestible protein, increases the digestibility of such a ratio, until the nutritive ratio becomes 1:10, or, in the case of pigs, 1:12, after which additional quantities of protein are of no advantage in increasing digestibility.

UTILIZATION OF FOODS.

As stated above, when food is digested, there are considerable losses, due to undigested food, to losses as gases, and to the work involved in digestion or metabolic processes consequent to the digestion. The remainder of the food represents the net value of the food to the animal. The net *food value* may be defined as the nourishment that is secured from the food after deducting all losses involved in the digestive processes or digestive metabolism, including the work of digestion.

This net nutriment must, first of all, be used for taking care of the bodily needs of the animal and then the excess, if any, may be used for productive purposes.

The animal must have a certain amount of food with which to build up the muscular tissues which are wasted away through life's processes. The animal must also have food supplies to keep the body warm and to maintain heat. The quantity of heat required will depend to some extent upon the temperature of the surroundings, and some of the heat may be furnished by the energy used in *digestion,* which appears as heat. The animal must also have food to take care of the various bodily movements of the lungs and body organs, and movements of the body which are essential to the life and well being of the animal.

The needs of the animal may be grouped into two classes.

First, *tissue-building materials* or food needed for building of tissue or for the repair of tissue consumed during the life processes of the animal.

Second, *energy-forming materials,* which may be used for heat, energy, or stored up as fat, or in the non-protein constituents of milk.

The protein of food is its only constituent which can be used for the repair of the animal tissue or for the building of lean meat. It is, however, required only in comparatively small amounts by full-grown animals. Growing animals, that are building tissues rapidly, require large quantities of protein. Animals giving milk also require quantities of protein, on account of the protein contained in milk.

The other constituents of the food provide energy for heating the animal, for digestion, for bodily movements, or for the production of milk or fat. The nitrogen-free extract, the fat, and the crude fiber, may all be used for energy, fat, etc., in this way. If an excess of protein is fed beyond the needs of the body for the other purposes mentioned above, the protein may also be used for production of energy. Protein, including the tissues of the body, may also be used for energy when the ration fed does not supply a sufficient quantity. The animal then loses flesh.

It is usually not economical to feed protein to be used for energy purposes, since protein is, ordinarily, somewhat more expensive than the other forms of feed. There are, however, conditions under which it is profitable to feed protein for energy purposes. This is particularly the case in some parts of the South, including Texas, where cottonseed meal may be fed for its productive value or value for producing fat or energy, rather than for its content of protein. In fact, the price of cottonseed meal is at times such that its protein value may be disregarded.

PRODUCTIVE VALUES OF FEEDS.

The value of a feed, for building or repair of flesh, is measured by means of its content of digestible protein.

The value of a feed for heat, bodily movements, or energy, or for productive purposes, is not so easily measured. The best measure that we have at present is the quantity of fat that it will produce upon a fattening animal. This we call the productive value of the food, or its fat-producing value, and it indicates not only the quantity of a fat that the food may be able to produce, but the relative value of the food for other purposes, such as for work, for energy, for uses of the animal body, etc.

The productive value of a food is experimentally ascertained by first feeding an animal a ration which should produce a little fat and estimating exactly how much fat is produced with this ration. Then to this ration the food to be tested is added, and the quantity of fat produced is again estimated exactly. This cannot be done by weighing the animal, as such a method is too crude for exact work. The difference between the first quantity of fat produced and the second quantity of fat produced, shows how much fat the food is capable of producing, when it is fed to an animal that is already receiving enough food to take care of its bodily needs. It is then a simple matter to calculate the fat-producing value or productive value of the feed tested.

The productive value, stated in terms of fat, is the most advanced method of measuring the value of a feed stuff. In the calculation of

rations for animals, it was formerly assumed that the digestible nutrients of one food are equally as good as the digestible nutrients of any other food. As a matter of fact, this is not true. Different feeds vary considerably in the value of the digested nutrients contained in them, due to differences in losses and the work involved in chewing and digestion. The use of the productive value is a decided step forward in the calculation of rations for feeding animals.

According to Kellner, 100 pounds of ether extract of roughages will produced 47.4 pounds of fat on a fattening animal; 100 pounds starch will produce 24.8 pounds fat; 100 pounds of protein will produce 24.8 pounds fat; 100 pounds crude fiber will produce 24.8 pounds of fat. These, then, are the productive values of the constituents of feeds.

If we assume that the digestible nutrients of all feeds have an equal value, we can calculate, from the above figures, that a certain wheat straw should produce 10.4 pounds of fat. But, by experiment, it was found that 100 pounds of this particular wheat straw produced only 2.1 pounds of fat. Hence the value calculated merely from the productive value of the nutrients without correction is utterly incorrect. On the other hand, the fat produced from cottonseed meal was found to be equal to that calculated. For this reason, it is plain that the digested constituents of wheat straw are quite different in productive value from the digested constituents of cottonseed meal, and correction must be made for the nature of the feed.

Other tests have given similar results, and proven conclusively that the digested nutrients of one feed may have a different value to the animal, pound for pound, from the digested nutrients of another feed.

It is quite possible that different animals may have different powers of utilizing the digested net nutrients of feeds, and that some animals may put on a different quantity of fat from the steers used by Kellner in ascertaining the productive values. This has indeed been found to be the case with pigs, which produce a larger amount of fat, than the steers, from the same digested nutrients; but the quantities of fat produced were in *proportion* to the productive values as determined on steers.

It is also possible that, for other energy uses, the value of a feed may not be *equal* to its productive value, but more probably would be in proportion to it. That is to say, the quantity of fat that the feed may produce on a fattening animal, may not represent the absolute value of the feed to animals for other purpose, but its value may be in proportion to the productive value, or fat formed.

MINERAL MATTER.

The full-grown animal does not need much mineral material, but growing animals require certain quantities of ash, for the production of bone, and also for storing away as part of the constituents of their flesh. Animals giving milk require ash for the purpose of milk formation. The most important constituents of the ash are phosphoric acid and lime.

Salt is found in digestive juices, and a certain quantity of salt appears to be very necessary to the welfare of animals. A moderate amount of salt increases the retention of protein by the animal body,

which results in an increased production of flesh. Steers of average weight require about one ounce of salt per day, and horses from one-half to one ounce. Steers on a fattening ration may require as much as two ounces of salt per day or even three ounces of salt per day. An excess of salt is undesirable.

Growing animals which do not receive sufficient lime and phosphoric acid, in their food, suffer from the deficiency. The bones become weak, the limbs and spinal column bend, and the animal does not develop properly. Pigs especially are liable to suffer in this way, because the food ordinarily fed to them in many cases does not contain a sufficient quantity of lime.

In restricted localities, the food ordinarily fed to animals does not contain sufficient lime, and the bones of the animal are poorly developed. In addition, the animals suffer from various diseases, which diseases, on investigation, have been found due to the deficiency of lime or phosphoric acid in the food fed.

A deficiency of lime in the food may be supplied by the use of precipitated chalk.

Lime and phosphoric acid together may be supplied by means of ground bone, or phosphate rock. We expect to discuss this matter furthem in subsequent bulletins.

MAINTENANCE RATION.

The maintenance ration is a ration which provides for the bodily needs of the animal, without supplying any excess to be used for fat, milk, work, or other productive purposes.

Horses may be placed upon a maintenance ration during periods of idleness.

Cattle may be placed upon a maintenance ration between the end of the fattening period and the time of sale; also during periods before the fattening period begins, if, for any reason, it is desirable to delay the fattening process.

Breeding stock may at times be placed on a maintenance ration.

The maintenance ration is also a basis for the other rations, since it is important to be able to calculate the portion of the ration which may be used for productive purposes.

Young animals may not normally be placed upon maintenance rations, since growth is a normal condition of the young, and the maintenance ration does not allow for growth.

The amount of food required for maintenance depends, to a considerable extent, upon the temperature. The maintenance ration is usually based upon a temperature of 64° F. At this temperature, a considerable portion of the needs of the animal are for heat to keep up the body temperature. As the temperature of the surroundings rise, less heat is required, until at 95° F. no heat from the food is needed to keep up the body temperature. As the temperature becomes lower than 64° F., on which the maintenance ration is based, the requirements of the animal increase, and a decided decrease in the temperature of the surroundings may cause a great increase in maintenance requirements.

This explains the great suffering which comes among the range ani-

mals, when snow at the same time decreases available forage, and increases the requirements of the animal.

The temperature of the drinking water has the same effect. Its temperature must be raised to that of the animal body, and the amount of heat required to do this is easily calculated. Suppose that an ox drinks his usual quantity of water, but at a temperature of 41° F.; the amount of feed required to heat this water to body temperature is equal to about 25 per cent. of his maintenance ration. That is to say, the needs of the animal are increased to this extent. Animals which are kept at a comfortable temperature, but drink colder water, thus need additional food for maintenance, for the purpose of warming the water.

A fat animal requires for maintenance more food, in proportion to its weight, than a thin animal.

THE FATTENING RATION.

The gain in weight during the process of fattening is largely *fat* in the chemical sense. The nutritive ratio of the gain of full-grown animals is about 1:20; that is, there is almost 1 pound of protein gained for every 20 pounds of non-protein (including fat x2.25). On an average, the gain in weight is two-thirds fat, the remainder being water, protein, ash, etc. Growing animals put on more protein (flesh) than full-grown animals, and have greater requirements for protein.

Only the excess of food over the quantity necessary for maintenance can be used for the actual increase in weight of the fattening animal. Anything which increases or decreases the quantity of food required for maintenance will thus decerase or increase the quantity available for gain in weight.

For the processes of digestion, animals use energy, which is finally liberated as heat. This heat may be used for warming the animal body, if needed for that purpose. Since fattening animals digest a larger ration than animals on maintenance, they have a larger excess of heat resulting from digestion of the larger ration, and may be kept in quarters having a lower temperature, without an increase in maintenance requirements.

In warm weather, fattening animals may have trouble in disposing of the excess of digestive heat. Instinctively, they then consume less food, which explains why the fattening process is not successful, as a rule, during hot weather.

On the other hand, if the fattening animal is exposed to too cold a temperature, or has too cold drinking water, his requirements for maintenance will be increased, less food will be available for fattening, and the result will show in a decrease in the gain of weight. In cold climates, it has been found desirable to warm drinking water, especially for hogs.

The fatter the animal, the more food is required for maintenance, and the less the proportion of the ration that is available for fat. Hence the cost of the gain increases with the fatness of the animal.

As has just been said, only the *excess* of food over that required for maintenance can be used for fattening. The larger this excess within the limit of the ability of the animal to utilize it, the larger is the

proportion of the ration which may be used for fattening, and the less is the cost of the gain in weight per unit of food.

Thus it is more economical to feed a heavy ration to a given animal than a light ration. The production of fat is proportionally greater. For example, if a steer whose maintenance requirements are 1.5 pounds productive value, is fed a ration equal to 2 pounds productive value, only .5 pound of food is available for production and hence only one-fourth of the ration produces fat. But if this animal should be able to use 3 pounds of productive value, the amount in excess of the maintenance requirement would be 1.5 pounds and this is one-half of the ration used in actual production of fat. Thus the gain produced by the second ration would be three times the gain by the first, and the cost of the gain produced by the first ration would be nearly twice the cost of that produced by the second. In other words, the cost of fattening may be reduced by feeding a ration which is as heavy as the animal can profitably utilize. Too heavy a ration, on the other hand, reduces the production of fat, since the excess interferes with the normal processes of the animal and makes the fattening process less successful.

The nutritive ratio is usually considered to be of considerable importance in calculating the ration for feeding. As a matter of fact, this ratio may vary between wide limits without affecting the process of fattening. The nutritive ratio should not be wider than 1 to 10 for cattle or 1 to 12 for swine, because in such a case the digestibility of the food is lowered. It should not be higher than from 1 to 4, because such excess of protein is not good for the welfare of the body. Between these limits, the nutritive ratio may vary.

As protein is expensive, it is usually better to figure the ration for the lowest quantity of protein. In Texas, however, the price of cotton-seed meal is often so low that one should use narrow nutritive rations and more protein.

This matter may, however, be taken care of in the feeding ration, in a different way, not by the nutritive ratio, but by regulating the total quantity of protein.

The quantity of fat fed is not of importance, provided that it does not exceed one pound fat per thousand pounds of live weight per day. Any excess over this quantity is liable to cause digestive disturbances and so interfere with fattening. Pigs can use larger quantities of fat than this amount, but even with these animals the quantity of fat should not exceed one and a half pounds per 1000 pounds of live weight.

WORKING ANIMALS.

The energy used for work comes directly or indirectly from the food. Food or body material is burned in the animal whenever work is done as coal is burned in an engine. The working animal should be fed such quantity of food as will maintain the body, and, in addition, the quantity that will supply the necessary energy for the quantity of work required. The ration must, therefore, depend on the amount and kind of work.

We have seen that only the excess of food over that required for maintenance can be used for the process of fattening. The same is

true for working animals. It is, therefore, more economical to feed a heavy ration and secure a large proportion of it in work, than to feed a light ration and secure only a small proportion in work. Also, the animal, when working, should receive a heavier ration than during periods of idleness.

Animals vary considerably in their capacities to do work. The conformation of the animal determines how much energy he will have to use to do a particular kind of work. For this reason, different types of animals are better adapted to the different kinds of work. Those adapted to the work can use the energy of the food better than the other types not so well adapted.

GROWING ANIMALS.

Growth is a normal condition for a young animal. It is not normally possible to put a young animal on a maintenance ration. The animal must secure enough food to provide for the proper growth of the flesh and enough mineral matter for the bony skeleton. A young animal gains more weight in proportion than an older animal, even on a fattening ration. Young animals do not require less food for maintenance, but they eat more in proportion to their weight, and they are thus able to store a greater proportion of the food eaten. It thus follows that the greatest gain in weight for the quantity of food eaten occurs with the younger animal, and the production of flesh requires more food as the animal grows older. This is shown by the following table, giving the quantity of food required for pound of gain at different weights:

PIGS.

Weight.	Pounds food eaten per 100 lbs. gain.
Below 100 lbs.	400
100 to 150	482
200 to 250	498
250 to 300	511

Similar results could be given for other animals.

The young animals intended for fattening purposes should be fed more liberally than those to be used for milk or work. Young animals are very sensitive to injurious influences and they require careful feeding, good food and protection from injurious influences. The food should be furnished often and regularly, clean vessels should be used for drinking water, and stalls should be dry and well ventilated. The animal should be supplied with clean dry bedding. Cold, wet and drafts should be avoided.

The calf requires from forty to sixty grams of phosphoric acid per day. The pig requires about twelve grams each of lime and phosphoric acid per day. These are needed to build up the skeleton. If not supplied in sufficient quantities, the animal will not develop healthily. The mineral matter deficient in the food may be supplied by means of phosphate rock, finely ground; by ground bone; or, if lime only is needed, by precipitated chalk.

THE FEEDING OF MILK COWS.

Milk cows are fed for the purpose of producing milk or butter fat. As is the case with other animals, only the excess of feed over that required for maintenance can be used for productive purposes. Therefore, the greater the quantity of the excess, within the capacity of the animal to utilize it, the greater is the return per unit of feed stuff consumed. In other words, heavy rations, within the capacity of the animal are more profitable than light rations. Furthermore, animals that can utilize heavy rations and can work them into milk, are more profitable than animals that can utilize only a small excess over the maintenance ration.

There is a great difference in the power of cows to utilize the productive values of feed stuff. Different individuals differ widely. Some cows are unprofitable and do not give sufficient milk or butter fat to pay for the feed which they consume. Other cows are highly profitable. Both kinds of cows may be found in the same herd. It is, therefore, important that the dairyman and the butter manufacturer should test the individual members of the herd and weed out those which are unprofitable or give only a small profit. They should be replaced with cows which have better abilities to utilize the feed stuff or to consume a larger quantity of food in excess of the maintenance ration and to turn it into milk or butter fat.

The composition and quantity of milk depends on the breed, the individual animal, the period of lactation, frequency of milking, and other conditions. Milk cows may be divided into two groups; the members of one group give relatively large quantities of milk with a moderate fat content; and the members of the other group give less milk but it contains a higher percentage of butter fat. The amount and composition of milk given by the same cow varies considerably from day to day. The amount of milk given decreases with the time that the animal has been giving milk, but the decrease varies with the animal. With some cows, the dcrease is regular and gradual; while others give the same quantity for a long time and then fall off rapidly.

The milk-secreting organs are closely related to the nervous system. Thus rough treatment, insufficient bedding, exposure to cold temperatures, and other unfavorable conditions, will decrease both the quantity and the quality of the milk.

The quantity of milk and its composition depends on the individual capacity of the animal, but it also depends on the quantity and quality of the food fed. It is not possible to push the production beyond the limits conditioned by the nature of the animal, but a deficiency of food will decrease the quantity of milk, shorten the period of lactation and may permanently injure the productiveness of the animal. When an animal is fed on a sufficient ration, and is changed to a ration containing insufficient food, there will be a reduction in the quantity and the quality of the milk.

Feeding standards for milk cows are based on the quantity of milk given and the maintenance requirements of the animal.

Milk contains lime and phosphoric acid. Ten pounds of milk require twenty-five grams each of lime and phosphoric acid and the cow requires about forty-five grams of lime and twenty-two grams of phos-

phoric acid per thousand pounds for maintenance. A deficiency in lime and phosphoric acid may be supplied by a precipitated phosphate of lime, or by ground bone, or by finely ground phosphate rock.

In feeding milk cows the concentrate may be adjusted by having different size measures for the different animals or by giving different numbers of the same measure of the concentrate to the different animals. The roughage remains constant. It is thus possible to adjust the food to the capacity of the animal and not to feed an excess. An excess is also injurious to milk cows, since the excess may go into fat and decrease the period of lactation.

WEIGHTS OF FEEDS.

The following table, from Farmers' Bulletin No. 22 of the U. S. Department of Agriculture, shows the weights of certain feeds per quart:

Corn, cracked	1 lb. 12 oz.
Corn meal	1 lb. 8 oz.
Corn and cob meal	1 lb. 6 oz.
Oats, whole	1 lb. .....
Oats, ground	12 oz.
Wheat, whole	1 lb. 14 oz.
Wheat bran	10 oz.
Wheat bran, coarse	8 oz.
Wheat middlings	1 lb. 2 oz.
Wheat middlings, coarse	13 oz.
Rye bran	10 oz.
Gluten meal	1 lb. 11 oz.
Gluten feed	1 lb. 3 oz.
Linseed meal	1 lb. 2 oz.
Cottonseed meal	1 lb. 8 oz.

Some of these materials, especially by-products like wheat bran, vary considerably in weight, and the above figures can not be regarded as strictly accurate for all cases. Weighing is, of course, always the safer way where it is desired to feed quite definite amounts.

DESCRIPTION OF FEEDING STUFFS.

The average composition of Texas feeding stuffs are given in Table No. 2. The coefficients of digestibility are given in Table No. 3. The feeding values of the various feeding stuffs are given in Table No. 4. There is a considerable variation in the composition of feeds, and it is necessary to recognize this fact in applying the tables to feeding conditions. We will not discuss these variations in detail in this bulletin. It is also not our intention to discuss all of the feeding stuffs, but we shall make some observations upon some of the more important feeds used in Texas.

ALFALFA MEAL.

Alfalfa meal is defined by the Association of Feed Control Officials as the entire alfalfa hay ground, and it should not contain an admixture of ground alfalfa straw or other foreign material.

Strictly speaking, alfalfa meal should be ground to a meal, so that there are no long pieces of the alfalfa stems. Some of the alfalfa meal, so-called, on the market should be designated as chopped alfalfa rather than alfalfa meal.

According to the investigations of Kellner, grinding a hay decreases the labor of chewing, and increases the feeding value left available to the animal. We have attempted to bring out this difference in the feeding values shown in the table. The difference is not in the digestible protein, but in the productive value.

The National Hay Association, July, 1914, adopted the following grades for alfalfa *hay:*

"Choice Alfalfa—Shall be reasonably fine, leafy alfalfa, of bright green color, properly cured, sound, sweet, and well baled.

"No. 1. Alfalfa—Shall be reasonably corase alfalfa of a bright green color, or reasonably fine leafy alfalfa of a good color and may contain two per cent. of foreign grasses, 5 per cent. of air bleached hay on outside of bale allowed. but must be sound and well baled.

"Standard Alfalfa—May be green color, of coarse or medium texture, and may contain 5 per cent. foreign matter. Or it may be green color, of coarse or medium texture, 20 per cent. bleached and 2 per cent. foreign matter. Or it may be greenish cast of fine stem and clinging foliage, and may contain 5 per cent. foreign matter. All to be sound, sweet, and well baled.

"No. 2. Alfalfa—Shall be of any sound, sweet, and well baled alfalfa, not good enough for standard, and may contain 10 per cent. foreign matter.

"No. 2. Alfalfa—May contain 25 per cent. stack spotted hay, but must be dry, and not contain more than 8 per cent. of foreign matter. Or it may be of green color, and may contain 50 per cent. of foreign matter. Or it may be set alfalfa, and may contain 5 per cent. foreign matter. All reasonably well baled.

"No Grade Alfalfa—Shall include all alfalfa not good enough for No. 3."

Alfalfa hay graded as No. 3 would not be suitable for the manufacture of alfalfa meal.

ANIMAL PRODUCTS.

The following are some definitions of animal products adopted by the Association of Feed Control Officials:

Blood Meal is ground dried blood.

Cracklings are the residue after partially extracting the fats and oils from the animal tissue. If they bear a name descriptive of their kind, composition or origin, they must correspond thereto.

Digested Tankage is the residue from animal tissue exclusive of hoof and horn specially prepared for feeding purposes by tanking under live steam, drying under high heat, and suitable grinding. If it contains any considerable amount of bone, it must be designated Digested Meat and Bone Tankage.

Meat Scrap and Meat Meal are the ground residue from animal tissue exclusive of hoof and bone. If they contain any considerable amount of bone, they must be designated Meat and Bone Scrap, or Meat

and Bone Meal. If they bear a name descriptive of their kind, composition and origin, they must correspond thereto.

CORN PRODUCTS.

The following definition and standards for corn products have been adopted by the Texas Feed Control (Bulletin No. 164):

Corn Chops consists of the pure grain of corn from sound seeds and good quality, chopped. It should contain not less than 9 per cent. of protein, 3.5 per cent. of fat, and not more than 3 per cent. of crude fiber.

Ear Corn Chops is husked corn and cob chopped, with not a greater proportion of cob than occurs in the ear corn in its natural state. It must contain not less than 8 per cent. of protein, 3 per cent. of fat, and not more than 8 per cent. of crude fiber. The percentages of grain and cob must be shown on the tax tag.

Ear Corn Meal corresponds to ear corn chops. The percentages of grain and cob must be shown on the tax tag.

Corn Bran is the outer covering of the corn grain, and must contain no less than 8 per cent. of protein, 3 per cent. of fat, and not more than 12 per cent. of crude fiber.

Hominy Feeds, Hominy Meal or Hominy Chops, is a mixture of the bran coating, the germ and a part of the starchy portion of the corn kernel, obtained in the manufacture of hominy grits for human consumption. It must contain not less than 10 per cent. of protein, 10 per cent. of fat, and not more than 7 per cent. of crude fiber.

Corn Feed Meal is the sifting obtained in the manufacture of cracked corn and table meal made from the whole grains. It must contain not less than 8 per cent. of protein, 3 per cent. of fat, and not more than 4 per cent. of crude fiber.

The following definitions of corn products not sold at present to any extent in Texas have been adopted by the Association of Feed Control Officials of the United States:

Corn Germ Meal is a product in the manufacture of starch, glucose and other corn products and is the germ layer from which a part of the corn oil has been extracted.

Grits are the hard, flinty portions of Indian Corn without hulls and germ.

Corn Gluten Meal is that part of commercial shelled corn that remains after the separation of the larger part of the starch, the germ and the bran by the processes employed in the manufacture of corn starch and glucose. It may or may not contaiin corn solubles.

Corn Gluten Feed is that portion of commercial shelled corn that remains after the separation of the larger part of the starch and the germ by the processes employed in the manufacture of corn starch and glucose. It may or may not contain corn solubles.

GRADES FOR COMMERCIAL CORN.

The Secretary of Agriculture fixed and promulgated the following grades of corn to take effect on July 1, 1914:

Grade, classification (white, yellow, and mixed corn).	Moisture.	Maximum Percentage of—		
		Damaged Corn.	Foreign material, including dirt, cob, other grains, finely broken corn, etc.	"Cracked" corn, not including finely broken corn. (See General Rule No. 9.)
No. 1	14.0	2 Exclusive of heat-damaged or mahogany kernels	1	2
No. 2	15.5	4	1	3
No. 3	17.5	6	2	4
No. 4	19.5	8 May include heat-damaged or mahogany kernels not to exceed	½ per cent	2
No. 5	21.5	10	1 per cent	3
No. 6	23.0	15	3 per cent	5
"Sample"	See General Rule No. 6 for sample grade.			

GENERAL RULES.

1. The corn in grades No. 1 to No. 5, inclusive, must be sweet.

2. White corn, all grades, shall be at least 98 per cent. white.

3. Yellow corn, all grades, shall be at least 95 per cent. yellow.

4. Mixed corn, all grades, shall include corn of various colors not coming within the limits for color as provided for under white or yellow corn.

5. In addition to the various limits indicated, No. 6 corn may be musty, sour, and may also include corn of inferior quality, such as immature and badly blistered.

6. All corn that does not meet the requirements of either of the six numerical grades by reason of an excessive percentage of moisture, damaged kernels, foreign matter, or "cracked" corn, or corn that is hot, heat damaged, fire burnt, infested with live weevils, or otherwise of distinctly low quality, shall be classed as sample grade.

7. In No. 6 and sample grade, reasons for so grading shall be stated on the inspector's certificate.

8. Finely broken corn shall include all broken particles of corn that will pass through a perforated metal sieve with round holes nine sixty-fourths of an inch in diameter.

9. "Cracked" corn shall include all coarsely broken pieces of kernels that will pass through a perforated metal sieve with round holes one-quarter of an inch in diameter, except that the finely broken corn, as provided for under Rule No. 8, shall not be considered as "cracked" corn.

10. It is understood that the damaged corn; the foreign material, including pieces of cob, dirt, finely broken corn, other grains, etc.; and the coarsely broken or "cracked" corn, as provided for under the various grades, shall be such as occur naturally in corn when handled under good commercial conditions.

11. Moisture percentages, as provided for in these grade specifications, shall conform to results obtained by the standard method and tester, as described in Circular No. 72, Bureau of Plant Industry, U. S. Department of Agriculture.

MOISTURE IN CORN CHOPS.

It has been pointed out in Bulletin No. 152 of this Station that corn or corn chops containing an excess of moisture is very liable to heat under Texas conditions, and the consumption of such heated corn or corn chops is dangerous to horses or mules. If corn chops contains over 14 per cent. moisture, it is almost certain to spoil in Texas during the warm months. As the differences in the grades of corn specified in the preceding table depend chiefly upon the quantity of water in them, and all exceed 14 per cent. except No. 1, it follows that No. 1 corn should be purchased for the Texas trade, or lower grades should be dried, or so stored that they will dry out, before being manufactured into corn chops, or exposed to warm temperatures. Corn chops containing over 10 per cent. of moisture should be well ventilated, or handled, if in bulk, so that it can dry out, especially during warm periods, otherwise it is likely to heat.

COTTONSEED PRODUCTS.

Cottonseed meal is composed of the kernels of the cottonseed after the oil has been extracted and the resulting cake ground up. As the separation of the kernels and hulls in the manufacturing process is not complete, cottonseed meal will contain some hulls, but any intentional addition of hulls or manipulation to allow hulls to enter the kernels, should be regarded as an adulteration. Some manufacturers make different artificial grades of cottonseed meal, by changing the screens so as to allow more or less hulls to enter with the cake. Some manufacturers also attempt to make a cottonseed meal uniform in protein or nitrogen content, by varying the separation of hulls and kernels with different lots of seed. This practice is clearly an adulteration of cottonseed meal, since the hulls are intentionally added for the purpose of reducing the quality or strength of the cottonseed meal. States which permit the sale of cottonseed meal upon a protein and fat basis alone, do not protect their citizens from this form of adulteration, and the cottonseed meal placed upon such markets is usually the lowest in protein allowed by the law, and therefore contains as much hulls as allowed. A moderate limit to the crude fiber allowed, limits the quantity of hulls which the manufacturers can introduce, and protects the consumer against excessive adulteration with hulls. It must be said, however, that some manufacturers will put in the maximum amount of hulls possible under the laws.

The following definitions and standards for cottonseed products have been adopted by the Texas Feed Control. (Bulletin 164.)

Cottonseed Meal is composed of the decorticated kernels of cottonseed, free from excess of hulls and other foreign materials. It should contain not less than 43 per cent. of protein, 7 per cent. of fat (not less than 50 per cent. of protein and fat combined) and *not over* 9 per cent. of crude fiber.

Cold Pressed Cotton Seed is the product obtained by subjecting undecorticated cottonseed to the cold pressure for the extraction of the oil, and includes the entire cottonseed, less the lint and oil extracted.

Ground Cold Pressed Cotton Seed is cold pressed cottonseed, ground.

According to the rules of the Texas Cottonseed Crushers Association *Choice Cottonseed Meal* or cake must contain 55 per cent. combined protein and fat, and must be reasonably bright in color, sweet in odor, and free from excess of lint and hulls.

Prime Cottonseed Cake or meal shall contain 51 per cent. of protein and fat combined, of sweet odor, variably bright in color, reasonably free from excess of lint.

No cottonseed meal or cake may be sold or offered under the rules of the Texas Cottonseed Crushers Association for sale for consumption in Texas which does not comply with the State Pure Food Law.

The following definitions have been adopted by the Association of Feed Control Officials of North America. The definition of prime, choice, and good meal are practically those of the Interstate Crushers Association. The definition of cottonseed meal was endorsed by a committee representing the Interstate Association.

Cottonseed Meal is a product of the cottonseed only, composed principally of the kernel with such portion of the hull as is necessary in the manufacture of oil; provided that nothing shall be recognized as cottonseed meal that does not conform to the foregoing definition and that does not contain at least 36 per cent. protein.

Choice Cottonseed Meal must be finely ground, not necessarily bolted, perfectly sound and sweet in odor, yellow, free from excess of lint, and must contain at least 41 per cent. of protein.

Prime Cottonseed Meal must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, yellow, not brown or reddish, free from excess of lint, and must contain at least 38.6 per cent. protein.

Good Cottonseed Meal must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color and must contain at least 36 per cent. of protein.

It will be noted that the definition of the Association of Feed Control Officials do not permit the adulteration of cottonseed meal with hull. If the meal contains any more hulls than is necessary in the manufacture of the oil, it is no longer cottonseed meal under the definition given, but is cottonseed meal and hulls. That is to say, this definition declines to recognize the addition of hulls or manipulation of screens, which has for its object the introduction of hulls to lower the grade of the meal.

QUALITY OF TEXAS COTTONSEED MEAL.

As pointed out in Bulletin 70 of this Station, Texas cottonseed meal is richer in protein than meal from other states. This is recognized by the Texas and the Interstate Crushers' Associations in the definitions just given, as the Texas standards are materially higher than the interstate. The composition and relative values of choice, prime, and average Texas cottonseed meals are given in the tables.

UTILIZATION OF COTTONSEED MEAL.

Cottonseed meal is undoubtedly a cheap feeding stuff, and gives the South great advantage, which have not yet been well utilized. Its price is very often such that a *feeder may disregard its protein value and*

feed it as a fat producing feed in competition with corn. It is often of advantage when feeding cottonseed meal in Texas, to feed the *maximum quantity of protein* consistent with the health of the animal, rather than the minimum advocated in most feeding standards or recommendations.

Cottonseed meal, in proper combination with other feeds, is an excellent feed for cattle, horses, mules, and poultry. At present prices of corn, it should be used more extensively for horses and mules. Two pounds per day per head may be fed with advantage.

According to Prof. W. A. Withers, of the North Carolina Experiment Station, cottonseed meal may be fed safely to hogs if an addition of copperas be made to the ration. He used one pound copperas dissolved in one barrel (50 gallons) water, and one gallon of this was mixed with one pound cottonseed meal, or in this proportion. Copperas changes on exposure to the air, and the solution should be freshly prepared, or not exposed to the air.

BREWING PRODUCTS.

The following are some definitions of brewing by-products, as adopted by the Association of Feed Control Officials.

Brewers' Dried Grains are the properly dried residue from cereals obtained in the manufacture of beer.

Distillers' Dried Grains are the dried residue from cereals obtained in the manufacture of alcohol and distilled liquors. The product shall bear the designation indicating the cereal predominating.

Malt Sprouts are the sprouts of the barley grain. If the sprouts are derived from any other malted cereal, the source must be designated.

BUCKWHEAT PRODUCTS.

Buckwheat Shorts or *Buckwheat Middlings* are defined as that portion of the buckwheat grain immediately inside of the hull after separation from the flour.

HAY GRADES.

The following are the grades of hay adopted by the National Hay Association, July, 1914. They are here printed as a matter of information:

"No. 1. *Timothy Hay*—Shall be timothy with not more than one-eighth ($\frac{1}{8}$) mixed with clover or other tame grasses, may contain some brown blades, properly cured, good color, sound and well baled.

"No. 2. *Timothy Hay*—Shall be timothy not good enough for No. 1, not over one-fourth ($\frac{1}{4}$) mixed with clover or other tame grasses, fair color, well baled.

"No. 3. *Timothy Hay*—Shall include all timothy not good enough for other grades, sound and reasonably well baled.

"*Light Clover Mixed Hay*—Shall be timothy mixed with clover. The clover mixture not over one-third ($\frac{1}{3}$) properly cured, sound, good color and well baled.

"No. 2. *Clover Mixed Hay*—Shall be timothy and clover mixed with at least one-fourth ($\frac{1}{4}$) timothy and clover reasonably sound and well baled.

"No. 1. *Clover Hay*—Shall be medium clover not over one-twentieth (1/20) other grasses, properly cured, sound, and well baled.

"No. 2. *Clover Hay*—Shall be clover sound and reasonably well baled, not good enough for No. 1.

"*Sample Hay*—Shall be sound, reasonably well baled, mixed grassy or hay not covered by other grades.

"*No Grade Hay*—Shall include all hay musty, threshed or in any way unsound.

"*Choice Prairie Hay*—Shall be upland hay of bright, natural color, well cured, sweet, sound, and may contain 3 per cent. weeds.

"No. 1. *Prairie Hay*—Shall be upland and shall contain one-quarter midland, both of good color, well cured, sweet, sound and may contain 8 per cent. weeds.

"No. 2. *Prairie Hay*—Shall be upland, of fair color and may contain one-half midland, both of good color, well cured, sweet, sound and may contain 12½ per cent. weeds.

"No. 3. *Prairie Hay*—Shall include hay not good enough for the other grades and not caked.

"No. 1. *Midland Hay*—Shall be midland hay of good color, well cured, sweet, sound and may contain 3 per cent. weeds.

"No. 2. *Midland Hay*—Shall be of fair color, or slough hay of good color, and may contain 12½ per cent. weeds.

"*Packing Hay*—Shall include all wild hay not good enough for other grades and not packed.

"*Sample Prairie Hay*—Shall include all hay not good enough for other grades."

KAFIR PRODUCTS.

The following definitions and standards have been adopted by the Texas Feed Control:

Kafir Chops consists of the entire grain removed from the head and chopped. It must contain not less than 9 per cent. of protein, 2.5 per cent. of fat, and not more than 3.5 per cent. of crude fiber.

Kafir Head Chops consists of the entire head chopped. It must contain not less than 8 per cent. of protein, 2.5 per cent. of fat, and not more than 8 per cent. of crude fiber.

The seeds of kafir and milo are hard, and if not crushed or ground, are liable to escape mastication or digestion.

MILO PRODUCTS.

The following definitions and products have been adopted by the Texas Feed Control:

Milo Chops consists of the entire grain removed from the head and chopped. It must contain not less than 9 per cent. of protein, 2.5 per cent. of fat, and not more than 3.5 per cent. of crude fiber.

Milo Head Chops consists of the entire head, chopped. It must contain not less than 8 per cent. of protein, 2.5 per cent. of fat, and not more than 8 per cent. of crude fiber.

RICE PRODUCTS.

The following definitions of rice products have been adopted by the Texas Feed Control:

Rice Bran is the cuticle of the rice grain, and must contain not less than 11 per cent. of protein, 10 per cent. of fat, and not more than 12 per cent. of crude fiber.

Rice Polish is the finely powdered material secured in polishing rice. It must contain not less than 11 per cent. of protein, 6 per cent. of fat, and not more than 4 per cent. of crude fiber.

Rice bran sometimes contains an excess of rice hulls, and sometimes quantities of broken rice. In either case, it is no longer properly labeled as rice bran.

OAT PRODUCTS.

The following definitions of oat products have been adopted by the Association of Feed Control Officials of North America:

Oat Groats are the kernels of the oat berry with the hulls removed.

Oat Hulls are the outer chaffy coverings of the oat grain.

Oat Middlings are the floury portion of the oat groat obtained in the milling of rolled oats.

Oat Shorts are the covering of the oat grain lying immediately inside the hull, being a fuzzy material carrying with it considerable portions of the fine floury part of the groat obtained in the milling of rolled oats.

Clipped Oat By-Product (term oat clippings not recognized) is the resultant by-product obtained in the manufacture of clipped oats. It may contain light, chaffy material broken from the ends of the hulls, empty hulls, light, immature oats and dust. It must not contain an excessive amount of oat hulls.

STRAW.

The following grades of straw were adopted by the National Hay Association, June, 1914:

"No. 1. *Straight Rye Straw*—Shall be in large bales, long rye straw, clean, bright, pressed in bundles, sound and well baled.

"No. 2. *Straight Rye Straw*—Shall be in large bales, long rye straw, pressed in bundles, sound and well baled, not good enough for No. 1.

"No. 1. *Tangled Rye Straw*—Shall be reasonably clean rye straw, good color, sound and well baled.

"No. 2. *Tangled Rye Straw*—Shall be reasonably clean, may be some stained, but good enough for No. 1.

"No. 1. *Wheat Straw*—Shall be reasonably clean wheat straw sound and well baled.

"No. 2. *Wheat Straw*—Shall be reasonably clean, may be some stained, but not good enough for No. 1.

"No. 1. *Oat Straw*—Shall be reasonably clean oat straw, sound and well baled.

"No. 2. *Oat Straw*—Shall be reasonably clean, may be some stained, but not good enough for No. 1."

WHEAT PRODUCTS.

The following definitions and standards have been adopted by the Texas Feed Control:

Pure Wheat Bran is the outer covering of the wheat grain, with or

without shorts, and must contain not less than 14.5 per cent. of protein, 3 per cent. fat, and not more than 10 per cent. of crude fiber.

Wheat Bran and Screenings is pure wheat bran with screenings not to exceed mill run, or 8 per cent.

Mixed Wheat Bran and Screenings includes all mixtures of wheat bran and screenings containing more than 8 per cent. of screenings.

Wheat Shorts is the starchy portion of the wheat seed, and must contain not less than 15 per cent. of protein, 3 per cent. of fat, and not more than 5 per cent. of crude fiber.

Wheat Chops is the entire grain of sound wheat, chopped. It must contain not less than 14 per cent. of protein, 2 per cent. of fat, and not more than 5 per cent. of crude fiber.

The following additional definitions have been adopted by the Association of Feed Control Officials:

Red Dog is a low grade wheat flour containing the finer particles of bran.

Wheat Bran with Mill Run Screenings is pure wheat bran plus the screenings which were separated from the wheat used in preparing said bran.

Wheat Bran with Screenings not Exceeding Mill Run is either wheat bran with the whole mill run of screenings or wheat bran with a portion of the mill run of screenings, provided that such portion is not an inferior portion thereof.

FEEDING STANDARDS AND FEEDING.

Table No. 1 gives the standards which seem advisable for use for various feeding purposes, based on 1000 pounds live weight. These standards have been calculated: First, upon the basis of exact experiments to ascertain the needs of the animal; secondly, on feeding experiments with various rations, carried on in large number and in various parts of the world in which the effects of the rations were determined, and thirdly, on the experience of practical feeders of large numbers of rations. The standards here used are those given in Fraps' Principles of Agricultural Chemistry.

The standards represent the rations, which should, as a rule, give the best results. The individuality of the animal should be considered and the ration changed or modified as may be necessary. The standards must not be regarded as fixed rules but are merely intended to enable a feeder to start with a well based average ration. He should then modify or change the ration to suit the requirement of his animals. This is particularly necessary in view of the fact that the feeding stuff used may differ materially from the average given in the table of analyses, and used in the feeding standards. There is undoubtedly a considerable variation in the composition and feeding values of different feeding stuffs of the same kind, and the feeder must take this fact most carefully into consideration.

The suitability of the feed to the animal to which it is given must also be considered. Some animals are only able to utilize well small quantities of certain feeding stuffs The palatability of the feed is also to be considered.

Every change in the food, whether it is a new food or a change in quantity, should be gradual, covering a period of four to seven days.

The feeding standards and the tables of analyses may also be used to great advantage in studying the rations which are being fed to animals, and to ascertain whether they cannot be improved in feeding value, or lowered in cost. This is a very important and significant use of the table. As has been pointed out in other parts of this bulletin, it is very often of advantage to feed higher quantities of protein than are called for in the standards on account of the comparatively low cost of such feeds at various times in this state. That is to say, the protein could be fed for its productive value, and not for its value as material for forming flesh. In other words, greater advantage should be taken of the cottonseed meal, and cottonseed meal should be used at a greater extent in rations.

Table 1. Feeding Standards Per Day and Per 1000 Pounds Live Weight.

	Total weight, dry matter. Pounds.	Proteids. Pounds.	Productive value. Pounds.	Nutritive ratio.	Lime. Grams.	Phosphoric acid. Grams.
Steers, maintenance	12–21	0.6–0.8	1.50	1:9	.....	.....
Sheep, coarse breeds	18–23	1.0	2.08	1:9	.....	.....
Sheep, fine breeds	20–26	1.2	2.25	1:8	.....	.....
Fat steers	21–24	1.0–1.50	1.75–2.25	1:8	.....	.....
Pigs, fattening—						
Preliminary period	33–37	3.0	6.8	1:55	.....	.....
Fattening period	28–33	2.8	6.5	1:6.0	.....	.....
Final period	24–88	2.0	5.0	1:6.5	.....	.....
Fattening sheep	24–32	1.6	3.6	1:4.5	.....	.....
Fattening oxen—						
Preliminary period	22–30	1.8	3.0	1:6.4	.....	.....
Main period	24–32	1.6	3.0–3.6	1:5.5	.....	.....
Finishing period	2.–30	1.4	2.8–3.4	1:6.0	.....	.....
Horse, light work	18–23	1.0	2.3	6.9	.....	.....
Horse, moderate work	21–26	1.4	2.9	6.9	.....	.....
Horse, heavy work	23–28	2.0	3.8	6.2	.....	.....
Ox, light work	20–25	1.1	1.9	10.9	.....	.....
Ox, moderate work	22–28	1.4	2.4	7.5	.....	.....
Ox, heavy work	25–30	1.8	3.2	6.0	.....	.....
Milk cows giving—						
Ten pounds milk	22–27	1.3	2.1	1:6.8	70	47
Twenty pounds milk	25–29	2.0	2.7	1:6.8	95	72
Thirty pounds milk	27–33	2.8	3.5	1:6.5	120	97
Forty pounds milk	27–34	3.7	4.2	1:6.5	145	122
For maintenance only	15–21	0.7	1.5	1:0	.....	.....
For each 10 pounds milk	.....	0.55	0.6	.....	.....	.....

EXACT CALCULATION OF A RATION.

Before beginning to calculate a ration, it is necessary to decide on the ration desired, the feeds available, and their probable composition. In calculating the ration we must consider:

1. The desired productive value.
2. The desired bulk.
3. The desired proteid content.

All these vary somewhat, especially the bulk and the proteids.

We will term the method of calculation given below, the method of substitution. It is best illustrated by an example. Suppose we desire a ration with a bulk of about 28 pounds, proteids 2.0 pounds, and productive value of 2.8 pounds, and wish to use corn chops, cottonseed meal, and cottonseed hulls, having the composition given below. As these feeds all contain about ten per cent. water, for which allowance

has been made in considering the total bulk to be fed, it is not necessary to calculate to dry matter.

First, let us assume that the 28 pounds fed is entirely cottonseed hulls. This quantity of cottonseed hulls has productive value of 0.84 pounds, and the value desired is 2.80 pounds, leaving a deficiency of 1.96 pounds. If now we replace cottonseed hulls having a productive value of 0.03 a pound, by corn chops, having a productive value of 0.206, for every pound of cottonseed hulls replaced, we gain 0.206—0.03=0.176 pounds productive value. Dividing 1.96 by 0.176 we have 11.1 pounds corn chops, which should replace an equal amount of cottonseed hulls.

Cottonseed hulls 17.9 pounds and corn chops 11.1 pounds contain 0.86 pounds proteids, while 2.0 pounds is desired, a deficiency of 1.14 pounds proteids. Since cottonseed meal has nearly the same productive value as corn chops, it can replace corn chops without materially altering the productive value of the ration. If one pound average cottonseed meal containing 0.352 pounds digestible protein replace one pound corn chops containing 0.065 pounds digestible protein, the digestible protein increases 0.352—0.065=0.287 pounds, so that to increase the ration 1.14 pounds, we require 1.14 divided by 0.287=4.0 pounds cottonseed meal in place of an equal quantity of corn chops. The ration would then consist of 17.9 pounds cottonseed hulls, 7.1 pounds corn chops, and 4 pounds cottonseed meal. The substitution of 1 pound cottonseed meal for 1 pound corn chops decreases the productive value 0.206—0.195=0.01, or 0.04 pounds for the 4 pounds substituted; and this can be adjusted by adding 0.25 pounds corn chops, making a total of 7.35 pounds corn chops in the ration. This finally gives the ration desired.

The method of calculation used above may be stated as follows:

1. Assume the bulk desired is composed of the roughage to be used and calculate its productive value.
2. Calculate the quantity of concentrate which would give the desired productive value if it replaced a portion of the roughage.
3. Calculate the proteids in the mixture having the composition ascertained above, and then calculate the quantity of a concentrate, rich in proteids, which must replace a portion of the other concentrate in order to give the desired quantity of proteids. The calculation is easier if the two concentrates have nearly the same productive value.
4. Adjust the ration by increasing or decreasing the quantity of one of the concentrates slightly, so that the change in the productive value caused by the second concentrate may be allowed for.

IMPROVING A RATION.

Suppose a horse weighing 1,000 pounds is at hard work, plowing for example, and is receiving 7 pounds corn, 6 pounds wheat bran, and 12 pounds timothy hay. How does this ration compare with the standard and how can it be improved? First, calculate the digestible proteids and productive value of the ration.

	Digestible Proteids.		Productive Value.
Corn	7x0.068—0.48 lbs.		7x0.206—1.44 lbs.
Wheat bran	6x0.12 —0.72		6x0.12 —0.72
Timothy hay	12x0.021—0.25		12x0.078—0.94
Total	25	1.45	3.10
Standard	23–28	2.0	3.8

The ration is too low in proteids and in productive value. Productive value may be increased by substituting corn for timothy hay. One pound corn substituted increases the productive value 0.206—0.078=0.128; so to gain the 0.7 pound desired would take 5.5 pounds corn chops. Each pound of corn chops substituted would increase the proteids in the ration 0.068—0.021=0.047 pounds, or 5.5 pounds would increase it 0.26 pound. This would increase the total proteids to 1.71, but would still leave a deficiency of 0.29 pounds proteids. If we replace corn by cottonseed meal to supply this protein, we require 0.29÷(0.352—0.068)=1.0 pound cottonseed meal.

The calculated ration would then be as follows:

	Pounds.
Corn	7+ 5.5—1.0=11.5
Wheat bran	= 6.0
Timothy hay	12 —5.5= 6.5
Cottonseed meal	= 1.0
Total	25.0

REDUCING THE COST OF A RATION.

The commercial prices of feeding stuffs are often not in proportion to their feeding values, and rations may often be modified so as to reduce the cost of the ration. There are four things to be considered in reducing the cost of a ration: (1) the suitability of the feed to the animal; (2) the cost of the productive value; (3) the cost of the digestible proteids per pound; (4) the cost of the bulk or volume of the feed.

The three last factors can be calculated from the known selling price, and the proteid content and productive value of the feeds. The bulk of the feed is of course measured by the total amount of dry matter. It often happens that hays cost more per unit of feeding value than concentrated feeds. In such cases, the cheaper bulky feeds should be used, and the difference in nutritive value compensated for by increasing the concentrates.

Suppose a feeder who is using 6 pounds wheat bran at a cost of $30.00 a ton, can secure corn at $30.00 and cottonseed meal at $40.00. Would it pay to substitute? Six pounds wheat bran contains 0.72 pound proteids and 0.72 pound productive value. Three and one-half pounds corn would contain 0.72 pound productive value and 0.241 pound proteids, or a deficiency of 0.48 pound proteids. Replacing corn by cottonseed meal, 0.48÷(0.352—0.068)=1.4 pounds. That is, 1.4 pounds cottonseed meal and 3.5 pounds corn are equivalent to 6 pounds wheat bran. The cost would be 6×1.5=9 cents for wheat bran; and for the mixture, 1.4×2.0=2.8 cents for the cottonseed meal, and for the corn

$3.5 \times 1.5 = 5.25$ cents, a total of 8.05 cents for the mixture or a difference of 0.95 cents, nearly one-ninth, in favor of the mixture. The difference in bulk of the ration should be adjusted when such substitutions are made, unless it comes within the range of the variations allowed.

The preceding illustration shows the method which may be followed in reducing the cost of a ration. In substituting for proteids, a suitable feed providing the proteids at the lowest cost per unit should be used. In substituting for productive value, a suitable feed productive value, a suitable feed providing the most productive value for the money should be used, and the same remark applies to substituting for bulk.

VARIATIONS IN THE COMPOSITION OF FEEDING STUFFS.

Variation in the composition of feeding stuffs is due to both natural and artificial causes. Feeding stuffs naturally vary somewhat in composition. The character of seed, the kind of soil on which they are grown, the kind of season, the fertility of the soil, and other factors, affect their chemical composition. Methods used in curing hays, states of growth at which they are cut, and the quantities of water contained in them, cause hays to vary. Manufactured products vary according to the methods of manufacture, and, sometimes, according to the additions which are made to them, or which are allowed to go into them, during the process of manufacture. It thus follows that the composition of a given feeding stuff may be materially different from the average composition, shown in the table of analyses. The variations in feeding values are indeed quite large at times, and this fact must be borne in mind when preparing rations for feeding, or otherwise arranging to make use of the nutritive value of feeding stuffs. Concentrated commercial feeding stuffs are sold under a guaranteed minimum analysis for protein, fat and nitrogen-free extract and a guaranteed maximum percentage of crude fiber. If the feeding stuff falls below the guarantee of protein, fat or nitrogen-free extract, or above the guarantee for crude fiber, or, if the feed in any way is not as represented, then the seller is liable to a fine, under the feeding stuff law. Inquiries concerning this matter should be addressed to the Feed Control, College Station, Texas.

TABLE OF THE AVERAGE COMPOSITION OF FEEDING STUFFS.

The average composition as given in this Table No. 2 is taken from the publications referred to in the columns, which are as follows:

Farmers' Bulletin No. 22, United States Department of Agriculture.

Bulletin No. 95, Texas Experiment Station.

U Compilations from analyses at the Texas Experiment Station, or analyses not previously published.

Bulletin No. 147, Texas Experiment Station.

Bulletin No. 154, Texas Experiment Station.

Bulletin No. 166, Texas Experiment Station.

Bulletin No. 102, Bureau of Animal Husbandry, U. S. Department of Agriculture.

Some few analyses from Henry's Feeds and Feeding.

The same references apply to Table No. 2, coefficients of digestibility.

The ones marked Mass, taken from tabulation of the Massachusetts Experiment Station.

Table No. 3 shows the average coefficients of digestibility of various feeds, and Table No. 4 shows the productive values of feeds, calculated from the values given in Tables Nos. 2 and 3.

Table No. 2. Average Composition of Feeding Stuffs.

	Protein.	Ether extract.	Crude fiber.	Nitrogen free extract.	Water.	Ash.	Number averaged.	Reference Number.
Alfalfa hay	14.42	1.97	29.98	35.81	9.61	8.41	34	166 Texas
Alfalfa meal	14.81	1.90	27.54	38.48	8.80	8.38	52	166 Texas
Alfalfa (green)	4.8	1.0	7.4	12.3	71.8	2.7	23	22 U. S.
Acorns	2.5	1.9	4.4	34.8	55.3	1.0	.....	Henry
Bermuda grass	2.2	0.9	5.9	17.2	71.7	2.1	.....	Henry
Bermuda hay	7.17	1.75	24.90	49.39	8.87	7.92	11	166 Texas
Barley chops	12.4	1.8	2.7	69.8	10.9	2.4	10	22 U. S.
Beet pulp (dried)	8.1	0.7	17.5	60.8	8.4	4.5	7	Henry
Beef scraps	60.05	14.43	2.17	2.75	7.09	13.51	4	U
Bone, fresh	20.6	20.5	.....	1.9	34.2	22.8	.....	Henry
Beef meal	53.24	9.86	2.92	12.91	7.59	13.48	4	U
Broom corn seed	9.9	3.2	7.0	64.3	12.8	2.8	4	Henry
Brewer's grains	23.84	6.20	17.61	41.91	6.31	3.74	12	U
Blood meal	82.85	0.46	1.48	2.16	9.87	3.18	4	U
Burr clover hay	23.43	2.12	20.81	31.83	9.73	12.10	2	147 Texas
Buffalo grass hay	7.85	1.83	26.13	45.29	7.57	11.34	3	147 Texas
Careless weed (dry)	18.57	1.27	19.47	42.13	9.07	18.49	1	U
Carrot	1.1	0.4	1.3	7.6	88.6	1.0	8	22 U. S.
Corn, Argentine	10.36	4.75	1.96	71.39	10.09	1.45	1	U
Corn bran	8.98	4.92	11.03	63.11	10.17	1.79	38	166 Texas
Corn chops	9.23	3.85	2.32	70.97	12.82	1.37	245	154 Texas
Corn and cob meal	8.92	3.44	7.93	68.35	9.75	1.53	30	U
Corn cob	2.4	0.5	30.1	54.9	10.7	1.4	18	22 U. S.
Corn fodder, green	1.8	0.5	5.0	12.2	79.3	1.2	126	22 U. S.
Corn fodder, field-cured (entire plant	4.5	1.6	14.3	34.7	42.2	2.7	35	22 U. S.
Corn silage	2.2	1.1	5.8	15.0	74.4	1.5	62	22 U. S.
Corn shucks	2.77	0.60	30.08	55.14	8.37	3.03	4	147 Texas
Corn stover field-cured (left after harvesting ears)	3.8	1.1	19.7	31.5	40.5	3.4	60	22 U. S.
Cold pressed cotton seed	26.47	7.31	24.58	29.53	8.11	4.10	73	166 Texas
Cotton seed (whole)	19.6	20.1	18.9	28.3	9.1	4.0	11	22 U. S.
Cottonseed meal, Texas averaged 1913	44.84	8.66	9.08	25.29	6.76	5.37	259	164 Texas
Cottonseed meal, Texas choice 1913	47.14	9.19	7.63	23.79	6.86	5.43	80	U
Cottonseed meal, Texas prime 1913	43.37	7.71	10.34	25.94	7.31	5.31	52	U
Cottonseed hulls	4.11	1.46	45.27	37.09	9.51	2.56	24	166 Texas
Cowpeas (seed)	23.5	1.7	3.8	55.7	11.9	3.4	17	22 U. S.
Cowpea hay	14.56	2.72	23.31	41.53	10.04	7.82	17	147 Texas
Cowpea vines, green	2.4	0.4	4.8	7.1	83.6	1.7	10	22 U. S.
Crimson clover, green	3.1	0.7	5.2	8.4	80.9	1.7	3	22 U. S.
Crimson clover hay	15.2	2.8	27.2	36.6	9.6	8.6	7	22 U. S.
Clover, sweet (green)	3.8	0.6	6.3	7.4	80.0	1.9	4	Henry
Ear corn chops	8.92	3.44	7.93	68.35	9.75	1.53	30	U
Ear corn chops with shucks	7.45	3.53	11.55	64.96	11.15	1.36	3	U
Fererita seed	12.95	2.89	2.04	69.66	10.83	1.64	4	U
Fish, dried	48.4	11.6	.....	.....	10.8	29.2	6	Henry
Forney hay	4.00	2.27	24.40	52.84	7.96	8.53	1	95 Texas
Egyptian wheat	11.25	3.78	2.47	72.09	9.52	0.89	1	U
Guam grass	8.43	1.73	26.00	49.40	7.66	6.79	1	147 Texas
Johnson grass (green)	2.99	1.16	5.60	8.12	78.78	1.92	7	.....
Johnson grass roots (fresh)	0.93	0.20	4.19	12.85	80.11	1.73	2	U
Johnson grass hay	7.22	1.90	30.00	44.06	9.70	7.12	11	147 Texas
Jack beans (seed) *Convolvia ensiformia*	23.82	3.52	8.05	50.79	11.06	2.77	2	U
Kaffir chops	10.84	3.00	2.46	70.88	11.22	1.65	1.56	166 Texas
Kaffir head chops	10.03	2.67	7.07	67.07	9.82	3.17	29	166 Texas
Kaffir fodder	13.10	4.15	22.37	40.18	8.37	11.83	7	147 Texas
Kaffir silage	2.1	1.4	11.2	15.2	67.2	2.9	3	Henry
Milk (whole)	3.6	3.7	.....	4.9	87.2	0.7	793	22 U. S.
Milk (skimmed) (separator)	3.2	0.3	.....	5.2	90.6	0.7	9	22 U. S.
Mangels wurzels	1.4	0.2	0.8	5.4	91.2	1.0	16	22 U. S.
Meat meal	58.20	13.60	3.08	2.65	7.05	15.42	4	U
Molasses (cane)	3.86	.....	.....	66.05	24.69	5.41	5	U
Mesquite beans (in pod green from trees) (dried)	13.77	3.15	25.84	45.29	7.53	4.42	1	U
Mesquite beans, windfalls	10.47	1.67	28.28	48.89	6.37	4.32	1	U
Millet hay	7.75	2.25	28.72	43.19	10.21	7.88	20	147 Texas
Millet seed	10.9	3.5	8.1	62.6	12.1	2.8	6	Henry
Milo chops	10.21	2.95	2.34	72.24	11.28	4.51	46	154 Texas
Milo head chops	9.75	2.64	5.54	68.48	10.39	3.01	17	154 Texas
Milo fodder	11.54	5.17	19.37	42.84	9.54	11.55	3	95 Texas

Table No. 2. Average Composition of Feeding Stuffs—Continued.

	Protein.	Ether extract.	Crude fiber.	Nitrogen free extract.	Water.	Ash.	Number averaged.	Reference Number.
Milo silage	2.2	0.7	7.9	12.7	74.6	1.8	1	Henry
Orchard grass hay	8.1	2.6	32.4	41.0	9.9	6.0	10	22 U. S.
Oats	11.8	5.0	9.5	59.7	11.0	3.0	30	22 U. S.
Oats (green)	3.4	1.4	11.2	19.3	62.2	2.5	6	Henry
Oat hay	7.72	2.89	27.80	42.16	13.44	5.99	11	147 Texas
Oat straw	4.0	2.3	37.0	42.4	9.2	5.1	12	22 U. S.
Para grass hay	3.34	0.91	33.80	46.74	8.36	7.10	.....	147 Texas
Poultry bone	24.04	0.46	1.89	3.17	7.22	63.22	2	U
Prairie hay (South Texas average)	4.04	2.10	29.74	47.18	8.93	8.05	2	166 Texas
Prickley pear	0.73	0.34	2.41	9.04	84.26	3.06	.....	102 U. S.
Palmetto seed	7.13	3.19	14.41	71.02	1.38	2.87	1	95 Texas
Peanut kernels	27.27	43.07	2.53	17.25	7.7	2.11	6	Tenn. Bull.
Peanuts with hulls	21.83	32.78	18.89	15.73	8.03	2.45	6	Calc.
Peanut cake (cold pressed)	30.88	11.00	22.52	23.28	6.28	3.75	.....	.....
Peanut hay	11.99	7.98	24.61	39.38	8.82	7.22	4	147 Texas
Peanut straw (no nuts)	10.7	4.6	23.6	42.7	7.6	10.8	6	22 U. S.
Potatoes	2.11	0.1	0.6	17.3	78.9	1.0	12	22 U. S.
Rape (green)	2.2	0.5	2.1	7.0	85.7	2.5	5	Henry
Rice (rough)	8.31	1.34	7.73	67.68	11.07	3.87	7	U
Rice bran	12.21	11.59	11.82	44.73	10.10	9.66	158	166 Texas
Rice hulls	3.07	1.12	36.17	34.66	8.62	15.38	14	95 Texas
Rice polish	12.22	9.74	2.89	60.38	9.55	5.07	97	166 Texas
Rice straw	4.11	1.54	31.56	41.37	6.57	14.85	6	147 Texas
Red clover, green	4.4	1.1	8.1	13.5	70.8	2.1	43	22 U. S.
Red clover hay	12.3	3.3	24.8	38.1	15.3	6.2	38	.....
Rye chops	10.6	1.7	1.7	72.5	11.6	1.9	.....	.....
Rye straw	3.0	1.2	38.9	46.6	7.1	3.2	7	22 U. S.
Sorghum seed	9.1	3.6	2.6	69.8	12.8	2.1	10	Henry
Sorghum silage	1.60	1.03	6.16	12.40	77.29	1.31	7	166 Texas
Sorghum (green)	1.3	0.5	6.1	11.6	79.4	1.1	11	Henry
Sorghum fodder	5.38	2.80	28.52	48.77	8.89	5.67	6	166 Texas
Sudan grass	6.11	1.49	30.64	45.37	10.00	6.40	4	U
Sunflower seed	16.3	21.2	29.9	21.4	8.6	2.6	2	Henry
Sugar cane (green)	1.2	0.5	4.0	9.0	84.2	1.1	2	Henry
Sugar beet	1.8	0.1	0.9	9.8	86.5	0.9	19	Henry
Tallow weed (dried)	8.25	1.80	22.46	32.29	6.38	28.82	1	95 Texas
Tankage (feeding)	49.68	14.60	6.29	4.84	6.76	17.83	3	U
Timothy grass	3.1	1.2	11.8	20.2	61.6	2.1	56	22 U. S.
Timothy hay	5.9	2.5	29.0	45.0	13.2	4.4	68	22 U. S.
Turnips	1.3	0.2	1.2	5.9	90.6	0.8	4	22 U. S.
Vetch hay	17.72	2.30	23.33	35.94	13.18	7.53	14	147 Texas
Water lilies	2.09	0.35	1.72	6.33	88.17	1.34	1	U
Wheat	11.9	2.9	1.8	71.9	10.5	1.8	310	22 U. S.
Wheat bran	16.59	4.03	8.84	54.87	9.86	5.75	71	154 Texas
Wheat screenings	15.71	2.34	5.15	63.49	9.69	3.57	35	U
Wheat shorts	17.22	4.04	4.39	61.05	9.58	3.52	68	154 Texas
Wheat straw	3.4	1.3	38.1	43.4	9.6	4.2	7	22 U. S.
Whey	0.6	0.1	.....	5.1	93.8	0.4	46	22 U. S.

Table No. 3. Average Coefficients of Digestibility.

	Protein.	Ether extract.	Crude fiber.	Nitrogen free extract.	Ash.	Number averaged.	Reference Number.
Alfalfa hay	75.29	38.40	46.77	68.83	49.17	18	166 Texas
Alfalfa (green)	74	39	43	72	.....	1	Mass.
Bermuda hay	53.10	41.60	53.17	50.63	33.73	3	166 Texas
Buffalo grass hay	53.8	49.0	61.5	59.9	15.2	2	147 Texas
Barley chops	77	78	56	92	.....	.....	Mass.
Brewer's grains	81	90	49	57	89	.....	Mass.
Blood meal	84	.....	.....	.....	.....	.....	Mass.
Burr clover hay	80.7	5.4	64.2	75.9	62.6	1	147 Texas
Corn bran	58.20	76.63	59.56	77.21	8.48	4	166 Texas
Corn meal	67	90	.....	92	.....	12	Mass.
Corn and cob meal	52	84	45	88	.....	1	Mass.
Corn cob	17	50	65	60	.....	1	Mass.
Corn fodder green	54	75	59	75	.....	12	Mass.
Corn fodder, dry	50	65	67	62	.....	6	Mass.
Corn silage	50	77	65	69	.....	17	Mass.
Corn shucks	12.5	38.6	69.3	60.6	21.5	2	147 Texas
Corn stover	37	69	64	59	.....	12	Mass.
Cold pressed cotton seed	74.28	85.98	39.55	63.23	54.22	4	166 Texas
Cottonseed (whole) row	68	87	76	50	.....	1	Mass.
Cotton seed (roasted)	47	72	66	51	.....	1	Mass.

Table No. 3. Average Coefficients of Digestibility—Continued.

	Protein.	Ether extract.	Crude fiber.	Nitrogen free extract.	Ash.	Number averaged	Reference Number.
Cottonseed hulls	14.1	68.9	49.0	47.7	25.2	8	166 Texas
Cottonseed meal, rich in hulls	72.9	90.9	37.3	61.8	.....	12	166 Texas
Cowpea meal	82	74	64	93	.....	.....	Mass.
Cowpea hay	68.5	40.2	46.7	67.9	30.3	.....	147 Texas
Cowpea vines, green	76	59	60	81	.....	2	Mass.
Crimson clover, green	77	66	56	74	.....	1	Mass.
Crimson clover hay	69	44	45	62	.....	3	Mass.
Ear corn chops	71	87	48	83	.....	1	Mass.
Guam grass hay	50.7	57.2	57.1	53.8	28.4	1	147 Texas
Hominy meal	65	92	67	89	.....	.....	Mass.
Johnson grass hay	43.9	44.9	66.2	56.8	27.1	.....	147 Texas
Kaffir chops	56.2	47.2	27.4	68.8	43.4	6	166 Texas
Kaffir head chops	63.41	74.35	61.08	80.41	36.15	.....	166 Texas
Kaffir fodder	63.0	53.1	67.1	69.4	43.6	1	147 Texas
Milk (whole)	95	97	.....	.....	.....	.....	.....
Milk (skimmed)	95	100	.....	100	.....	.....	.....
Mangels wurzels	75	.....	43	91	.....	.....	Mass.
Molasses (cane)	57	.....	.....	90	.....	.....	104 Texas
Millet hay	52.2	49.6	64.4	56.7	54.3	.....	147 Texas
Milo chops	66	90	100	85	92	.....	Mass.
Orchard grass hay	60	55	61	55	.....	2	Mass.
Oats (grain)	77	89	31	77	25	2	Mass.
Oat hay	54.4	62.9	52.7	56.7	37.2	.....	147 Texas
Oat straw	21	42	61	55	.....	4	Mass.
Para grass hay	9.9	45.0	52.8	46.9	23.2	.....	147 Texas
Prairie hay (Texas average)	.....	39.1	53.5	46.9	4.9	3	166 Texas
Peanut cake (cold pressed)	90	90	9	84	.....	.....	German
Peanut hay	71.0	78.0	52.2	71.9	20.9	.....	147 Texas
Potatoes	44	13	.....	91	1	.....	Mass.
Rice bran	64.35	80.85	19.05	89.92	15.98	4	166 Texas
Rice hulls	10	67	.....	35	.....	.....	German
Rice polish	67.3	82.1	25.7	91.1	30.0	2	166 Texas
Rice straw (Japan)	16.8	6.4	60.3	45.0	12.1	1	147 Texas
Rice straw (Honduras)	26.6	36.4	58.0	47.3	15.0	1	147 Texas
Red clover, green	67	63	53	72	.....	12	Mass.
Red clover hay	58	56	54	65	.....	.....	Mass.
Rye meal	84	64	.....	92	.....	1	Mass.
Rye fodder (green)	79	74	80	71	.....	1	Mass.
Sorghum silage	9.0	56	58	64	.....	.....	166 Texas
Silage, sorghum and cowpea	23.8	57.9	49.2	63.7	19.8	2	166 Texas
Sorghum fodder	35.5	62.2	60.6	61.5	.....	3	166 Texas
Sudan grass	.....	.....	.....	.....	.....	.....	.....
Salt bush	66	52	8	49	.....	1	Mass.
Tabosa grass hay	20.0	37.0	54.5	50.4	19.9	2	166 Texas
Timothy grass	48	52	56	66	.....	1	Mass.
Timothy hay	48	50	50	62	39	24	Mass.
Turnips	73	.....	51	92	.....	.....	German
Vetch hay	67.6	55.2	56.4	72.6	44.1	.....	147 Texas
Wheat chops	74	71	.....	93	.....	.....	Mass.
Wheat bran	77	63	39	71	.....	4	Mass.
Wheat middlings	77	88	30	78	.....	2	Mass.
Wheat screenings	75	94	65	85	.....	1	Mass.
Wheat shorts	88	86	36	88	.....	2	Mass.
Wheat straw	23	31	50	37	.....	.....	German

Table No. 4. Average Digestible Protein and Productive Values.

	Digestible protein.	Productive value.
Alfalfa hay	11.04	8.18
Alfalfa meal	11.2	10.9
Alfalfa (green)	3.6	3.3
Bermuda grass	.....	.....
Bermuda hay	3.81	7.32
Barley chops	9.5	19.2
Brewer's grains	19.3	12.9
Burr clover	18.9	11.2
Buffalo grass hay	4.2	8.6
Corn bran	5.23	13.3
Corn chops	6.5	20.63
Corn and cob meal	5.1	18.1

Table No. 4. Average Digestible Protein and Productive Value.—Continued.

	Digestible protein.	Productive value.
Corn cob	0.4	10.1
Corn fodder, green	1.0	5.4
Corn fodder, dry (average)	2.25	7.0
Corn fodder (estimated 10 per cent water, Texas)	3.2	10.0
Corn silage	1.0	2.7
Corn shucks	0.4	9.6
Corn stover (average)	1.4	5.8
Corn stover (estimated 10 per cent water, Texas)	2.3	9.7
Cold pressed cottonseed	19.7	12.0
Cottonseed (whole)	13.3	17.9
Cottonseed meal (Texas average)	38.7	18.5
Cottonseed meal, Texas prime	37.3	18.1
Cottonseed, Texas choice	40.8	19.2
Cottonseed hulls	0.06	4.08
Cowpeas	19.3	18.6
Cowpea hay	10.0	9.5
Cowpea vines, green	1.8	2.2
Crimson clover, green	2.2	2.6
Cromson clover hay	10.5	9.4
Ear corn chops	6.3	16.3
Buffalo grass hay	4.2	8.6
Guam hay	4.3	8.3
Johnson grass (green)	1.3	2.2
Johnson grass hay	3.2	8.2
Kaffir corn chops	7.0	18.2
Kaffir head chops	6.36	16.3
Kaffir fodder	8.3	10.8
Milk (whole)	3.4	3.1
Milk (skimmed)	3.0	2.2
Mangels wurzels	1.0	1.4
Molasses (cane)	2.2	12.2
Millet (hay)	4.0	8.3
Milo chops	6.7	19.1
Orchard grass hay	4.9	7.9
Oats	9.0	14.4
Oats hay	4.2	7.7
Oat straw	0.8	7.0
Para grass hay	3.3	6.1
Prairie hay (Texas average)	.....	7.0
Peanut cake (cold pressed)	27.7	17.7
Peanut hay	8.5	12.1
Potatoes	0.9	4.1
Rice bran	7.88	17.2
Rice hulls	0.3	3.2
Rice polish	8.22	20.67
Rice straw	0.9	5.4
Red clover, green	2.9	3.9
Red clover hay	7.1	9.0
Sorghum silage	0.14	2.69
Sorghum and cowpea silage	0.53	3.6
Sorghum hay	3.9	9.7
Tabosa grass hay	0.7	5.7
Timotny grass	1.5	4.5
Timothy hay	2.8	8.8
Turnips	0.9	1.2
Vetch hay	12.0	10.2
Wheat chops	8.8	18.4
Wheat bran	12.5	12.0
Wheat shorts	15.1	18.9
Wheat straw	0.7	4.9
Whey	0.5	1.5

SUMMARY AND CONCLUSIONS.

This Bulletin contains a discussion of the composition of Texas feeds, their utilization, their values, the calculation of balanced rations, and tables showing composition, coefficients of digestibility, and feeding values.